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Research Article
Effect of Feed Form and Water Addition on Growth Performance of Finishing Broilers in a Hot Humid Environment

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Abstract

Background and Objective: High temperature and humidity are major challenges to poultry production in tropical countries. Several feeding strategies have been found to alleviate the effect of heat stress (HS) in poultry. This study aimed to ascertain the effects of feed physical form and water addition on the performance of finishing broilers in a hot humid environment. **Materials ans Methods:** A total of 180, three-week old, Cobb 500 broilers (1,207.8±22.09 g) were used for a 3-week study. Two forms of feed (whole pellet and ground pellet) were fed with 3 water: feed ratios (0; control, 0.15 and 0.3) to 3 replicates of 10 birds each in a completely randomized design. **Results:** Results showed lower feed intake and better feed conversion ratio on whole pellet compared to ground pellet ($p<0.05$). Water addition and feed form had no effects on the relative weights of carcass, breast, thighs, drumsticks, organs (liver, crop, proventriculus, small intestine, caeca, gizzard and pancreas) and digesta content of gut segments ($p>0.05$). There were no interaction effects of feed form and water addition on growth parameters and the relative weights of carcass, organ and digesta in the gut segments. **Conclusion:** Feeding pellet is beneficial in term of feed utilization but wet feeding has no effects. Further studies on higher feed: water ratios and environmental temperatures are recommended.

Key words: Feed technology, growth performance, heat stress, tropical environment, wet feeding

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Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Despite the rapid increase in demand of poultry products in developing tropical countries, climatic factors such as high temperatures are major impediments to increased poultry production in these regions. In the tropics, temperatures are almost always above the comfort zone of poultry. As temperatures are projected to further increase with changing climate, the effect of heat stress (HS) on poultry will be more pronounced. The effects of HS on poultry are diverse and include reduced feed consumption, growth, egg production and high mortality. Several feeding strategies have been reported to minimize the effect of HS on poultry. Forbes[1] reported a significant improvement in feed intake and growth performance of broilers fed wet mash under high temperatures. The improved performance with wet feeding has been attributed to higher dry matter intake[2], growth stimulation[1] improved nutrient digestibility and utilization[3-6], palatability and increased rate of digesta passage through the gastrointestinal tract[2,3]. There is literature on the feeding of pellet vs. dry or wet mash[7], dry mash vs. wet mash[2,8-12] and dry pellet vs. wet pellet[4] but there is dearth of information about the effect of feeding of pellet and mash at different water: feed ratios on broiler performance. This study compared the effect of feeding whole pellet and ground pellet to mash with different water: feed ratios on broiler performance in a hot humid environment.

MATERIALS AND METHODS

Feed processing: A commercial broiler finisher pellet purchased from Main Feed in New Zealand was divided into two parts. One part was left as pellet while the other was ground in a hammer mill to pass through a 2 mm sieve to obtain ground pellet. Water was added to the feed at increasing levels to test the ratio of water addition that will keep the pellet intact (not disintegrated) after 6 h. After ascertaining this ratio to be 0.3 (water: feed) the feeds (whole and ground pellets) were treated each with water at the ratios of 0 (control), 0.15 and 0.3 (water: feed). The experiment was laid in a 2×3 factional arrangement of treatments (2 feed forms and 3 water: feed ratios).

Experimental birds and management: A total of 180, 20 days-old Cobb broilers were used for the experiment. This age was chosen because HS is more a problem in the finisher than starter broiler. Birds were weighed and assigned to 18 open-sided floor pens (238×109 cm) of similar weights (1,207.8±22.09 g). Each of the 6 dietary treatments was fed to 3 pens containing 10 birds in a completely randomized design. Feed and drinking water were supplied *ad libitum* for a period of 22 days (20-42 days). The Animal Ethics Committee of the University of the South Pacific approved the experimental protocol.

