Plant Archives Vol. 20 No. 1, 2020 pp. 603-608 e-ISSN:2581-6063 (online), ISSN:0972-5210

EFFECT OF PELLET DIAMETER WITH DIFFERENCE LEVELS OF PROTEIN AND ENERGY ON BROILER CHICKEN PERFORMANCE

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Abstract

The objective of this study was determine the pellet diameter with different levels of protein and energy and their interaction on broilers performance in the grower and finisher period. A total of 480 unsexed 9 days' broiler chicks completely randomized design in a 2 × 2 × 2 factorial was used two pellet diameters (2 and 3mm) and (4 and 5mm) dies, two levels of energy (3000 and 2800 Kcal/Kg ME) and (3200 and 3000 Kcal/Kg ME) and two levels of protein (23% and 21% CP) and (21% and 19% CP) in grower and finisher diets respectively. In grower and finisher period the interaction between different pellet diameter with different levels protein and energy had significant ($p<0.05$) difference between treatments in weight gain, FCR and body weight, in grower period large pellet diameter had significant ($p<0.05$) improve performance however, the large pellet diameter in finisher period make a negative effect on body weight, moreover in both period high levels of protein and energy more effectiveness to improve performance. In the same time large pellet diameter and high levels of protein had significantly ($p<0.05$) increase mortality, the interaction between of the three categories had significant different between abdominal fat, gizzard weight and small intestine and their parts, but the main effect of small pellet diameter make to increase small intestine and their parts but reverse effect on abdominal fat.

Key words: pellet diameter; protein; energy; grower period; finisher period; broiler.

Introduction

Animal performance may be increased by thermo-mechanical treatments such us for example steam-pelleting. Processing parameters, ingredient source and level of moisture among other factors influence pellet quality and chemical changes during process the most. Pelleting process have limited possibility to chemically modify starches and possibly other feed components (Skoch *et al*., 1981; Perez and Oliva-Teles, 2002; Zimonja and Svihus, 2009). However, increase in operation temperature and moisture content, may increase level of the starch gelatinization during pelleting (Skoch *et al*., 1981). Choice of the equipment and screen size during grinding also has strong influence on the chemical changes of the feed components during feed processing (Svihus *et al*., 2004; Svihus *et al*., 2004a).

Energy and protein are two main nutrients that can affect all production parameters in broiler chickens (Collin *et al*., 2003; Kamran *et al*., 2008). These nutrients are the major factors that influence the cost of chicken diets. Lowering percentage of dietary protein and energy may be decreased the charge of diets and it is possible to achieve significant cost savings. Firman (1998) reported that it is possible to save five dollars per ton of feed by reducing the protein level in the diet of turkeys by one percent. In addition to reducing feed costs, the ability to lower crude protein in the diet can result in decreased nitrogen excretion (Kidd *et al*., 1996; Ferguson *et al*., 1998; Nahm, 2002; Namroud, *et al*., 2008), improved ability to cope with heat stress, and allow for the use of a greater variety of feedstuffs (Kidd *et al.,* 1996). The relationship between protein and energy requirements has been discussed by many researchers around the world. It is clear that protein requirements have little meaning unless energy requirements have been considered. Several workers have chosen to expressed these nutrient requirements in terms of protein and energy ratios. The objectives of the present study were to compare the performance of chicks fed diets using different pellet size dies with different levels of protein and energy in the grower period (10-24days) and finisher period (24-42 days) on broiler chicken performance.

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Materials and methods

The chicks were brought up to Poultry farm consisting of several separated rooms with an area of (2) m^2. A total of 480 ten days old broiler chicks (Ross-308), average chicks (average body weight 300 g) were used. Chicks were distributed randomly into 32 groups of 15 chicks in each pen. The chick's groups were assigned to eight treatments each four replicates. The measurements of temperature and humidity of the farm were taken at the height of 30-40cm from the ground by special electronic tools of measuring temperature and humidity. Environmental conditions during the rearing period were provided with brooders and adequate ventilation. The cages floors were covered by 5 cm deep dry litter. Chicks were feed with plastic chick tray feeder and plastic handing watering one day to ten days after that plastic hanging poultry feeder and automatic chicken watering system were used. The experimental design in grower and finisher period is show below.

Table 1: The experimental design in grower and finisher period.

