MANAGEMENT

Dietary Mannan Oligosaccharides improves broiler performance

The ban on antibiotic growth promoters has lead to a search for alternatives. Almost a decade ago mannan oligosaccharides have been introduced as such a feed additive. Many trials have shown that this component improves bird performance and causes a drop in mortality rates.

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Broilers fed with mannan oligosaccharides perform well and show less mortality.
(Photo: World Poultry)

The use of antibiotic growth promoters has come under increasing scrutiny because of the issue of antibiotic resistance in certain bacteria. In the European Union only avilamycin and bambermycins remain approved and in the United States voluntary reduction or replacement of antibiotics has begun to occurr. In order to help maintain live performance without antibiotics, a number of natural alternative growth promoters have been developed for use in commercial broiler chicken feeds.

Saccharomyces yeast outer cell wall components known as phosphorylated mannan oligosaccharides (MOS) were introduced as a feed additive for broiler chickens in 1993 by Alltech. Since then MOS has been shown in many trials to improve body weight, feed conversion ratio, liveability and performance index compared to unsupplemented diets. The stability of MOS to steam heat during pelleting has been an advantage allowing it to be added directly in the mixer to broiler feeds.

Global pen trial research on dietary MOS for broiler chickens (Arbor Acres, Avian, Cobb, Ross, Hybro) under different diet formulation and environmental conditions since its introduction has been summarized in this article. Final ages ranged from 25 to 49 days, and evaluations were made between diets with or without an antibiotic compared to MOS supplemented diets in pen trials (including new litter, used litter, cages, or slatted floors).

The levels of dietary MOS sometimes varied by trial and by feed phase, ranging from 0.05 to 0.30% (500 to 3,000 ppm) in the different studies. The European Poultry Efficiency Factor (EPEF) for broilers in these trials has been calculated from averages by treatment or by trial based on the formula: EPEF = [(live weight, kg X liveability, %)/(feed conversion ratio X age, days)] X 100. Because fewer trials had mortality data than body weight and feed conversion data, so the days of age differed slightly for these parameters, but the estimated EPEF was determined by using average ages for body weight and feed conversion ratio.

The averages of the various parameters of interest (body weight, feed conversion ratio, and mortality) were analysed statistically as pairs of observations, using either negative control versus MOS or positive (antibiotic) control versus MOS treatments, by the Paired T-test (Statistix for Windows 7.0, 2000. Analytical Software, Tallahassee, Florida).

Negative control versus MOS diets

Broiler chicken body weight means from studies using antibiotic-free negative control versus MOS diets are shown in *Table 1*. There were 24 pen trials involving 34 comparisons. As indicated for averages by treatment, MOS-fed broilers had higher weight gain (+1.88%) than antibiotic-free birds, and by trial a similar result occurred (+1.70%). These results were highly significant ($P < 0.001$). Averages by treatment for feed conversion ratios favoured the MOS group (-2.25%), and by trial the improvement with MOS was similar (-2.27%) compared to the negative control treatment results. Mortality percentages were lowered by MOS diets, with the relative reductions compared to negative control being -21.78% for averages by treatment and -21.95% averaged by trial ($P < 0.017$). The EPEF indexes by treatment would be 256 for negative control and 270 for MOS group.

Assuming a negative control flock commercially has the same "average by trial" results as given here — 2.247 kg body weight, 1.812 feed/body weight, 6.051% mortality, 288 EPEF — the addition of MOS to their diets would be expected to give improved live performance results to 2.285 kg body weight, 1.771 feed/body weight, 4.723% mortality, and 304 EPEF. The absolute or numerical improvements expected would be +0.038 kg per bird, -0.041 feed/body weight, -1.328% actual mortality, and +16 EPEF.

Positive control versus MOS diets

Worldwide there were 20 pen trials and 25

Table 1. Broiler chicken body weight, feed conversion ratio, and mortality results from pen trials (including litter, wire, or slats) worldwide comparing antibiotic-free negative control diets versus MOS diets during the entire study periods

Parameter (number; probability)	*Average Age (days)*	*Negative Control Diets*	*MOS Diets*	*Rel. Change w/MOS (%)*
Body weight, kg:				
Average by treatment (n = 34; P = 0.000)	42.2	2.149[b]	2.189[a]	+1.88
Average by trial (n = 24; P = 0.000)	40.4	2.247[b]	2.285[a]	+1.70
FCR, feed/body weight:				
Average by treatment (n = 34; P = 0.000)	42.2	1.879[a]	1.837[b]	-2.25
Average by trial (n = 24; P = 0.000)	40.4	1.812[a]	1.771[b]	-2.27
Mortality, %:				
Average by treatment (n = 19; P = 0.014)	42.6	5.582[a]	4.366[b]	-21.78
Average by trial (n =17; P = 0.016)	39.9	6.051[a]	4.723[b]	-21.95

[a-b] Means in a row and not having the same superscript differ by Paired T-test.
[1] Relative change as a result of MOS diets with negative control diets assumed to be 100% standard.

