# Self-Selection of Dietary Protein and Energy by Broilers Grown Under a Tropical Climate: Effect of Feed Particle Size on the Feed Choice

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**ABSTRACT** Broilers, 2 wk of age, that had been previously adapted to energy:protein choice feeding, were offered corn (either ground, cracked, or presented as whole grains) and a protein concentrate (43.7% CP) in mash or pellet form. When corn was fed as whole grains, protein concentrate in the selected diet was significantly higher (35.1%) than with cracked corn (29.3%) or ground corn (29.1%). Presenting the concentrate as pellets resulted in a significantly higher concentration in the diet (32.7%) than when mash concentrate was fed (29.6%). Live BW at 4 and 6 wk of age were not significantly affected by feed texture. However, offering corn as whole grains or concentrate as pellets induced a significant improvement in feed efficiency.

Total time to eat larger size particles (whole grains, pelleted concentrate) was significantly less than total time to eat ground corn or mash concentrate. Furthermore, the mean duration of the feeding bouts was two times shorter for whole grains (48 s) than for ground corn (98 s) and for pelleted concentrate (56 s) than for mash concentrate (114 s). Chickens ate whole grains or pellets at a significantly slower rate (number of pecks per second feeding time) than when eating ground corn or mash concentrate. There was a rejection during the first 24 h when the form of the concentrate (mash to pellets) was changed. Full adaptation to the new size of the concentrate required about 3 d.

(*Key words*: broiler, feed selection, feed particle size, feeding behavior, tropical climate)

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## INTRODUCTION

Choice feeding systems with whole cereal grains and protein concentrate may have potential for poultry production under tropical climates. Offering free choice diets allows individuals opportunity to select the foods needed for maintenance and production and may increase efficiency over that when fed a single diet (Emmans, 1978; Robinson, 1985) allowing for a better adaptation to high environmental temperatures (Cowan and Michie, 1978a). Furthermore, economic advantages could be expected from reduced handling costs and not having to grind grains (Petersen, 1976; Cumming, 1994). Studies conducted on free choice feeding of poultry have resulted in conflicting conclusions. Under certain conditions, growing broilers given simultaneous access to a high protein feed and a high carbohydrate feed were able to compose diets that yielded growth equivalent to that of controls receiving a complete diet (Mastika and Cumming, 1987; Shariatmadari and Forbes, 1993; Yo *et al.*, 1994). In other studies, chickens under choice situations failed to adequately adjust their feed intake and had poorer growth performances than those having a complete diet (Cowan and Michie, 1978b; Scholtyssek, 1982; Sinurat and Balnave, 1986).

There is a need for knowledge on factors that influence a bird when selecting its diet under a choice situation (Hughes, 1984). To date, choice feeding experiments have been based mainly on the proposition of Emmans (1978), who suggested that the feed intake in the choice situation depends on the nutrient requirements of the animal and the feed composition, with little consideration for other factors. Factors such as sensory characteristics of diets (smell, taste, texture), which are unrelated to the nutrient composition, however, may have key roles in nutrient intake and regulation. In a choice feeding experiment with broilers, Rose *et al.* (1986) offered wheat, either whole or ground, and a complementary diet, either pelleted or as mash. They observed that although physical forms of the cereal and compliment fractions and their interactions had an effect on diet selection, there was no effect on total feed intake or weight gain. Karunajeewa and Tham (1984) indicated that pullets given whole grains ate more protein concentrate and grew faster than those given crushed grains, although there was no difference in total intake.

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McArthur and Blundell (1986) observed in rats that the selection of protein and carbohydrates was markedly altered by the physical form of the diet (powder, granular, or gel). They suggested that intake of certain nutrients was not strictly regulated at a particular value and could probably be allowed to fluctuate between upper and lower limits.

The experiment reported in this paper was designed to measure the effect of particle size of corn (ground, cracked, whole) and protein concentrate (pellet, mash) on feed choice and growth of broilers raised under an energy:protein choice situation. Data were also obtained on the feeding behavior of the broilers (time budget, feeding bouts, pecking rate) under these conditions.

