METABOLISM AND NUTRITION

Factors Affecting Pelleting Response. 1. Influence of Dietary Energy in Broiler Starter Diets

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ABSTRACT Commercial day-old broiler cockerels were fed to 28 days of age to study the influence of dietary energy level on the effectiveness of the pelletized-crumbled process. Corn-soybean meal-meat protein diets were formulated to contain calculated levels of either 3100, 3150, or 3200 kcal metabolizable energy (ME)/kg of diet and fed in mash or crumbled form in three separate experiments. Dietary energy fed at 3100 to 3200 kcal ME/kg of diet, irrespective of feed form, resulted in no differences in mean body weight and feed consumption. Heavier body weights resulted from feeding a crumbled diet compared to an all-mash diet when the dietary energy level was 3150 kcal ME/kg of diet. Body weights were similar among feed forms when dietary energy levels were 3100 and 3200 kcal ME/kg of diet.

The feed:gain was reduced .088, .078, and .042 in diets that contained 3100, 3150, and 3200 kcal ME/kg of diet, respectively, by feeding crumbled pellets as compared to all-mash diets. Toxic factors, such as soybean meal trypsin inhibitor, were not excessive.

(*Key words:* pelleting, dietary energy, broilers, environmental temperatures)

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INTRODUCTION

Patten *et al.* (1937) reported that chicks fed pelleted rations gained more weight and consumed less feed than chicks fed unpelleted rations. Since this research, many researchers have shown the benefit of steam pelleting broiler, turkey, and laying hen diets (Heywang and Morgan, 1944; Bearse *et al.*, 1952; Dymsza *et al.*, 1955; Lanson and Smyth, 1955; Allred *et al.*, 1957; Pepper *et al.*, 1960; Bayley *et al.*, 1968; Waldroup and Payne, 1974; White and Balloun, 1977). Very few reports (Eley and Bell, 1948; Stewart and Upp, 1951) have shown negative results from steam pelleting.

Reddy *et al.* (1962) reported that apparent metabolizable energy values of some feedstuffs are increased by steam pelleting. In contrast, McIntosh *et al.* (1962) and Sibbald (1977) found that steam pelleting did not change the apparent and true metabolizable energy values of the diets. Diets reported by Sibbald (1977) appeared to be very high in dietary energy reported as true metabolizable energy, although the compositions of diets were not reported. Bayley *et al.* (1968) and Summers (1975) observed that steam pelleting had the most marked effects when the feedstuff contains either high levels of fiber or heat labile growth depressants.

Although the general consensus is that pelleting improves broiler performance, the reason or reasons for the improvement is not fully understood. Bearse *et al.* (1952) reported that chickens fed pelleted high, but less than 18%, fiber rations were heavier than those fed high corn, low fiber rations in mash form. Dietary energy was not reported and may not have been isocaloric. Dymsza *et al.* (1955), using rations containing 5, 10, and 15% fiber, showed that pelleting and crumbling concentrated the nutrients and counteracted some of the adverse effects of low energy diets when fed to poults. Allred *et al.* (1957) concluded that a large part of the increased growth and improved feed efficiency obtained by pelleting may be due to some chemical change, possibly the inactivation of a growth inhibitor in a ration. A growth response to pelleting was obtained even when the pellets were ground to a particle size and density similar to the original mash.

Pepper *et al.* (1960) found that pelleting exerted a sparing effect on the energy re-

[1] Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the US Department of Agriculture and does not imply its approval to the exclusion of other products that may be suitable.

quirements of chicks and poults. Essentially equivalent weights and feed efficiencies were obtained when high energy mash diets supplemented with fat and lower energy pelleted diets with no added fat were fed. Sibbald *et al.* (1960) observed a linear relationship between the concentration of nutrients per unit volume of feed and the weight gains of chicks. They concluded that the influence of nutrient density on weight gain might help to explain the improvement in feed utilization brought about by pelleting.

Feed manufacturers are currently questioning the feasibility and profitability of pelleting as compared to feeding all-mash diets. High fossil fuel cost is forcing reevaluation of the pelleting process. Experiments were conducted to determine the relationship of dietary energy, pelleting, and broiler performance in 1- to 28-day broiler diets.