Table 2. Broiler chicken body weight, feed conversion ratio, and mortality results from pen trials (including litter, wire, or slats) worldwide comparing antibiotic-supplemented positive control diets versus MOS diets fed at levels stated during the entire study periods

Parameter (number; probability)	*Average age (days)*	*Antibiotic diets*	*MOS diets*	*Rel.cChange w/MOS (%)1*
Body weight, kg:				
Average by treatment (n = 25; P = 0.381)	40.1	2.172	2.163	-0.37
Average by trial (n = 20; P = 0.444)	41.5	2.263	2.254	-0.39
FCR, feed/body weight:				
Average by treatment (n = 25; P = 0.448)	40.1	1.808	1.800	-0.45
Average by trial (n = 20; P = 0.924)	41.5	1.820	1.819	-0.07
Mortality, %:				
Average by treatment (n = 20; P = 0.007)	40.3	4.833a	4.003b	-17.17
Average by trial (n =16; P = 0.008)	41.9	5.404a	4.426b	-18.10

[a-b] Means in a row and not having the same superscript differ by Paired T-test.
[1] Relative change as a result of MOS diets with antibiotic diets assumed to be 100% standard.

comparisons of positive control diets with an antibiotic or antibiotic shuttle program versus MOS diets from which body weight and feed conversion ratios were obtained (*Table 2*). The antibiotics used were avilamycin, bacitracin, bambermycins, or virginiamycin at various levels. Coccidiostats used included diclazuril, lasalocid, monensin, or nicarbazin (in some studies name of coccidiostat was not given). There were no significant differences in body weight for antibiotic diets versus MOS diets either for averages by treatment (-0.37% for MOS) or by trial (-0.39% for MOS). Similarly, there were no significant differences between antibiotic-fed and MOS groups for feed conversion ratio averages by treatment (-0.45% for MOS) or by trial (-0.07% for MOS). The positive control and MOS diets gave statistically equivalent performance with regard to growth promotion and feed utilization.

Mortality percentages for positive control versus MOS diets were obtained from 17 trials and 21 treatment comparisons *(Table 2)*. The strong beneficial effect of MOS in lowering mortality observed in the negative control versus MOS trials *(Table 1)* was demonstrated again for MOS diets in comparison to antibiotic supplemented diets (-17.17% relative change in mortality averaging by treatment and -18.10% averaging by trial). This indicated that MOS had a significantly greater ($P < 0.009$) beneficial influence on broiler chicken liveability than the antibiotics against which it was evaluated. The mortality lowering ability of MOS was its strongest attribute. The EPEF indexes for negative control and MOS groups were 285 and 288 by treatment and 287 and 286 by trial, respectively.

Modes of action

Phosphorylated mannan oligosaccharides have at least three distinct modes of action by which broiler performance is improved:

- adsorption of pathogenic bacteria containing Type 1 fimbrae, sometimes referred to as the "receptor analogue" mechanism (strongly binding to and decoying pathogens away from the "sugar coated" intestinal lining), or stated another way, different bacterial strains can agglutinate mannan oligosaccharides;
- improved intestinal function or "gut health" (for example: increases villi height, uniformity, and integrity) and
- immune modulation simulates gut associated and systemic immunity by acting as a non-pathogenic microbial antigen, giving an adjuvant-like effect.

A high level (0.40%) of dietary MOS given to young chicks challenged with *Salmonella typhimurium* reduced cecal counts and challenged with *Salmonella dublin* reduced the number of positively infected birds by day 10. There was no effect on cecal concentrations of *Lacto-bacilli*, *Enterococci*, anaerobic bacteria, lactate, volative fatty acids, or pH of cecal contents, suggesting that alteration of populations of these species is probably not part of the chick growth promotion mechanism. In some studies in which certain antibiotics were used in combination with MOS, additive beneficial effects on broiler live performance were observed compared to antibiotic alone (for example: virginiamycin + MOS, significant feed conversion improvement; bacitracin-MD and virginiamycin shuttle program + MOS, feed conversion and mortality improvements.

Dietary MOS has other effects that influence performance of broiler chickens. In a Czech Republic caged broiler study, using 0 to 0.3% MOS at 0.05% increments of addition to the diets, 0 to 21 day fibre digestibilities significantly improved with diets containing each level of MOS compared to the negative control diets. In a U.K. trial in which either clean litter or recycled litter was used, and results for litter types were combined, water intake per bird from 0 to 14 days of age expressed as dL water/100 g feed (that is, water:feed ratio) was significantly lower for MOS-fed birds (1.91) than for negative control broilers (1.99). As a result, 0 to 35 day subjective or visual litter scores, using 0 as worst to 10 as best, were significantly improved with the MOS diets (4.0) compared to the negative control diets (3.0). It is conceivable that improved health of the intestinal mucosa due to feeding MOS diets could benefit carcass and breast meat yield. Although limited research has been done on processing yields, it was reported from a Brazilian pen trial that dietary MOS (0.1%) significantly increased breast yield as a percentage of dressed carcass plus head and feet compared to the negative control treatment (32.91 vs 31.07%, respectively).□