## MATERIALS AND METHODS

Commercial broilers (Hubbard) were wing-banded and assigned to 18 floor pens (two rows of nine pens) measuring 6 $m^2$ each. There were 20 broilers (n = 360) in each pen. For the experimental design, the pens were divided into three blocks with three pens from each of the two rows forming one block. Litter was rice hulls and lighting was continuous. During the 1st wk, temperature in the pens was maintained at 32 to 35 C using electrical heaters. Thereafter, room temperature varied from a low 23.6 1.3 C to a high 29.2 1.8 C.

### *Pre-Experimental Period*

During the first 2 wk (1 to 14 d), chicks in all pens were adapted to self-selection feeding, consisting of an energy-rich feed (ground corn) and a protein-rich feed (protein concentrate presented in mash form). The protein concentrate was based on soybean meal and fish meal (Table 1). It was formulated by removing the corn part from the complete diet formula. Feed in each pen was provided in two troughs, one with corn and the other with protein concentrate. Positions of the troughs were the same in each pen and remained unchanged during the entire experimental period. Free access to feed and water was allowed through this period. At 14 d of age, birds were individually weighed.

### *Experimental Period*

***Procedures.*** The experimental period started when the broilers were 14 d old. Six dietary treatments were assigned to pens in each of the three blocks, i.e., each treatment was replicated three times. The six dietary treatments consisted of corn presented in three physical forms (ground, cracked, whole) associated, on a choice basis, to the protein concentrate presented in two physical forms (mash, pellets). Therefore, six different associations of corn and protein diet were tested: 1) ground corn + mash concentrate, 2) ground corn + pelleted concentrate, 3) cracked corn + mash concentrate, 4) cracked corn + pelleted concentrate, 5) whole corn + mash concentrate, and 6) whole corn + pelleted concentrate. However, for treatments with whole corn, cracked grains were mixed with whole grains during the first 5 d of the experiment (80% whole grains + 20% cracked grains) in order to allow the chicks to adapt to the ingestion of the whole grains. Although the six treatments were nutritionally equivalent, they varied in the texture of the two feeds offered. The protein concentrate used during the experimental period was the same as that used during the first 2 wk (Table 1).

After mixing the different ingredients (Table 1), the whole protein concentrate obtained was pelleted. One part was used as pellets and it constituted the treatment called *pelleted concentrate.* The other part was ground again and was named *mash concentrate.* This procedure of pelleting and regrinding was adopted to eliminate any effect directly related to the pelleting process (Carré *et al.*, 1987). Corn was either finely ground (ground corn), or coarsely ground (cracked corn), or fed as whole grains (whole corn). The mean particle sizes of the different feeds were measured using standard testing sieves.[2] For the protein concentrate, the mean diameter of the particle was 0.356 mm for mash, 4.0 mm for pellets. Respective means for corn particles were 0.783 and 2.898 mm for ground and cracked grains.

### *Measurements*

During the 1st wk (15 to 21 d), feed consumption was measured daily by weighing each feeder. For the remaining period (22 to 42 d), feed consumption was

**TABLE 1. Composition and calculated nutritive value of the protein concentrate and the corn used during the experiment**

| Ingredients and content | Protein concentrate | Corn |
|---|---|---|
| | (%) | |
| Corn | | 100.00 |
| Soybean meal | 67.85 | |
| Fish meal | 25.00 | |
| Premix[1] | 6.00 | |
| Dicalcium phosphate | 1.00 | |
| DL-methionine | 0.15 | |
| Nutrient contents, calculated | | |
| Metabolizable energy, kcal/kg | 2,348 | 3,345 |
| Crude protein | 43.73 | 8.0 |
| Lysine | 2.93 | 0.23 |
| Methionine | 0.91 | 0.18 |
| Methionine + cystine | 1.51 | 0.40 |
| Calcium | 3.50 | 0.02 |
| Available phosphorus | 1.27 | 0.05 |

[1]Composition of 1 kg premix: phosphorus, 48 g; calcium, 240 g; NaCl, 154 g; vitamin A (retinyl palmitate), 760,000 IU; cholecalciferol, 98,000 IU; vitamin E (dl-$\alpha$-tocopheryl acetate), 1,200 IU; vitamin $B_1$, 16 mg; vitamin $B_2$, 210 mg; d-pantothenic acid, 600 mg; vitamin $B_6$, 30 mg; vitamin $B_{12}$, 1 mg; niacin, 1,200 mg; menadione, 150 mg; folic acid, 30 mg; choline chloride, 17,700 mg; coccidiostat, 6,000 mg; bacitracin zinc, 250 mg; cobalt, zinc; manganese; iron; selenium.

