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Effect of Particle Size of Starter Diet on Broiler Chicken Performance

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ABSTRACT

Background: This study was conducted to determine the effect of particles size of starter diet on growth performance of broiler chickens.

Methods: A total of 384 Arbor Acres broiler chicks were usedin a completely randomized design with three treatments and four replicates of 32 birds each.Birds were fed diets with 3 particles sizes of starter diet (T1: 1.0 mm; T2: 0.8 mm; T3: 0.7 mm) during the first week of life. At 7 d, the same starter diet was offered in a crumbled form until 10 d of age. Then, common grower and finisher diets were provided in a pelleted form. Body weight (BW), feed intake (FI), feed conversion ratio (FCR) and mortality rate were evaluated at 7, 14 and 42 days of age.

Result: The results showed thatchicks receiving diet with intermediate particles size (0.8 mm) had the higher BW at 7 and 14 d. The FCR was also improved (-6.25%; P<0.01) with the same diet at 7 days of age. No feed particle size effect for FIand mortality was observed throughout the 42 d trial. In conclusion, birds fed intermediate particles size (0.8 mm) diet showed better FCR and BW at starter phase. However, no significant effect was observed at slaughter age.

Key words: Broiler, Particles size, Performance, Starter diet, Starter phase.

INTRODUCTION

The feed particle size and physical form is considered to have a significant influence on feed consumption and growth performance of broilers (Dozier *et al*., 2010; Shabani *et al*., 2015). However, since the first week of life, birds are able to choose between different sizes of feed particles (da Silva Soares *et al*., 2020). Even at the age of four days, chicks were able to distinguish minor differences in particle size (Nir, 1997). This ability improves as the bird grows older (Nir *et al*., 1990).

Young birds prefer to eat brightly colored feed particles first and they will always exhibit preference for larger feed particles, regardless of particle composition (Oppong-Sekyere *et al*., 2012). Nir *et al*. (1994b) reported a preference for intermediate particle size (between 0.64 mm and 1.4 mm) during the first week of life, followed by a preference for particles higher than 1.14 mm at 21 days. However, birds will ingest little amounts of a food initially, but their preference will gradually change based on sensory and nutritional testing of the food (Nir *et al*., 1990). Any change in the feed structure could have a significant impact on performance by limiting or making some components unavailable (Dahlke *et al*., 2003).

The nutritional and physical properties of the feed must take into account the anatomical and physiological characteristics of the chicken digestive tract, especially during the first week of life. At this age, food sorting is triggered much more by particle size than by food composition (Wanters *et al*., 1997). However, relatively few studies have been conducted on the effect of particles size of starter diet on broiler chicken performance.

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Therefore, the objective of this study was to investigate the effects of particles size of starter diet on broiler chicken performance.

MATERIALS AND METHODS

The study was conducted in a commercial broiler farm (Salem Poultry Group, Biskra, Algeria) covering a total period from September 5 to October 16, 2021.

Broiler management

The experiment was carried out in a commercial broiler house, which was equipped with exhaust fans, cooling pads and forced-air heaters. A total of 384 one day-old Arbor Acres mixed-sex broiler chicks obtained from a commercial hatchery were used in the study. Initial body weights of the birds were taken and birds were randomly allocated to three starter diet treatments of different particle

sizes (T1, T2 and T3) with four replications of 32 birds each in a completely randomized design. Birds were reared in battery cages equipped with 6 nipple drinkers and 1 tube feeder. Each cage was 1.50 m in width, 2.4 m in length and 0.5 m in height. Water and food were distributed ad libitum throughout the rearing period. Temperature and ventilation are controlled via electronic controllers. Initial house temperature is 34°C and was then gradually reduced until a temperature of 20°C was achieved at slaughter age (42 d). The photoperiod was 23 h of light and 1 h of darkness (23L: 1D) throughout the experiment.

Feed preparation and experimental design

Broiler diets were formulated to meet Arbor acres guide nutrient requirements and differed only in particle size of starter diets (Table 1). These foods had the following nutritional characteristics: 3000 kcal ME/kg and 21% CP for the starter diet (1-10 days); 3100 kcal ME/kg and 20% CP for the grower diet (11-30 days) and 3150 kcal ME/kg and 18% CP for the finisher diet (31-42 days). The different diets ensured the requirements for essential amino acids and minerals of broilers.