Data collection: Data were collected on growth performance (feed intake, weight gain and feed conversion ratio), carcass traits, gut measurements and organ weights. Known quantities of feed were fed and the leftover weighed the next day to account for feed consumption by difference. Weight gain was monitored by weekly weighing and feed conversion ratio was calculated as the ratio of feed consumed to weight gained. Relative humidity and temperature were recorded twice daily (morning and afternoon) with a combined digital thermometer/hygrometer and the daily means were calculated. At the end of the trial, 1 bird having the closest weight to the mean of the pen was fasted overnight and slaughtered the next morning for carcass and internal organ weight measurements. Slaughtered birds were scalded in hot water (about 57°C) for 2 min, plucked manually and eviscerated. Eviscerated chickens were then dressed and dressing percentage was calculated as the weight of hot carcass divided by the live weight and multiplied by one hundred. Carcass cut up parts (breast, thigh and drumstick) were also weighed and expressed as per cent live weight.

Segments of the gut (crop, proventriculus, gizzard and caeca) were weighed full and empty to account for digesta weight by difference. Empty weights and digesta weights were expressed as percentages of the live weight of the bird. The weights of liver, pancreas, heart and abdominal fat were also expressed as percentages of the live weight of the bird.

Statistical analysis: Data were subjected to the two-way factorial analysis of variance[13] using SPSS (SPSS for windows, version 22.0; IBM Corp., Armonk, NY, USA). Pen was the experimental unit for feed intake and weight gain whereas carcass, organ and gut data were collected on individual birds. Treatment differences were compared using the least significant difference (LSD) test and significant differences reported at 5% probability.

RESULTS

During the experimental period the average temperature and relative humidity were 29.75°C (28-31.5°C) and 66.5% (60-73%) respectively. The growth performance results

Table 1: Influence of feed form and water addition on growth performance of broiler Chickens (20-42 days post hatch)

	Performance parameters			
Treatments feed form	Water: feed	Feed intake (g)	Weight gain (g)	FCR
Ground pellet	0.00	2468.00	1498.00	1.650
	0.15	2409.00	1473.00	1.600
	0.30	2426.00	1516.00	1.600
Pellet	0.00	2216.00	1606.00	1.400
	0.15	2385.00	1787.00	1.300
	0.30	2271.00	1504.00	1.500
SEM[1]	65.30	161.30	0.13	
Main effects				
Ground pellet		2440.00[a]	1461.00	1.680[a]
Whole pellet		2910.00[b]	1633.00	1.450[b]
Water		2366.00	1547.00	1.500
SEM[1]		37.70	93.10	0.700
Probabilities				
Feed form		0.02	0.20	0.040
Water		0.70	0.90	0.900
Feed *water		0.20	0.40	0.600

[1]Standard error of the mean, [a,b]Means in the same column with different superscripts differ significantly ($p<0.05$)

Table 2: Influence of feed form and water addition on relative weight of carcass and cuts (%slaughter weight) of 42 day-old broiler chickens

Treatments feed form	Water: feed	Carcass	Breast	Thigh	Drumstick	Abdominal fat
Ground pellet	0.00	74.000	28.300	12.600	9.000	1.840
	0.15	76.000	25.000	14.800	11.300	1.900
	0.30	72.900	24.400	13.300	12.000	2.400
Whole pellet	0.00	79.000	26.700	15.700	13.000	1.900
	0.15	74.200	23.600	9.500	9.500	2.600
	0.30	73.600	20.700	11.500	10.300	1.8.00
SEM[1]	2.02	2.910	1.710	1.900	0.400	
Main effects						
Ground pellet		74.300	25.900	13.600	10.800	2.000
Whole pellet		75.700	23.660	12.200	11.000	2.000
Water		75.400	24.800	12.800	10.900	2.200
SEM[1]		1.400	2.000	1.200	1.300	0.300
Probability						
Feed Form		0.400	0.300	0.900	0.400	0.900
Water		0.300	0.400	0.900	0.500	0.600
Feed *water		0.900	0.900	0.200	0.300	0.300

[1]Standard error of the mean

(Table 1) showed no significant interaction effects of feed form and water: feed on feed intake, weight gain and feed conversion ratio (FCR) of the broilers ($p>0.05$). The main effects showed significantly higher feed intake and poorer FCR ($p<0.05$) on ground pellet compared to whole pellet. There were no significant interaction or main effects of feed form and water addition ($p>0.05$) on any of the carcass traits measured (Table 2). Similarly, the weights of organs and the digesta content of the gut segments were not affected ($p>0.05$) by feed form, water addition or their interaction (Table 3 and 4).