Treat-ments	Grower period 10-24 days			Finisher period 25-42 days		
	Protein levels/ %	Energy levels/ Kcal/kg	Pellet diameter /mm	Protein levels / %	Energy levels/ Kcal/kg	Pellet diameter /mm
T1	23	3000	3	21	3200	5
T2	23	3000	2	21	3200	4
T3	23	2800	3	21	3000	5
T4	23	2800	2	21	3000	4
T5	21	3000	3	19	3200	5
T6	21	3000	2	19	3200	4
T7	21	2800	3	19	3000	5
T8	21	2800	2	19	3000	4

Results and discussion

Show table 2 and 3 the effect of pellet diameter, protein and energy levels and there interaction on body Wight, weight gain, feed intake and FCR of broiler chicken in grower and finisher period.

In grower period there were significant($p<0.05$) different in weight gain, body weight and FCR, On the same trend non-significant ($P>0.05$) difference in feed intake between treatments had offered different pellet diameter, energy and protein on growth performance. The main effect, pellet diameter on growth performance show that (3mm pellet diameter)

Table 2: The effect of pellet diameter, energy and protein and their interaction on body Wight, weight gain, feed intake and FCR of broiler chicken in grower period.

Treatment	Protein	Energy	Pellet size	Grower			
				Weight gain	FCR	Feed intake	Body weight
1	23	3000	3	862.73±13.67a	1.35±0.02d	1167.27±29.774^{a}	1106.06±29.77^{ab}
2	23	3000	2	835.86±28.28ab	1.43±0.04cd	1195.57±49.160^{a}	1121.59±15.15^{a}
3	23	2800	3	813.98±9.79ab	1.46±0.01bc	1185.00±10.785a	1068.18±15.08a^{b}
4	23	2800	2	737.89±17.67c	1.53±0.05abc	1128.93±29.763a	1038.64±30.72^{c}
5	21	3000	3	826.82±9.87ab	1.46±0.01bc	1204.77±11.838a	1047.73±19.77^{c}
6	21	3000	2	761.45±24.20c	1.56±0.02a	1186.29±24.690a	1040.91±38.99^{c}
7	21	2800	3	788.06±15.25bc	1.26±0.03ab	1201.02±9.914a	1036.36±14.37^{c}
8	21	2800	2	762.96±8.23c	1.50±0.02abc	1145.00±15.857a	1014.77±8.97^{c}
Main effect							
pellet diameter:							
Pellet 3mm				812.82±10.18a	1.44±0.02a	1169.19±12.20a	1073.01±24.11a
Pellet 2mm				784.61±21.11b	1.51±0.01b	1184.27±20.22a	1041.20±15.30b
Protein levels:							
23%				821.61±20.34a	1.45±0.01a	1189.51±10.16a	1079.26±12.81a
21%				775.72±15.77b	1.51±0.04b	1163.95±30.27a	1039.95±30.09b
Energy levels:							
3000				822.89±34.20a	1.51±0.03a	1188.48±20.48a	1081.25±14.10a
2900				774.57±25.11b	1.45±0.01b	1164.99±19.27a	1032.96±30.72b
P value							
Pellet diameter				0.034	0.004	NS	0.026
Protein levels				0.001	0.018	NS	0.003
Energy levels				0.001	0.011	NS	0.001

a,b,c Means in the same column followed by different letters are significantly different at (p d" 0.05); NS, not significantly; SEM, Standard error of mean.

significant (p<0.05) improve all parameter compared to (2mm pellet) without feed intake, furthermore 3mm pellet diameter improve feed intake but not statistically improved. Also effect of high level of protein and energy were significantly (p<0.05) improve weight gain, body weight and FCR.

