Just Add Water

New research indicates broilers fed high-moisture pellets may be able to better utilize feed energy for growth. Add this to milling and feeding efficiencies as reason to add moisture to pelleted feed.

by J.S. Moritz and R.S. Beyer

Broiler producers feed pelleted rations due to advantages in feed handling as well as improved gains in bird performance (Briggs, *et al.*, 1999). Feed manufacturers strive to produce pelleted diets of high quality, while minimizing production expenses (Mommer and Ballantyne, 1991). Fairchild and Greer (1999) have demonstrated that increasing feed mash moisture at the mixer can increase pellet durability and decrease pellet mill energy consumption, consequently improving pellet quality and reducing milling expense. Decreasing pellet mill energy consumption alone provides an incentive for feed manufacturers to consider moisture addition during the manufacturing process. However, potential improvement in pellet durability adds even more enticement for the use of moisture in broiler feeds since past research has illustrated positive relationships between pellet quality and broiler feed efficiency (Moran, 1989; Nir, *et al.*, 1994). The evidence these past studies provides warrants further research involving the application of pelleting broiler feeds with added water as well as determining the effect of this process on broiler performance.

A preliminary study (Study 1) was conducted which compared similarly formulated mash and pelleted diets with and without added moisture. These diets were then fed to commercial broilers, and the effect of the dietary treatments on bird performance was determined. Moisture was added at the mixer prior to oil addition. A commercial surfactant/water application system with a moisture sensor mounted directly in the mixer (Grain Prep non-acidic surfactant and Grain Prep Auto Delivery System, Agrichem, Inc.) was used to add surfactant/water solution to high-moisture treatments until an end point of 15 percent moisture was reached. The only difference between the high-moisture and low-moisture treatments was the addition of water. Pelleted treatments were processed by means of a short-term conditioner (1 x 3 ft (0.31 x 0.91 m) 10 second retention time) and a California Pellet Mill Master Model HD Series 1000 with a 5/32 x 1.25 in (3.97 x 31.75 mm) die. Broiler performance parameters were determined using Cobb-Vantress broilers in a floor pen setting. Forty-five male broiler chicks were allotted to each 4.83 x 6.33 (1.47 x 1.93 m) floor pen. The four experimental treatments were applied to 16 replicate pens and data was collected at the end of the three-week and six-week periods. The experiment was conducted during the months of November and December.

High-moisture pellets

Table 1. Experimental Diet Characteristics (Study 1)

Pellet characteristics	Starter Diet: Low moisture	Starter Diet: High moisture	%	Grower Diet: Low moisture	Grower Diet: High moisture
DM (after moisture addition)	91.87	85.55		92.37	84.99
Standard PDI[A]	51.34	77.07		61.72	87.29
Modified PDI[B]	31.30	67.90		42.57	80.76
Starch gelatinization	6.97	13.11		16.48	22.77
Mash characteristics					
DM (after moisture addition)	93.07	85.53		93.5	85.12

[A] Standard pellet durability index
[B] Modified pellet durability index-utilizing five 13-mm hex nuts for added pressure on pellets

Moisture addition to feed mash generated extensive differences in pellet durability and starch gelatinization between low-moisture and high-moisture treatments (Table 1). High-moisture pellets

Table 2. Influence Of Moisture Level And Feed Form On Broiler Performance, Three- to Six-Week Data, (Study 1)

P-values generated for main effects and the interaction	Live wt. gain (g)	Feed efficiency (g/g)	Feed eff. @ 12.5% calc moist.	Mortality (percent)
Moisture level	0.0210	0.0001	0.0263	0.6207
Feed Form	0.0001	0.0001	0.0001	0.0001
Interaction	0.2847	0.0001	0.0011	0.2114
Treatment means among performance parameters				
Low moisture mash	1,456.48^{b}	0.538^{a}	0.504^{c}	2.01^{b}
High moisture mash	1,411.77^{c}	0.487^{c}	0.501^{c}	2.48^{b}
Low moisture pellet	1,559.07^{a}	0.544^{a}	0.515^{b}	5.99^{a}
High moisture pellet	1,542.21^{a}	0.514^{b}	0.529^{a}	4.89^{a}
LSD[A]	36.65	0.007	0.007	1.77