[2]AFNOR NFX 11-501, Association Française de Normalisation, 92049 Paris La Defense cedex, France.

measured weekly. Broilers were individually weighed at 14, 28, and 42 d of age.

Beginning at 30 d of age, time budgets were monitored on 2 consecutive d. A scan sampling technique (Martin and Bateson, 1986) was used to measure the percentage of time that chicks allotted to four activities: 1) eating (corn or concentrate), 2) drinking, 3) resting, and 4) other activities when standing on the litter that were neither eating nor drinking. A chick was assumed to be eating or drinking when, at the moment of the observation, its head was in the through or in the drinker. Each pen was scanned hourly from 0600 to 2400 h. At each passage of the observer at a given pen, the number of chicks in each activity was recorded and related to the total number of individuals in the pen. Observations repeated on the 2 consecutive d were pooled for each pen and each hour. The percentage of chicks eating a given feed in a pen was assumed to be equivalent to the mean percentage of time that each individual in the pen spent eating this feed. Additionally, the feeding bout duration and the number of pecks given at the feed during a feeding bout were measured for each feed using a behavioral observation package (Observer 3.0) edited by Noldus Information Technology (1993), which permits an accurate time-related recording. For that purpose, an adequate configuration was defined to allow the recording of precise time of the beginning and of the end of a feeding bout and the number of pecks given at the feed meanwhile (Yo *et al*., 1997). During an observation the observer recorded the beginning and the end of a feeding bout and each peck by typing on specific keys of the portable computer defined by the configuration. The pecking rate (number of pecks per second of feeding) was calculated by dividing the total number of observed pecks given during a feeding bout by the duration (in seconds) of the feeding bout. For each feed, 30 feeding bouts were recorded.

### Statistical Analysis

Data related to production performances (weight gain, feed intake, feed efficiency) and time budgets were submitted to a two-way ANOVA with texture of corn (three levels), texture of concentrate (two levels), and the interaction between them as main effects. Prior to analysis, percentages were transformed to arc sine square roots. Treatment means were compared using Newman and Keuls test. Data related to bout duration, peck number, and pecking rate were tested for overall heterogeneity using Kruskall-Wallis one-way analysis of variance followed by mean comparisons using Mann-Whitney test. Significance was at $P < 0.05$.

## RESULTS

### Feed Intake, Feed Selection, and Growth Performances

Feed intake and choice, growth performances, and feed efficiencies are presented in Table 2. Over the experimental period (15 to 42 d), the intake of corn was significantly influenced by the grain texture but not by the form of the associated concentrate. Chickens feeding on whole corn had a lower corn intake (73.3 g / d) than those fed cracked (87.1 g / d) or ground corn (84.1 g / d). Similarly, the intake

**TABLE 2. Body weight, weight gain, feed intake, feed choice, and feed efficiency of birds fed corn and mash or pelleted protein concentrate during the experimental period (15 to 42 d)**