In finisher period the effect of main effects, pellet diameter, protein and energy levels had non-significant (P>0.05) effect on body Wight, weight gain, feed intake and FCR only A significant effect of pellet diameter was observed for body weight, however had significant (p<0.05) deferent in interactions of treatments without feed intake, These results were obtained the same results with most of researcher were worked in this field, one of the effects of pellet feed efficiency is reduction in feed energy used for maintenance therefore, improved productive energy (Nir *et al*., 1994). High intact pellet weight means less time, physical activity and energy expended to pick the same amount of feed, more nutrients per unit of feeding energy spent (Scheideler, 1991; Jones *et al*., 1995), more energy available for growth (Jensen *et al*., 1962) and better feed efficiency this explanation are suitable for discuss my result because small and large pellet size had same clarification, Also Jones *et al*., 1995), mentioned increasing pellet diameter not only enhances pellet quality but also increases intact pellet weight Although not conclusive, based on the current results, it may be considered that a high pellet quality were improved feed per gain but rather the actual weight of pellet which may reduce maintenance energy and divert more energy for productive purposes. On the other hand, Some researcher had different belief about increase pellet diameter, as increasing the pellet diameter and pellet length was also associated with significant improvements in pellet durability index and pellet hardness, it may be hypothesized that harder and more durable pellets tend to remain longer in the digestive tract and provide better chance for substrates to mix with digestive enzymes. Stevens (1987) reported higher degree of gelatinization in the outer portion of the pellet compared to the whole pellet. He suggested that frictional heat and mechanical shear generated next to the surface of the die hole were responsible for the substantial degree of gelatinization this stat take place in small pellet diameter. Therefore, it is plausible that using a die with small diameter holes may enhance frictional forces and provide more heat

Table 3: The effect of pellet diameter, energy and protein and their interaction on body Wight, weight gain, feed intake and FCR of broiler chicken in finisher period.

Treatment	Protein	Energy	Pellet size	Grower			
				Weight gain	**FCR**	**Feed intake**	**Body weight**
1	21	3200	5	1759.54±62.24b	1.582±0.034ab	2784.94±127.652a	2880.00. ±91.10.^{ab}
2	21	3200	4	1827.95±40.42ab	1.528±0.051bc	2788.48±62.255a	2920.000±25.00^{ab}
3	21	3000	5	1810.45±47.18ab	1.504±0.015bc	2722.04±56.221a	2890.00±29.44^{ab}
4	21	3000	4	1940.00±40.20a	1.484±0.029bc	2876.93±32.722a	2940.00±94.52^{a}
5	19	3200	5	1816.36±83.44ab	1.509±0.027bc	2736.90±96.832a	2905.00±62.45^{ab}
6	19	3200	4	1814.09±63.59ab	1.477±0.019c	2681.35±112.250a	2830.00±95.22^{ab}
7	19	3000	5	1708.63±47.88b	1.674±0.038a	2856.83±69.072a	2745.00±45.46^{b}
8	19	3000	4	1746.14±16.86b	1.511±0.045bc	2638.29±89.356a	2770.00±36.87a^{b}
Main effect							
pellet diameter:							
Pellet 5mm				1834.49±43.22a	1.54±0.22a	2793.10±76.89a	2812.50±55.40b
Pellet 4mm				1771.30±33.11a	1.52±0.10a	2728.34±87.45 a	2907.50±40.12a
Protein levels:							
21%				1804.49±54.87a	1.53±0.02a	2773.52±32.22a	2865.±25.22a
19%				1802.31±47.65a	1.52±0.01a	2747.12±22.34a	2855±34.66a
Energy levels:							
3200				1832.04±76.43a	1.57±0.04b	2775.18±21.11a	2883±56.55a
3000				1773.75±45.65a	1.50±0.03a	2746.27±32.56a	2836±66.33a
P value							
Pellet diameter				NS	NS	NS	0.048
Protein levels				NS	NS	NS	NS
Energy levels				NS	0.031	NS	NS

a,b,c Means in the same column followed by different letters are significantly different at (p d" 0.05); NS, not significantly; SEM, Standard error of mean.

Table 4: The effect of pellet diameter, energy and protein and their interaction on gizzard, abdominal fat and mortality of broiler chicken in finisher period.

Treatment	Gizzard	abdominal fat	Mortality %
T1	1.05±0.11^{Ab}	0.68±0.04^{BC}	12.00±6.45a
T2	1.106±0.08^{Ab}	0.71±0.16^{BC}	9.00±4.08b
T3	1.02±0.08^{A}	0.55±0.13^{C}	6.00±2.88bc
T4	1.21±0.11^{A}	0.99±0.17^{AB}	4.00±5.00cd
T5	1.05±0.08^{Ab}	1.26±0.30^{A}	2.00±2.88de
T6	1.02±0.17^{Ab}	0.97±0.19^{B}	0.00±0.00e
T7	0.91±0.18^{b}	0.86±0.183^{B}	0.00±0.00e
T8	0.91±0.15^{b}	1.13±0.19^{Ab}	0.00±0.00e
Main effect			
pellet diameter:			
Large diameter	1.09±0.10a	1.05±0.10a	8.22±a
Small diameter	0.97±0.09a	0.72±0.07b	0.57±b
Protein levels:			
High levels	1.06±0.11a	0.90±0.15a	5.95±a
Low levels	1.01±0.89a	0.88±0.12a	2,84±b
Energy levels:			
High levels	1.06±0.12a	0.94±0.13a	5.35±a
Low levels	1.00±0.99a	0.84±0.12a	4.41±a
P value			
Pellet diameter	NS	0.022	0.001
Protein levels	NS	NS	0.012
Energy levels	NS	NS	NS