[A] Fisher's Least Significant Difference Value
[a-c] Means within a column with no common superscript differ significantly (P<0.05)

for both starter and grower diet formulations produced higher durabilities and gelatinization percentages compared to their respective low-moisture equivalents. The manufacturing data represent sub-sampled averages since milling was not replicated. Broiler performance was most markedly affected in the three- to six-week period (Table 2). Pelleted treatments produced significantly higher live weight gains and feed efficiencies compared to mash treatments. Surfactant/water additions to high-moisture treatments created a dilution of nutrients. Feed efficiencies were adjusted to a 12.5 percent calculated moisture content in order to place all treatments at a similar nutrient density. Adjusted feed efficiency values illustrated that high-moisture pelleted treatments produced significantly higher feed efficiencies compared to any other treatment. A possible explanation for these findings is that broilers fed high-moisture pellets were able to better utilize feed energy for growth (productive energy) as opposed to using feed energy for food prehension (maintenance). Broilers fed intact pellets of high durability would expend less energy in the act of feeding compared to broilers fed pellets of low durability and high percentages of fines. This speculation has been supported in past research (Moran, 1989; Nir, *et al.*, 1994). Mortality was not affected by moisture additions; however, pelleted treatments produced significantly greater mortality percentages compared to mash treatments.

A follow-up study (Study 2) was then conducted with the primary objective of clarifying the relationships between moisture addition, pellet manufacturing and quality, nutrient density and broiler performance. A secondary objective was to compare different types of moisture addition for potential use in broiler feeds. In this study, feed manufacturing was replicated to provide statistical data, and diet formulations were adjusted in order to compare moisture additions to treatments of different nutrient densities. Experimental grower diets consisted of two different nutrient-dense formulations arranged in a factorial structure with two different moisture-type additions. One formulation reflected NRC recommended values for all nutrients prior to moisture addition. The other formulation was increased 5 percent above all nutrients included in the first formulation, also prior to moisture addition. Moisture was added at 5 percent of the diet. Each formulation was composed of the same ingredient profile. Adjusted diet formulations contained high amounts of soybean oil (6.5 percent of the base formulation) compared to NRC formulations that contained soybean oil at 3.0 percent of the base formulation. Moisture additions were made through use of either a commercial surfactant/water mixture or ordinary tap water. Two control grower diets were also manufactured, which consisted of the two diets of different density without any moisture addition. Experimental treatments were manufactured in the same manner as the first study with the exception that all treatments were pelleted, and processing was conducted at a constant pellet mill motor load. Broiler performance parameters were again determined using Cobb-Vantress male broilers in a floor pen setting. The six experimental treatments were applied to 10 replicate pens

Low-moisture pellets

during the three- to six-week grower period. The experiment was conducted through the months of March and April.

The two moisture-type additions did not significantly differ from one another with respect to feed milling parameters and pellet quality. However, differences in formulation density significantly affected pellet quality. Table 3 illustrates the milling parameter and pellet quality effects of the four factorial treatments including the two control treatments. The production rate of the formation of pellets approached significance (P = 0.209), where treatments having adjusted formulation densities produced higher rates of production as compared to non-adjusted formulations. This finding may be the result of the high soybean oil content of the

Table 3. Treatment Effects On Milling Parameters And Pellet Quality (Study 2)