DISCUSSION

The thermal comfort zone of broilers ranges from 18-22°C[14]. The mean temperature during the experimental period was 29.75°C (28-31.5°C) with a humidity of 61% (49-73%). Environmental temperatures above 30°C have been reported to affect feed intake, body weight gain and feed conversion efficiency[15]. The intake of both feed forms in this study is lower than the value (4,786 g) reported for broilers at 42 days of age[16].

In the main effect ground pellet fed birds consumed more feed than those fed whole pellet. This finding is in agreement with those of Ahmed and Abbas[17] who recorded increased feed intake in 42-day-old broilers given coarse mash compared to pellet. Contrary to our findings however[18-21], recorded lower feed intake of birds fed on mash compared to pellet. Bolukbasi *et al.*[22] and Agah and Norollahi[23] observed that feed form has no effect on weight gain, feed intake and FCR. Lal and Atapattu[24] did not also record any significant difference in feed intake between ground pellet to mash and

Table 3: Relative weight of organ (% slaughter weight) of broiler chickens fed ground or whole pellet with different feed to water ratios

Treatments feed form	Water: feed	Liver	Crop	Proventriculus	Small intestine	Caeca	Gizzard	Pancreas
Ground pellet	0.000	1.900	0.300	0.300	2.300	0.510	1.300	0.140
	0.150	2.300	0.300	0.340	2.300	0.420	1.000	0.140
	0.300	2.300	0.430	0.500	2.200	0.410	0.800	0.160
Pellet	0.000	2.100	0.420	0.400	2.400	0.420	1.200	0.180
	0.150	2.000	0.420	0.300	2.100	0.450	0.900	0.140
	0.300	2.000	0.350	0.370	2.100	0.430	1.200	0.170
SEM[1]	0.165	0.030	0.030	0.240	0.040	0.100	0.020	
Main effect								
Ground pellet		2.200	0.340	0.310	2.300	0.450	1.000	0.150
Pellet		2.100	0.400	0.350	2.200	0.430	1.100	0.160
Water		2.000	0.400	0.300	2.400	0.400	1.080	0.160
SEM[1]		0.100	0.020	0.020	0.140	0.020	0.060	0.010
Probability								
Feed form		0.409	0.056	0.522	0.719	0.617	0.278	0.271
Water		0.498	0.510	0.549	0.760	0.493	0.016	0.338
Water *feed		0.307	0.016	0.224	0.860	0.289	0.087	0.393

[1]Standard error of the mean

Table 4: Relative weight of digesta (% slaughter weight) in the gut segments of 42 day-old broiler chickens

	Digesta content of gut segments (% slaughter weight)					
Treatments feed form	Water: feed	Crop	Proventriculus	Small intestine	Caeca	Gizzard
Ground pellet	0.000	0.060	0.010	0.200	0.210	0.300
	0.150	0.010	0.010	0.400	0.220	0.200
	0.300	0.100	0.020	0.500	0.200	0.020
Pellet	0.000	0.100	0.040	0.200	0.140	0.400
	0.150	0.500	0.020	0.400	0.260	0.200
	0.300	0.060	0.010	0.500	0.280	0.300
SEM[1]	0.042	0.010	0.100	0.100	0.200	
Main effect						
Ground pellet		0.050	0.010	0.300	0.200	0.200
Pellet		0.700	0.020	0.400	0.200	0.300
Water		0.150	0.010	0.370	0.200	0.270
SEM[1]		0.040	0.010	0.100	0.040	0.100
Probability						
Feed form		0.636	0.293	0.825	0.142	0.368
Water		0.395	0.613	0.081	0.578	0.345
Feed*water		0.602	0.171	0.938	0.736	0.665