EXPERIMENTAL PROCEDURE

A total of 576 commercial one-day-old broiler cockerels (Arbor Acre × Arbor Acre) were housed in battery brooders with raised wire floors and electrically heated batteries. The brooding temperatures were 30 C during the first week, 27 C during the second week, 24 C during the third week, and 21 C during the fourth week. Newcastle and bronchitis vaccines were administered shortly after hatching. Each experimental diet was fed to four lots of 8 broiler chicks from one day to 28 days of age in three separate experiments.

The corn-soybean meal diets consisted of two feed forms (mash and crumble), and three dietary energy levels (3100, 3150, and 3200 kcal ME/kg diet) with all combinations constituting six diets.

Experimental diets are shown in Table 1. Dietary lysine and sulfur-containing amino acids (methionine plus cystine) were held constant at 1.20 and 1.02%, respectively. All other nutrients except dietary energy were added to meet or to exceed the National Research Council (1977) requirements for poultry.

Diets were mixed and one-half of each diet was pelleted, cooled, and crumbled; the remaining feed was left as a mash form. Pelleting was accomplished by steam heating feed to 80 C and pelleting through a 4.76 mm opening (64 mm bore length) in a 40 H.P. Master Model California Pellet Mill.[1] Corn was ground to pass a 3.2 mm mesh screen.

Broiler chicks were weighed individually at 28 days of age and feed consumption determined for the 1- to 28-day test period. Statistical examination was performed using the

TABLE 1. *Composition of diets used to determine the effect of feed form and dietary energy on broiler performance from 1 to 28 days of age*

Ingredient	Dietary metabolizable energy, kcal/kg 3100	3150	3200
	(%)		
Yellow corn	62.27	60.95	59.95
Soybean meal (48.5%)	27.22	27.32	27.14
Animal Protein Pack (60%)[1]	5.00	5.00	5.00
Animal fat (7716 kcal/kg)	2.64	3.85	5.00
Dicalcium phosphate (18.5% Ca, 22% P)	1.04	1.05	1.06
Limestone	.72	.72	.72
Salt	.41	.41	.41
Broiler trace element premix[2]	.25	.25	.25
Methionine hydroxy analogue-Ca, 93%	.35	.35	.35
L-Lysine-HCl, 93%	...	...	...
Coban[3] (50 g/ton)	.10	.10	.10
Total	100	100	100
Calculated analysis:			
Metabolizable energy, kcal/kg	3100	3150	3200
Crude protein, %	21.60	21.54	21.38
Total lysine, %	1.20	1.20	1.20
Total methionine + cystine, %	1.02	1.02	1.02
Calcium, %	.90	.90	.90
Available phosphorus, %	.45	.45	.45
Sodium, %	.20	.20	.20

[1]The animal protein pack (Pro-Pak) was made by a combination of menhaden fish meal, poultry byproduct meal, and poultry offal meal to produce a consistent 60% protein meat meal.

[2]The broiler premix furnished the following amounts of other ingredients per kilogram of feed: vitamin A, palmitate, gelatin coated, 6614 IU; vitamin D_3, 1654 ICU; vitamin E, 2.2 IU; riboflavin, 4.4 mg; niacin, 27.6 mg; d-pantothenic acid, 8.8 mg; folic acid, 275.6 μg; vitamin B_{12}, 8.8 μg; choline chloride, 551 mg; ethoxyquin, 55 mg; menadione sodium bisulfite complex, 2.8 mg or menadione sodium bisulfite, 1.7 mg; pyridoxine, .55 mg; manganese, 66.25 mg; zinc, 44 mg; iodine, 1.25 mg; iron (in sulfate form), 20 mg; copper (in sulfate form), 2 mg.

[3]Trade name for monensin, a coccidiostat, Elanco Products Co., El: Lilly & Co., Indianapolis, IN.

TABLE 2. *Composite data showing the effect of feed form and dietary energy on body weights and feed consumption*

Metabolizable energy	1- to 28-day results					
	Feed consumption			Body weight		
	Mash	Crumble	Mean	Mash	Crumble	Mean
(kcal/kg)	(g/day)			(g)		
3100	46.54	45.44	45.99	834[b]	863[ab]	848
3150	46.41	46.29	46.35	845[b]	888[a]	866
3200	46.70	44.76	45.73	868[ab]	856[ab]	862
Mean	46.55	45.50		849	869	

[a,b]Means within a measurement and without a common superscript are significantly different (P<.05).

analysis of variance (Steel and Torrie, 1960) in a split-plot arrangement. Significant differences among means were separated using Duncan's multiple range test (1955). Significance was determined at the 5% level of probability.