	PDI[A] (%)	Mod PDI[B] (%)	BD[C] (kg/m^3)	REE[D] (Kwh/MT)	Fines (%)	HPT[E] (°C)	P-rate[F] (MT/hr)	PMC[G] (%)
P value	0.0001	0.0001	0.4038	0.2718	0.001	0.5088	0.209	0.0001
Treatment means among milling parameters and pellet qualities								
NRC + surfactant/water	87.48[a]	79.89[a]	589.78	6.06	11.58[c]	82.75	2.35	15.95[ab]
NRC + water	87.29[a]	79.81[a]	586.78	5.98	13.33[bc]	82.43	2.48	16.08[a]
Adj + surfactant/water	75.83[b]	55.30[b]	594.47	5.92	30.36[b]	81.04	2.9	15.60[c]
Adj + water	73.54[b]	58.35[b]	586.86	6.45	23.09[bc]	82.78	2.83	15.65[bc]
NRC	70.1[b]	55.28[b]	609.47	6.12	23.17[bc]	83.65	2.16	12.48[d]
Adj	36.92[c]	16.25[c]	606.82	5.92	55.28[a]	83.02	2.8	11.68[e]
LSD[H]	11.37	20.06	—	—	17.33	—	—	0.34

[A] Pellet durability index
[B] Modified pellet durability index (utilizing five 13-mm hex nuts for added pressure on pellets)
[C] Bulk density
[D] Relative electrical energy (pellet mill)
[E] Hot pellet temperature
[F] Production rate
[G] Pellet moisture content
[H] Fisher's Least Significant Difference Value
[a-e] Means within a column with no common superscript differ significantly (P<0.05)

adjusted formulations, which would aid in lubricating the pellet die. When the production rates of the experimental treatments were compared to their respective controls, it appeared that moisture additions of both types also contributed to increasing production rates. Adjusted formulation treatments produced pellets of significantly lower durabilities and higher percentages of fines as compared to NRC formulated treatments. Nonetheless, when the experimental treatments' pellet qualities were compared to that of the control treatments, moisture addition significantly improved durability and decreased the percentage of fines. This finding is especially important since the adjusted formulation treatments contained high percentages of soybean oil. Past research has shown that increasing fat above 2 percent in a corn-soybean broiler diet prior to pelleting will decrease pellet quality with respect to durability and the percentage of fines (Richardson and Day, 1976). The current study demonstrates that adding fat at 6.5 percent prior to pelleting in conjunction with added moisture can produce pellets of 75 percent durability and less than 27 percent fines. These results show that the addition of moisture, even if ordinary tap water, can potentially increase pellet mill production rates and significantly increase pellet quality.

Table 4. Influence Of Moisture Type And Formulation Density On Broiler Performance, Three- to Six-Week Data, (Study 2)

P-values generated for main effects and the interaction	Live wt. gain (g)	Feed intake (pen) (g)	Feed eff.[A] (g/g)	Mortality (percent)
Moisture type	0.7275	0.5515	0.7231	0.3799
Formulation density	0.0015	0.0029	0.0001	0.2221
Interaction	0.8426	0.4668	0.2004	0.5966
Treatment means among performance parameters				
NRC + surfactant/water	1,603.92[b]	136,192[ab]	0.598[b]	2.89
NRC + water	1,605.70[b]	138,153[a]	0.588[b]	2.67
Adj + surfactant/water	1,643.11[a]	132,480[b]	0.626[a]	2.44
Adj + water	1,649.61[a]	132,282[b]	0.632[a]	1.56
LSD[B]	34.1	4,242.6	0.02	—

[A] Feed efficiency
[B] Fisher's Least Significant Difference Value
[a-b] Means within a column with no common superscript differ significantly (P<0.05)

Live Weight Gain, Feed Efficiency And Mortality

Broiler performance was similarly unaffected by moisture-type additions; however, formulation density did significantly impact performance. Table 4 illustrates the effects of live weight gain, feed efficiency and mortality in response to differences in moisture-type additions and formulation densities. Broilers fed

Broiler grower diet formulations that include added moisture prior to conditioning and pelleting may improve three- to six-week performance, without negatively acting on broiler survivability.