| | Ground corn | | Cracked corn | | Whole corn | | ANOVA[1] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | Mash | Pellets | Mash | Pellets | Mash | Pellets | M | C | M C | Residual SEM |
| Live weight 14 d, g | 335 | 315 | 328 | 330 | 332 | 336 | NS | NS | NS | 8 |
| Live weight 28 d, g | 921 | 960 | 969 | 903 | 936 | 972 | NS | NS | NS | 21 |
| Live weight 42 d, g | 1,738 | 1,798 | 1,792 | 1,804 | 1,803 | 1,804 | NS | NS | NS | 44 |
| Mean weight gain, g / d | 50.1 | 52.5 | 52.2 | 53.1 | 52.6 | 52.2 | NS | NS | NS | 1.4 |
| Feed intake[2] per day | | | | | | | | | | |
| Corn, g | 83.3 | 84.9 | 88.6 | 85.6 | 73.5 | 73.1 | *** | NS | NS | 3.4 |
| Concentrate, g | 31.3 | 39.0 | 34.0 | 37.7 | 34.8 | 43.5 | NS | *** | NS | 2.5 |
| Total feed, g | 114.6 | 123.9 | 122.5 | 123.3 | 108.4 | 116.6 | * | * | NS | 4.3 |
| Concentrate, % | 27.3 | 31.7 | 28.4 | 30.3 | 33.1 | 37.1 | *** | *** | NS | 0.9 |
| ME, kcal | $350^{b}$ | $376^{a}$ | $379^{a}$ | $375^{a}$ | $330^{c}$ | $348^{b}$ | *** | ** | * | 0.9 |
| Crude protein, g | $20.7^{d}$ | $24.4^{a}$ | $22.5^{bc}$ | $23.9^{ab}$ | $21.7^{cd}$ | $25.4^{a}$ | NS | *** | * | 0.8 |
| Feed efficiency[3] | | | | | | | | | | |
| Feed conversion ratio | 2.27 | 2.30 | 2.33 | 2.33 | 2.07 | 2.23 | *** | * | NS | 0.06 |
| Protein conversion ratio | $0.41^{c}$ | $0.45^{b}$ | $0.43^{bc}$ | $0.45^{b}$ | $0.42^{c}$ | $0.48^{a}$ | NS | *** | * | 0.08 |
| Energy conversion ratio | 6.98 | 6.96 | 7.13 | 7.10 | 6.26 | 6.63 | *** | NS | NS | 0.13 |

[a–d]Means within a row with no common superscript differ significantly ($P < 0.05$).

[1]Main effects of the ANOVA M = texture of corn; C = texture of protein concentrate.

[2]Per bird per day.

[3]Feed conversion ratio, protein conversion ratio, and energy conversion ratio were calculated by dividing, respectively, the total feed intake (grams), the total crude protein intake (grams), and the total ME intake (kilocalories) during the period 15 to 42 d by the weight gain (grams) during the same period.

**TABLE 3. Effects of changing the physical forms of the feeds on the intake during the first 24 h**

| | Ground corn | | Cracked corn | | Whole corn[1] | | ANOVA[2] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Feedstuff | Mash | Pellets | Mash | Pellets | Mash | Pellets | M | C | M | C | Residual SEM |
| | (g/bird/d) | | | | | | | | | | |
| Corn | 32.5 | 32.0 | 35.0 | 25.7 | 12.1 | 26.7 | NS | NS | NS | | 7.6 |
| Protein concentrate | 16.8 | 2.4 | 27.0 | 0.01 | 23.0 | 0.3 | NS | *** | NS | | 5.2 |

[1]A mixture of 80% whole corn and 20% cracked corn was used for the first 5 d of the experimental period.
[2]Main effects of the ANOVA; M = texture of corn; C = texture of protein concentrate.

of the concentrate was significantly affected by its particle size, but not by the form of the associated corn. Presenting protein concentrate as pellets induced a higher intake (40.1 g/d) than when mash concentrate was fed (33.4 g/d). There was no significant interaction between corn texture and concentrate texture for intake of corn and intake of concentrate. Total feed intake was lower for whole corn + mash concentrate and ground corn + mash concentrate than for the other combinations.

For the experimental period (15 to 42 d), feed choice (percentage of concentrate or percentage of corn in the ingested diet) was significantly affected by particle size of corn and concentrate. There was no significant interaction between the physical aspects of the two feeds offered on choice for the effective diet selection. Presenting protein concentrate as pellets resulted in a higher proportion of concentrate in the selected diet (33.0%) than when mash concentrate was fed (29.6%). When corn was presented as whole grain, the percentage of concentrate in the diet was higher (35.1) than for cracked (29.4) or ground corn (29.5), which did not differ from each other.

Live BW at 4 and 6 wk of age and weight gain from 15 to 42 d were not significantly affected by the texture of the two feeds offered, whereas feed conversion (grams of feed:grams of weight gain) was affected by corn and concentrate texture. Feeding whole grains significantly decreased the feed conversion ratio (2.15) in comparison with cracked (2.33) or ground corn (2.28). The difference between cracked and ground corn was not significant. Treatments with pelleted concentrate had a significantly lower feed conversion ratio than those with mash concentrate (2.22 vs 2.29).