All starter feeds were ground using an electric grinder and screened through sieves of different diameters. The particle size was determined by the method devised by the American Dairy Science Association (1970).

In this study, birds were fed starter diets with 3 particles sizes (T_1: 1.0 mm; T_2: 0.8 mm and T_3: 0.7 mm) during the first week of life. At 7 d, feeders were emptied and the same starter diet was offered in a crumbled form until 10 d of age. Common grower diets were provided in a pelleted form from 11 to 30 d and a common finisher diets were offered in pelleted form from 31to 42 d of age.

Measurements

Birds and feed were weighed to determine BW, FI and FCR at 1, 7, 14 and 42 d of age. Feed consumption was recorded by weighing residual feed for each replicate pen on a daily basis. FCR was calculated per pen by dividing feed intake (g) by body weight gain (g) and corrected for mortality. Mortality was recorded daily from 1 d until the end of the experiment.

Statistical analysis

A one-way analysis of variance (Anova) test was used to compare the means of the various parameters studied, followed by Tukey's test for pairwise comparisons between groups. Differences were considered significant at $P<0.05$. Statistical analysis was performed with SPSS version 22.0 for windows software.

RESULTS AND DISCUSSION

The starter diets with the intermediate particle size (0.8 mm) resulted in an improvement in BW (+5.5%; $P<0.03$) and FCR (-6.25%; $P<0.01$) at 7 d. This response was also observed on BW (+1.6%; $P<0.04$) with the same diet at 14 days of age. However, the overall effect of particle size on BW and FCR at 42 d was not different. There was no significant effect of particles size of starter diet in the case of FI recorded throughout the experimental period (Table 2).

The weight gain achieved at 07 days of age is one of the necessary conditions to optimize the technical and economic performance of broiler chickens (Michard and Rouxel, 2013). This effect can be related to the feed physical form, but also to the type of production envisaged. In the present study, the improvement observed in BW and FCR at 7 days of age was also reported by Ribeiro *et al*. (2004) with feed particle size close to 0.8 mm. Similarly, Mingbin *et al*. (2015) found feeding medium or coarse particle size diets caused a significant increase in broiler average daily gain and average daily feed intake during the starter phase. However, from 1 to 20 days of age, Roulleau *et al*. (2015) showed a positive effect of particle size and feed form on growth and FCR at starter phase and on slaughter weight. In contrary to our findings, Shirani *et al*. (2018) found no significant influence of particle size (500, 1000 and 1500 µm) on the BW of Ross 308 chickens at 10 days of age.

Table 1: The composition of the broiler starter, grower and finisher diet.

Item	Starter	Grower	Finisher
Corn	58.0	61.0	53.5
Soybean meal	32.0	27.5	25.0
Wheat bran	5.0	5.0	5.0
Vitamin-Premix	1.0	1.0	1.0
Dicalcium-phosphate	1.9	1.5	1.6
$CaCo_3$	0.9	0.8	0.7
Salt	0.2	0.2	0.2
ME (Kcal/Kg)	3000	3100	3150
Crude Protein (%)	21	20	18
Lysine (%)	1.1	0.9	0.7
Methionine (%)	0.42	0.38	0.35
Methi+Cyste (%)	0.85	0.83	0.78
Ca	1.2	0.85	0.65
P	0.75	0.55	0.50

Table 2: Effect of particles size of starter diet on growth performance of broilers.

Particles size performance	T_1 (1.0 mm)	T_2 (0.8 mm)	T_3 (0.7 mm)	P value
		1 d-7 d		
BW (g)	$163^{(b)}$±4	$172^{(a)}$±2	$166^{(b)}$±2	P<0.03
FI (g)	151±1	153±1	156±7	NS
FCR (g/g)	$1.28^{(b)}$	$1.20^{(a)}$	$1.30^{(b)}$	P<0.01
		1 d-14 d		
BW (g)	$449^{(b)}$±7	$456^{(a)}$±4	$448^{(b)}$±1	P<0.04
FI (g)	531±8	521±8	525±16	NS
FCR (g/g)	1.32	1.27	1.30	NS
		1 d-42 d		
BW (g)	2640±38	2665±36	2656±32	NS
FI (g)	4693±71	4751±84	4846±175	NS
FCR (g/g)	1.81	1.81	1.86	NS

[a.b]Means in the columns within same treatment with different superscripts differ significantly (P<0.05).