RESULTS AND DISCUSSION

Diets that contained 3100 to 3200 kcal ME/kg of diet resulted in statistically (P>.05) equivalent body weights (Table 2). Broilers that consumed a crumbled diet with 3150 kcal ME/kg of diet weighed more (P<.05) than broilers that consumed a mash diet with the equivalent dietary energy. No statistical differences were found in body weights due to feed form when either 3100 or 3200 kcal ME/kg of diet was fed.

Feed consumption (Table 2) was unchanged by either dietary energy level or feed form. The interaction of feed form and dietary energy level was not significantly different (P<.05). Lindblad *et al.* (1955) observed a growth response to pelleting without an increase in feed consumption. In contrast, Hussar and Robblee (1962) found that 49-day-old broilers fed pellets consumed 15% more feed and gained 25% more weight with a feed conversion that was 10% lower than those fed the same ration in mash form. Body weights cited in this report do not substantiate such findings.

As previously reported by McNaughton and Reece (1982), dietary energy level inversely affected feed efficiency (Figure 1) when protein levels remained unchanged.

The most important factor that a nutritionist and feed mill has to consider is the question of whether to pellet or use other available means of maximizing bird performance. Figure 1 shows graphically the relationship between pelleted and mash diets with various dietary energy levels using feed efficiency as the criteria. Pelleting the ration that contained 3100 kcal ME/kg of diet resulted in statistically equivalent (P<.05) feed utilization values as compared to diets containing either 3150 or 3200 kcal ME/kg of pelleted diet. Furthermore, pelleting improved the feed efficiency by a magnitude of .088 with 3100 kcal ME/kg; .078 with 3150 kcal ME/kg; and .042 with 3200 kcal ME/kg as compared to feeding broilers an all-mash diet. With the inclusion of high energy diets the advantage of pelleting a ration appeared to be replaced.

The trypsin inhibitor level of the 48.5% protein soybean meal was 7 μg trypsin inhibited per milligram of protein, and the urease value was .09 pH; therefore, the soybean meal used in

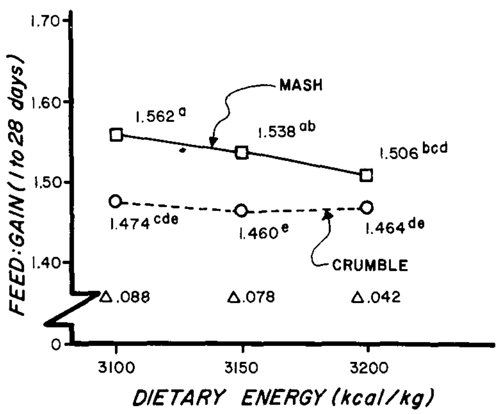

FIG. 1. Composite results of all experiments showing the influence of dietary energy on the effectiveness of pelleting.

this study appeared to be of good quality. In contrast to reports by Hussar and Robblee (1962), feed consumption did not change appreciably (P<.05) due to the diet being pelleted and crumbled, but pelleting the ration resulted in slightly lower feed consumptions. Therefore, the most likely explanation of improved broiler performance due to the pelleting process is a combination of slightly higher growth, slightly lower feed consumption, and possibly increased utilization of available nutrients, particularly dietary energy furnished by the carbohydrate sources. McIntosh *et al.* (1962) and Sibbald (1977), however, found that a steam pelleted complete ration did not change the apparent or true metabolizable energy, respectively. Hussar and Robblee (1962) also found that pelleting did not influence apparent feed metabolizable energy or energy retention.

In contrast, Reddy *et al.* (1961) reported that pelleting a complete ration resulted in a marked increase in productive energy content. Also, Sibbald (1977) reported pelleting increased the true metabolizable energy values of wheat and barley. Corn was not tested by Sibbald (1977).

Therefore, there is continued controversy as to why pellets improve broiler performance. The results in our studies indicate that pelleting and subsequent crumbling of broiler chick starting rations will improve feed efficiency. Advantages of a pelleted chick starter diet may be reduced or eliminated by increased dietary energy. Because high energy diets are more expensive, an economical evaluation must be made to determine the profitability of pelleting *versus* the use of high energy diets.

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