## *Short-Term Adaptation to Different Particle Size*

Short-term effects of changing the form of feed on the feed intake are presented in Table 3. Changing the particle form of the protein concentrate after 2 wk of adaptation (from mash to pellets) drastically reduced the intake of the protein diet during the first 24 h after the change. Although broilers essentially rejected the concentrate presented in the new form during this period, they gradually increased their intake of the new feed and equalized the intake of those fed the mash form after 3 d of adaptation (Figure 1). In contrast, changing the form of corn (ground corn to cracked corn or ground corn to whole corn) had no significant effect on the intake of corn during the first days. This was probably because chicks actually received during this adaptation period (the first 5 d of experiment) a mixture of cracked corn and whole corn.

## *Influence of Feed Particle Size on Feeding Behavior*

Table 4 presents time-budgets according to the dietary treatments. Total time allocated to the eating activities was significantly influenced by the physical form of the feed. Broilers receiving whole corn spent only 4.1% of their total time at this feeder, whereas those fed ground corn spent 8.5% of their time at the corn feeder. Pelleting the protein diet also reduced the eating time from 9.7% for mash concentrate to 5.9% for the pelleted form. Diet form did

**TABLE 4. Effect of feed form on the time budgets of 30-d-old chickens: percentage of the total time allocated to different activities (eating corn, eating concentrate, drinking, resting or other activities)**

| | Ground corn | | Cracked corn | | Whole corn | | ANOVA[1] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Behavior | Mash | Pellets | Mash | Pellets | Mash | Pellets | M | C | M | C | Residual SEM |
| | (%) | | | | | | | | | | |
| Eating corn | 8.30 | 8.71 | 7.93 | 7.80 | 4.50 | 3.62 | *** | NS | NS | | 0.81 |
| Eating concentrate | 9.63 | 6.68 | 10.00 | 5.53 | 9.36 | 5.43 | NS | *** | NS | | 0.84 |
| Drinking | 3.24 | 3.68 | 3.11 | 2.90 | 3.56 | 3.01 | NS | NS | NS | | 0.42 |
| Resting | 67.58 | 66.58 | 66.87 | 69.79 | 69.98 | 75.27 | NS | NS | NS | | 2.09 |
| Other activities | 11.27 | 14.42 | 12.10 | 13.98 | 12.61 | 12.66 | NS | NS | NS | | 0.94 |

[1]Main effects of the ANOVA; M = texture of corn; C = texture of protein concentrate.