We also found that the particle size had no significant effect on BW and FCR at slaughter age (P>0.05) which is consistent with prior research (Mingbin *et al*., 2015).

Particle size of diet may have an impact on feed consumption and ingredient digestion as a result of changes in gastrointestinal tract structure and digestive secretions (Ribeiro *et al*., 2004). In the current study, no marked effect of FI on the overall period was noted (P>0.05). However, Nir (1997) found that 0.88 mm geometric mean diameter (GMD) diets were consumed more than 0.7 and 0.5 mm GMD diets. The particle size of feed has been shown to have an important role in regulating broiler intake, with smooth particles being preferred over finely ground or coarser particles (Nir *et al*., 1994a). Furthermore, Nir *et al*. (1990) reported that when young birds had a free choice of feed, they consume it according to its coarseness.

For the first week of life, Ribeiro *et al*. (2004) suggested a maximum GMD limit; particles larger than 0.80 mm may reduce bird feed intake. In the same line, Nir *et al*. (1994b) found a preference for intermediate particle size (between 0.64 mm and 1.4 mm) during the first week of life, followed by a preference for particles larger than 1.14 mm at 21 days. However, particles larger or smaller than the size of a bird's beak are difficult for them to consume (Moran, 1982; Dahlke *et al*., 2003).

The diet physical form is a tool to improve growth performance of broilers, especially FCR (Arce-Menocal *et al*., 2020). Our results showed that, at 7 day of age, an improvement in FCR was observed when birds were fed 0.8 mm particle size (P<0.01) compared to 0.7 and 1.0 mm particle size. In contrast to these findings, Amerah *et al*. (2008) observed an enhanced FCR of 1.58 vs. 1.62 when caged birds were given coarse (1164 µm) vs. medium (839 µm) particle sizes. However, Klein *et al*. (2015) reported that compared to large particles, a fine feed would be favorable to the acceleration of intestinal transit, motivating the deterioration of the FCR. The rate of passage of coarse feed particles through the gastrointestinal tract can also be slower than that of fine particles, allowing for more contact of dietary nutrients with digestive enzymes and intestinal villi, which improves digestion and absorption (Zaefarian *et al*., 2016; Siegert *et al*., 2018). In addition, feed particle sizes between 0.8 and 1 mm are favorable for gizzard development at 7 and 42 days of age (Ribeiro *et al*., 2004).

In broiler production (Labroie *et al*., 2013) as in other animal species (Picard *et al*., 2003), the first weeks of life have a crucial importance on the overall performance of the batch. The effects of starter diet on future performance, not only of broiler, but also of pullets and breeders have been well reported by Michard and Rouxel (2013). Bigot *et al*. (2001) reported that the feeding of very young chicks can have a lasting influence on their development and long-term performance. The composition of the starter diet has also been cited as a factor that can induce long-lasting metabolic changes with negative consequences on performance (Picard *et al*., 2003; Mahapatra *et al*., 2017; Srilatha *et al*., 2018). Also, feeding during the first days of life can have an impact on the early immune development of the young chick, giving it resistance and susceptibility to pathogens and achieving optimal performance (Bigot *et al*., 2001; Sohel *et al*., 2020; Boussaada *et al*., 2020).

CONCLUSION

The observations of current experiment demonstrated that particle size of starter diets improved broilers performance during starter period. At 7 days of age, particle size (0.8 mm) had a significant positive effect on BW and FCR. This response was also observed on BW with the same diet at the end of the starter phase (14 d). However, the particle size of starter diets had no effect on FI during all rearing period. No significant differences (p>0.05) were detected at slaughter age (42 days) for different particle sizes on BW and FCR.

Conflict of interest

All authors declare that they have no conflict of interest.

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