a,b,c Means in the same column followed by different letters are significantly different at (p d” 0.05); NS, not significantly; SEM, Standard error of mean.

transfer and gelatinization to the core of the pellet. Moreover, according to Löwe (2005) and Miladinovic and Svihus (2010), the most sensitive part of the pellet is the surface of the break resulting from cutting the pressed and extruded feed into cylindrical pieces. It seems plausible that using small diameter die holes through increasing, and possibly uniformly distributed, starch gelatinization and longer pellet lengths through decreasing the number of sensitive breaks (Löwe, 2005), may have an additive effect on pellet quality Higher starch gelatinization content in small pellet diameter grower pellets compared to pellets large pellet diameter in current study was as expected and is in agreement with study by Heffner and Pfost (1973) who reported that reducing the pellet diameter can produce more starch gelatinization.

Show table 4 the effect of pellet diameter, energy , protein and there interaction on gizzard, abdominal fat, and mortality of broiler chicken in whole period. The interaction between treatments had offered different pellet diameter, energy and protein were significant($p<0.05$) different in all parameter were mentioned. The main effect of large pellet diameter significantly ($P>0.05$) increase abdominal fat and mortality also non-significantly ($P>0.05$) affected on gizzard, the main effects of protein and energy levels not significant effect on all parameters without high levels of protein significantly ($p<0.05$) increase mortality. In general, large pellet diameter increases abdominal fat. In terms of activity, different pellet diameter induces a profound adjustment of the feeding behavior in that broilers don't spend equal time at the feed trough consuming either small and large pellet diameter. Also chickens ate large pellet diameter at a significantly slower rate (number of pecks per second feeding time) than small pellet diameter. Besides spending less time at the feed trough large pellet diameter birds spends more time resting than those small pellet, the increase rest saves energy, which can be used for growth. One of the disadvantages of the increase rest is that large pellet-fed birds are fatter than small pellet-fed birds. In recent years there has been a lot of concern about excess fat deposition in broilers. May these result it is true for large and small pellet diameter. Moreover, technical parameters of pelleting process, such as pellet diameter and the gap between the rollers and pellet die, may potentially influence the final particle size. There is very limit or not research about pellet diameter in whole period of broiler. Many researchers are agree with that, digestive tracts parts such as gizzard influence by size of grinding or size of row material According to Nir and Ptichi (2001), the relative gizzard weight was positively correlated to feed particle size, but grinding in current study had same particle size, therefore not deferent between treatment had deferent pellet diameter. In birds fed mash diets with coarsely ground particles, digesta were retained for longer in the gizzard along with greater gizzard development (Nir *et al.*, 1994a; Hetland and Svihus, 2001; Engberg *et al.*, 2002). To make pellet feed you should be grinding raw material very fine to agglomeration in pellet process, there four deferent pellet diameter do not make change in gizzard size as shown in my current result. about increase mortality, it have not enough information to discuss this results high mortality caused by large pellet diameter compared to small pellet diameter, may high mortality induce by large pellet diameter had recorded caused by ascites, it may cause by high energy as a results show that broilers don't spend equal time to fed the equal amount of feed to consuming small and large pellet diameter same, thus more energy in diet have reverse effect on normal body physiology and health or may large pellet diameter decrease intestine PH, therefore some type of ascites makes by E.coli observed that infection plays an important role in the production of ascites in the field. (Julian *et al.*, 1989).

Table 5: The effect of pellet diameter, energy and protein and their interaction on duodenum, jejunum, ileum and small intestine of broiler chicken in finisher period.