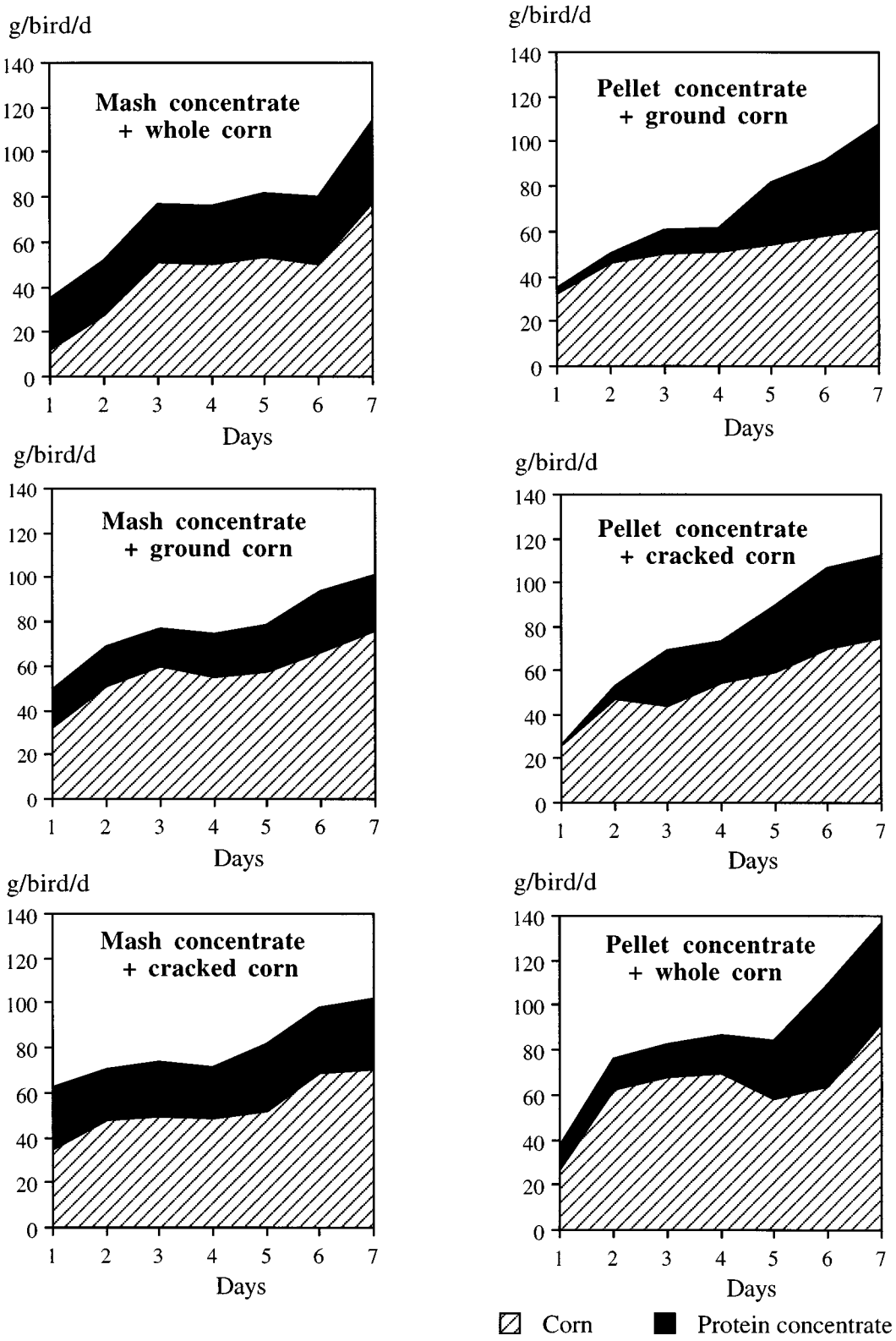


**FIGURE 1.** Corn and protein concentrate intake by broilers during the 1st wk after dietary change depending on the offered choice. (Whole corn treatments: a mixture of 80% whole corn and 20% cracked corn was used for the first 5 d of the experimental period).

not influence the time spent on other activities (drinking, standing, or resting).

Mean duration of feeding bouts, the mean number of pecks per feeding bout, and mean pecking rate are presented in Table 5 for each feed form. Time spent during each feeder access was significantly influenced by the particle form of the feed. Broilers feeding on whole corn spent about half the time per feeder visit than those

**TABLE 5. Mean duration of the feeding bouts; mean number of pecks per feeding bout and mean pecking rate measured at 30 d of age for each feed form**

| Variable | Ground grains | | Cracked grains | | Whole grains | | Mash concentrate | | Pellet concentrate | | SEM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Feeding bout duration, s | 98.0 | 65.2[a] | 59.4 | 39.7[b] | 48.4 | 48.9[b] | 114.0 | 71.7[a] | 55.9 | 29.8[b] | 11.8 |
| Number of pecks per feeding bout | 129.5 | 99.5[b] | 83.2 | 60.5[bc] | 37.1 | 45.7[c] | 196.9 | 145.9[a] | 60.5 | 52.5[c] | 19.6 |
| Pecking rate, no. of pecks/s of feeding | 1.24 | 0.30[b] | 1.36 | 0.16[b] | 0.69 | 0.21[d] | 1.61 | 0.40[a] | 0.97 | 0.38[c] | 0.07 |

[a–d]Means SD within a row with no common superscript differ significantly ($P < 0.05$).

feeding on ground corn (48 vs 98 s). Similarly, feeding bouts on the pelleted concentrate were half that on mash concentrate (56 vs 114 s). Furthermore, chicks eating diets with larger particle size (whole corn, pelleted concentrate) had slower pecking rates than those feeding on ground corn or mash concentrate. Consequently, broilers fed diets with low particle size (ground corn, mash concentrate) had three times more pecks during each feeder visit than those fed whole corn or pelleted concentrate.

## DISCUSSION

This study confirmed the central thesis that broilers are able to express an effective self-selection mechanism when raised under choice feeding conditions (Hughes, 1984). The results clearly showed that when two feeds are simultaneously offered, the physical form of the feeds can significantly modulate the levels of their intake and, subsequently, the composition of the ingested diets. Changing the particle size of the feeds induced a variation of the protein level in the ingested diets from 18.1 to 21.8%, respectively, for the associations of ground corn + mash concentrate and whole corn + pelleted concentrate. This increase had a significant effect on the amount of protein and energy ingested. These results confirm that preference for the sensory characteristics of the diet can interfere with underlying processes to regulate the intake of a specific nutrient (McArthur and Blundell, 1986; Rose *et al.*, 1986).