adjusted formulation treatments exhibited significantly higher live weight gains and significantly lower feed intakes, which collectively produced significantly higher feed efficiencies. These data support the adjusted feed efficiency calculations derived in the first study. Mortality percentages were not effected due to experimental treatments. Table 5 describes the relationship between the experimental treatments and their respective control treatments. The adjusted formulation diets were the only treatments to improve live weight gain compared to their control treatment. The two control treatments were superior in regards to feed efficiency compared to their corresponding experimental treatments. This finding was probably a result of both controls being more nutrient dense than their respective experimental treatments, which caused feed intake to be significantly decreased. Contrary to the speculations of the first study, the adjusted formulation control, which possessed the lowest durability of all treatments, produced the highest feed efficiency value. It should be noted, however that the live weight gains produced by the adjusted formulation control were the lowest of all treatments, despite this formulation having the most concentrated nutrient profile (growing broilers in this manner would not be cost effective). A possible explanation for this finding could be that the current study was conducted through the months of March and April during ideal broiler-rearing outside temperatures, whereas broilers in the previous study were reared during the much colder months of November and December. Ideal outside environmental temperatures could have dictated a lessened need for broiler maintenance energy. Nir *et al.*, (1994) define productive energy as net feed energy less bird maintenance energy. Although improved pellet quality would be expected to increase productive energy, this energy gain could be in excess relative to low maintenance energy requirements as well as the fixed protein content of the diet. Past research has also illustrated that broilers raised from three weeks to marketing during favorable outside environmental temperatures demonstrated decreased feed efficiency despite improved pellet quality (Acar *et al.*, 1991). Mortality percentages did not differ among control treatments and experimental treatments. These data suggest that adjusted broiler grower diet formulations that include added moisture of either experimental type prior to conditioning and pelleting may improve three- to six-week performance, without negatively acting on broiler survivability.

Table 5. Treatment Effects On Broiler Performance, Three- to Six-Week Data, (Study 2)

	Live wt. gain (g)	Feed intake (pen) (g)	Feed eff.[A] (g/g)	Mortality (percent)
P value	0.0013	0.0001	0.0001	0.7309
Treatment means among performance parameters				
NRC + surfactant/water	1,603.92^{b}	136,192^{ab}	0.598^{c}	2.89
NRC + water	1,605.70^{b}	138,153^{a}	0.588^{c}	2.67
Adj + surfactant/water	1,643.11^{a}	132,480^{bc}	0.626^{b}	2.44
Adj + water	1,649.61^{a}	132,282^{bc}	0.632^{b}	1.56
NRC	1,610.27^{b}	130,187^{c}	0.625^{b}	2.67
Adj	1,584.65^{b}	122,139^{d}	0.664^{a}	2.89
LSD[B]	32.46	4,912.2	0.02	—

[A] Feed efficiency
[B] Fisher's Least Significant Difference Value
[a-d] Means within a column with no common superscript differ significantly ($P<0.05$)

Problems concerning feed mold should be insignificant since feed moisture content in both studies did not exceed 16 percent. Poultry can be negatively affected by feed mycotoxins produced by the fungi *Fusarium*, *Aspergillus* and *Penicillium*. However, these fungi require a minimum moisture content of 19 percent to 25 percent (Trigo-Stockli and Herrman, MF-2061).

These two studies support the use of moisture in broiler grower diet formulations when the formulations account for nutrient density. The data support the use of moisture for potential improvements in pellet manufacturing, pellet quality and broiler performance. Future studies should expand upon these findings by exploring the effects of graded levels of moisture addition and formulation adjustment. In addition, future work should investigate the relationship between pellet quality, broiler performance and outside environmental temperature. Such studies are necessary before an accurate recommendation for moisture usage can be provided.

J.S. Moritz and R.S. Beyer, Department of Animal Science and Industry, Kansas State University; Phone (785) 532-1284 or (785) 539-7329; Fax (785) 532-5681; E-mail jmoritz@oz.oznet.ksu.edu. References available from the author upon request.

Reprinted from April 2001 Watt Poultry USA