Treatment	Duodenum	Jejunum	ileum	Small intestine
T1	0.42±0.04^{C}	0.89±0.09^{ABC}	0.79±0.04^{ABC}	2.10±0.05^{A}
T2	0.44±0.04^{BC}	0.69±0.03^{CD}	0.81±0.06^{AB}	1.94±0.08^{AB}
T3	0.37±0.04^{C}	0.63±0.06^{D}	0.66±0.05^{BC}	1.66±0.14^{BC}
T4	0.45±0.02^{ABC}	0.75±0.08^{CD}	0.62±0.12^{C}	1.83±0.21^{BC}
T5	0.46±0.01^{ABC}	0.85±0.05^{BC}	0.77±0.03^{ABC}	2.09±0.04^{BCD}
T6	0.45±0.05^{ABC}	0.83±0.06^{BCD}	0.74±0.04^{BC}	2.02±0.14^{CD}
T7	0.55±0.07^{AB}	1.00±0.06^{AB}	0.82±0.04^{AB}	2.56±0.13^{CD}
T8	0.57±0.03^{A}	1.06±0.10^{A}	0.93± 0.03a	2.36±0.16^{D}
Main effect				
pellet diameter:				
Large diameter	0.42±0.01b	0.74±0.03b	0.72±0.02b	1.88±0.08b
Small diameter	0.51±0.02a	0.94±0.06a	0.82±0.04a	2.26±0.11a
Protein levels:				
High levels	0.48±0.03a	0.81±0.04a	0.78±0.04a	2.04±0.13a
Low levels	0.44±0.02a	0.86±0.05a	0.76±0.07a	2.10±0.12a
Energy levels:				
High levels	0.48±0.01a	0.84±0.03a	0.76±0.05a	2.05±0.10a
Low levels	0.45±0.02a	0.83±0.01a	0.78±0.02a	2.08±0.09a
P value				
Pellet diameter	0.007	0.002	0.045	0.001
Protein levels	NS	NS	NS	NS
Energy levels	NS	NS	NS	NS

a,b,c Means in the same column followed by different letters are significantly different at ($p \leq 0.05$); NS, not significantly; SEM, Standard error of mean.

Show table 5 the effect of pellet diameter, energy, protein and their interaction on duodenum, jejunum, illume and small intestine of broiler chicken in whole period. The interaction between treatments had offered different pellet diameter, energy and protein were significant($p<0.05$) different in all parameter were mentioned, although the main effect of pellet diameter had significant ($P<0.05$) effect on all traits, on the other hand other two main effects had non-significantly ($P>0.05$) affected on small intestine and their parts.

Data in my our study show that large pellet diameter improve intestine parts it had not clear reason for this development, some researcher had different belief about increase pellet diameter, as increasing the pellet diameter and pellet length was also associated with significant improvements in pellet durability index and pellet hardness, it may be hypothesized that harder and more durable pellets tend to remain longer in the digestive tract and provide better chance for substrates to mix with digestive enzymes, However, no information about the passage rate of the increased pellet size has been reported. Our data indicated that large pelleting the diet increased flow rate and decreased retention time of the food in the digestive tract. The rate of feed passage through the gastrointestinal tract influences nutrient utilization by determining the time available for nutrient interaction with digestive enzymes, absorptive surfaces, and microbial populations (Rao and Clandinin, 1970; Mateos and Sell, 1980). The mechanism of decreased retention time of a pelleted diet may be similar to The large pellet diameter its fact more consumption means increase flow rate the whole or unground feed ingredients. Hetland and Svihus (2001) found that addition of coarsely ground oat hull increased feed retention time due to the fact that particles will remain in the gizzard until the particles were broken down to a certain size (Svihus *et al.*, 2002). Also Duke (1986) stated that peristaltic movement in the intestine is influenced by gizzard contraction. This theory suggests that faster contraction of the gizzard will increase the contraction of the intestine and thus decrease the passage time of digest in the intestine. the stimulation of gut motility is an important effect of coarse particles (Sacranie, 2006) and has been hypothesized to improve intestinal strength due to greater muscular activity related to reverse peristalsis (Xu *et al.*, 2015).

Conclusion

In conclusion, increase pellet diameter in grower period for10 to 24 d of age had significantly higher body weight and better feed conversion than birds fed the small pellet, however in finisher period generally pellet diameter had versus effect on performance. On the other hand, large pellet diameter had significant effect on small intestine and their parts, gizzard, mortality and abdominal fat at the end of the experiment. High protein and energy levels had significant effect on all traits were measured in grower period but not effect in finisher period. In general interaction between factors had significant different between all traits.

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