Based on the levels of intake, it can be postulated that corn was more acceptable when presented in ground or cracked forms than as whole grains, whereas a pelleted concentrate was more acceptable than a mash concentrate. These results suggest that the intake level of a feed can vary with the acceptability of the physical form of the particles. The fact that grit was not given to the chickens during the experiment may have influenced development and grinding efficiency of the gizzard and thus interfered with expressed preferences (Forbes and Covasa, 1995). When two feeds are offered as a choice, the composition of the selected diet (percentage of each feed in the ingested ration) varies with the relative acceptability of each feed. When the two feeds offered are of different acceptability levels (ground corn + mash concentrate or whole corn + pelleted concentrate), broilers tended to include in their ingested diet a larger part of the feed with the higher acceptability level. Therefore, the combination with whole grain + pelleted concentrate gave the highest level of concentrate in the diet (37%), whereas the combination with ground corn + mash concentrate gave the lowest level of concentrate in the ingested diet (27%). Similar results were observed by Calet (1965) when choice feeding chickens with a protein concentrate in mash and corn either ground or in pellets. He reported that the intake of the mash concentrate was decreased if ground cereal was supplied. Contrary to this situation, when feeds with similar acceptability were offered during the present study (ground corn + pelleted concentrate or whole grains + mash concentrate), broilers selected a diet with 32 to 33% concentrate corresponding to a protein level of 19.7 to 20.0%, which is closer to the nutritional recommendations for broilers of this age (INRA, 1984).

The present results suggest that the relative acceptability of feed textures can play an important role in the effective choice of broilers. If so, broilers raised under choice situations can probably be guided to select an efficient diet if the feeds are adequately presented.

Although the alteration of the feed forms resulted in significantly different intakes of energy and protein, there were no significant differences in the live weight gains. Only feed efficiency was affected. Measurements of fat and protein contents in the carcass would have given insights to explain this lack of effect. Regardless, our results confirm that when a chick is self selecting its diet, maximum growth may not be the sole endpoint of the system controlling selection (Kaufman *et al.*, 1978).

During the first 2 wk of life, chicks were adapted to choice feeding with ground corn and mash concentrate. When these chicks were changed from mash concentrate to the same concentrate presented in pelleted form, there was nearly a complete rejection of this feed during the first 24 h and about 3 d were required for them to adapt to this new presentation of the feed. This adaptation period may be necessary for broilers to adequately evaluate the sensory characteristics of the new particles and to learn to grasp and swallow them. The end of the beak contains a number of mechanoreceptors that play an important role in the tactile assessment of the feed particles (Hughes and Gentle, 1995). Varying the particle size of the feeds induced a profound alteration of the feeding behavior. Broilers receiving larger size particles (whole grain or pelleted concentrate) spent about a twofold less time at eating activities and pecked in the feed at a very lower rate than those eating mash concentrate or ground corn. Furthermore, chicks receiving whole grains or pelleted concentrate had feeding bouts that were about two times shorter than those of chicks fed ground corn or mash concentrate. It may

therefore be postulated that, although feeding larger size particles reduces the total feeding time and the duration of feeding bouts, it does not alter the interval between two feeder accesses. This reasoning is consistent with the results reported by Savory (1980) for Japanese quail receiving a complete diet in mash or pellet form. He observed that pelleting feed reduced total feeding time and bout duration but not frequency of the feeding activity. Accordingly, he concluded that meal occurrence in birds is probably associated with emptying and filling of the digestive tract, and not with changing levels of circulating nutrients.

In conclusion, this study confirmed the thesis that chicks are able to self-select their diets when raised under choice situations. The pattern of selection, however, is not governed solely by the nutritional characteristics of the feeds offered. In addition to the metabolic requirements, pleasure procured from food represents probably a crucial factor in their selection, absorption, and utilization (Delessert, 1995). It seems, therefore, important, when choice feeding chickens, to take into account the physical presentation of the feeds offered.

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