Liquid and solid wheat starch in diets for broilers: effect on feed intake, foregut development and performance

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Abstract

A study was carried out to quantify the effect of solid and/or liquid wheat starch diets in a choice feeding system on feed intake, foregut development and performance of broilers. One-day-old male broiler chickens were randomly allocated to three treatments with six pens of 6 birds each. Within each pen, broilers had access to two feeders filled with the liquid experimental diet (EE treatment), the solid control diet (CC treatment) or the experimental and control diet in each of the feeders (EC treatment). Birds that had access to the liquid diet (as sole diet or in a choice) showed an increased appetite (higher feed intake), resulting in an improved BW gain, however, without affecting FCR's. A small ratio between weights of proventriculus and gizzard was evident in the liquid feeding strategy. It is suggested that the moistening capacity of the crop ('swallowing') during the first few weeks post-hatch in a standard solid diet could be a limiting factor for an optimal functioning of the foregut.

Introduction

The physical and functional development of the gastro-intestinal tract (GIT) of broiler chickens is related to diet structure (Nir and Ptichi, 2001). This relationship initiates the search for feed technological treatments and/or practical feeding methods that supports GIT development. Many studies reported dietary factors that change the size and rate of development of digestive organs, such as type of cereals (Jamroz et al., 1992), enzyme supplementation (Brenes et al., 1993), grinding/pelleting (Nir et al., 1995), feeding of wet or dry feed (Yasar et al., 1997), as well as the inclusion of whole grain into diets (Jones and Taylor, 2001).

The foregut segment, which is the focus of this study, plays an important role in digestive processes; it involves the mechanical and chemical changes of the ingested feed before the nutrients will be absorbed in the small intestines. Mechanical changes include swallowing, maceration and grinding of feed in the gizzard; chemical digestion includes the secretion of enzymes and mucus from the crop, proventriculus and pancreas, bile from the liver, as well as some bacterial activity in the crop (Duke, 1994). Wet feeding might be a promising feeding strategy, particularly during certain age-intervals of broilers life (Yasar et al., 1997).

This study was carried out to quantify the effect of solid and/or liquid wheat starch diets in a choice feeding system on feed intake characteristics, foregut development and subsequent performance of broiler chickens.

Materials and Methods

A total 108 one day-old male broiler chickens were housed in 18 floor pens, 6 birds in each pen. All birds were provided feed and water *ad libitum*. Temperature was initially set at 32ºC for a few days and thereafter gradually reduced to a constant temperature of 18ºC at 6 weeks of age. Artificial light was provided at schedule of 23L:1D.

Birds were allocated randomly to 3 treatments with 6 replicates each. The control diet (C) was a commercial formulated diet with a 38.3% inclusion of solid wheat starch, and with wheat (13.3%), maize (29.6%) and toasted full far soybeans (20.0%) as main ingredients. In the

experimental diet (E), solid wheat starch was replaced by liquid wheat starch (22.3%). Both diets were complete diets. Chickens in each pen had access to 2 feeders containing both the experimental liquid diet (EE), the control solid diet (CC) or the control and experimental diets (EC), respectively.

The feeders were filled three times daily (*ad libitum*) during the first 2 weeks (9AM, 12AM and 7PM) and twice daily during the last 4 weeks (9AM and 7PM).

Results

The results on technical performance and GIT development are shown in Table 1 and 2, respectively.

Table 1: Effect of solid and/or liquid diets in a choice feeding system on feed intake (on a dry matter basis), BW gain and FCR (g/bird)

Period (days of age)	Traits	Treatment				
		CC	EC	EE	Diet selection in EC	
					E	C
3 - 21	BW gain (g/day)	51.2[a]	57[b]	52.4[a]		
	Feed intake (g/day)	60.5[a]	68[b]	59.4[a]	33.8[a]	34.2[b]
	FCR	1.18	1.19	1.13		
22-42	BW gain (g/day)	101.8[a]	109.4[b]	107.4[b]		
	Feed intake (g/day)	146.2[a]	166.6[b]	159.2[a]	126.2[a]	40.4[b]
	FCR	1.44	1.52	1.48		
slaughter	Final BW (g)	3137[a]	3425[b]	3280[c]		

Means in the same row (treatment and division) with different superscripts are significantly different ($P<0.05$)

EC birds had significantly higher body weight gain and feed intake than both other groups during the first three weeks. No differences in FCR could be observed in this period. From 22 to 42 days of age, both EC and EE groups showed larger BW gains and slightly increased FCR. Again, FCR differences were not statistically significant. Final BW of the EC birds (fed the choice between liquid and solid wheat starch) was significantly higher than in both other groups.

Table 2. Effect of solid and/or liquid diets in a choice feeding system on empty organ weights of individual male broiler chickens killed at days 46 or 47.

Organs	Treatment		
Absolute fresh weight (g)	CC	EC	EE
Crop	18.1	18.8	17.0
Proventriculus	9.41	8.81	8.60
Gizzard	33.0	33.0	36.5
Duodenum	14.1[a]	14.9[ab]	15.3[b]
Relative fresh weight (g per kg BW)			
Crop	5.34	4.97	4.61
Proventriculus	2.76[a]	2.32[b]	2.35[b]
Gizzard	9.88	8.68	10.00

Duodenum	4.17	3.93	4.18

Means in the same row with different superscripts are significantly different (P<0.05)

Diet selection of choice fed chickens (EC) is also given in Table 1. From day 3 to 8, birds consumed significantly more diet C than diet E (data not shown) but this was counterbalanced in the subsequent period (8 – 21 days); surprisingly, birds consumed significantly more from diet E than from diet C in the period 22 to 42 days.

There were hardly significant differences in organ weights between the 2 days of post mortem examination. Therefore, data were pooled. With regard to the development of the foregut, all three treatments had no clear effect on the fresh weight of these organs, except for the duodenum. Although non-significant, a solid diet (C) seems to result in a large proventriculus and a small gizzard, whereas a liquid diet (E) shows the opposite.

Relative empty weight of the proventriculus was significantly higher in CC birds compared to birds of both EC and EE. Other (obvious) differences in relative weight of organs between the treatments were not statistically different, due to large variations in the data.

Conclusions

It seems that birds that had full access to the liquid diet (as sole diet or in a choice feeding system) show an increased appetite, resulting in an improved BW gain, however without affecting FCR's. A better development of the proventricular-gizzard system (i.e., a small ratio between weights of proventriculus and gizzard) seems to be in favour in a liquid feeding strategy. It is suggested here that the moistening capacity of the crop ('swallowing') during the first few weeks post-hatch in a standard solid diet could be a limiting factor for an optimal functioning of the foregut.

Further research will be directed to the functional use of liquid feeding strategies during early life of broiler chickens.

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