[1]Standard error of the mean

whole pellet. Some researchers have shown that feeding ground, mash and whole pellet results in similar growth performance[23,24]. Hull *et al*. (1968) cited in Behnke and Beyer[25] observed that birds fed whole pellet had a 5% better FCR compared to those fed ground pellet. Sell *et al*.[26] also observed a 5.6 and 7.6% increase in feed intake and weight gain, respectively in pellet fed compared to mash fed broilers. These authors attributed improved performance to facilitated prehension of the compact pellet. In the present study, both feed underwent the same initial processing (pelleting). It appears therefore, that differences in performance on mash and pellet may not be due to feed form *per se*. It is also possible that modification of feed physical structure improved the digestibility and hence, the growth performance on pellet. Parsons *et al*.[27] observed an increased intake on mash than pellet and attributed this to excessive feed wastage. Although not measured in the present study there was no noticeable feed wastage in any of the treatments. The improved performance on whole pellet over ground pellet may be attributed to several factors including palatability, reduced energy for consumption and reduced selective feeding as observed in previous studies[7,28]. During the experiment the poorest FCR was recorded on ground pellet. Similar to our results Howlider and Rose (1992) cited in Jahan *et al*.[19] observed that pelleting improved FCR by 5.9%. Even at high altitude poorer FCR was also observed in mash compared to pellet fed birds[29].

Water addition to the feed has been reported to improve performance in broilers at normal and high temperature[3,8,10,30-34]. In the present study, water addition to the feed had no effects on the performance parameters measured. Results of the current study are in line with those of

Emadinia *et al.*[6] but contrary to these findings, Awojobi *et al.*[9] and Awojobi and Meshioye[35] recorded improved feed intake, weight gain and FCR in birds fed wet compared to dry mash. Syafwan *et al.*[36] reported a 22% reduction of feed intake on wet compared to dry mash. From the lack of significant effects of water addition on the growth parameters in this study it could be speculated that (1) The effect of wet feeding is temperature dependent and may not be pronounced below 30°C and (2) Lower water to feed ratios may not have beneficial effects at this temperature. Mortality recorded in the experiment was not traceable to any treatment effects.

Modern broilers have been selected for greater carcass and breast yields and lower fat deposition[37]. The effects of feed form[7,38-41] and wet feeding[3,9,35] on carcass traits have been studied. Farghly *et al.*[7], Ahmed and Abbas[17] Beg *et al.*[38], Mirghelenj and Golian[42], found that the relative weights of carcass, thigh, breast, drumsticks and abdominal fat were not affected by feed form. In an earlier study, Sarvestani *et al.*[43] reported higher carcass, breast, thigh and abdominal fat weight on pellet compared to mash. Nizza *et al.*[40] also reported higher carcass and abdominal fat in pellet over mash. Several factors including nutrition, temperature and relative humidity may all affect carcass traits in broilers.

The effects of feed form and wet feeding on organ weights have not been consistent. Akinola *et al.*[11], Afsharmanesh *et al.*[12], Awojobi and Meshioye[35] reported significant effects of wet feeding on organ weights. Similar to these findings, Farghly *et al.*[7] also observed no effects of feeding pellet, dry or wet mash on organ weights. Awojobi *et al.*[9] and Uchewa and Onu[44] also observed no effects of wet feeding on organ weights in broilers and cockerels, respectively. Contrary to our results however, Yasar[45] reported lower gizzard weight in wet feeding and attributed this to the slow tissue development in the proventriculus and gizzard. The similarity in organ weights in this study may be reflective of the feeds used which had the same physiochemical characteristics as both underwent similar processing (pelleting) initially.

There were no effects of feed form and water addition on the weight of digesta in any of the gut segments observed. Digesta transit time is an important factor affecting its weight in the gut. Feed composition, especially fiber content is known to influence digesta transit through the gastrointestinal tract[2]. Pelleting is also reported to reduce digesta viscosity[46]. Wetting the feed mainly cereal grains caused a reduction in digesta viscosity[5]. The similarity in the digesta weight in this study suggests that the feeds must have transited at the same speed through the gastrointestinal tract due to the similarity in the composition and the initial processing (pelleting) method.

CONCLUSION

Adding water to whole pellet or ground pellet to mash has no beneficial effects on weight gain, carcass traits and organ weights of finishing broilers at temperatures up to 29°C. Feeding whole pellet reduces feed intake and improves feed conversion ratio compared to ground pellet. In the light of these findings, it is recommended that further studies be conducted on higher water: feed ratios, broiler age and environment temperatures as well as ingredients composition and feed processing conditions.

SIGNIFICANCE STATEMENT

This study shows that feeding whole pellet is beneficial in term of feed utilization compare to wet feeding. This study will help researchers to assets the most suitable water: feed ratio that would be effective at high temperature and humidity for finishing broilers.

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