Feeding Value of L-Methionine Versus DL-Methionine

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All amino acids, with the exception of Glycine, can exist in either the D or L form. The basic structure of an amino acid can be thought of as a central carbon atom (the alpha carbon) with four side groups attached. Three of the side groups (a carboxyl group, an amino group and a hydrogen atom) are the same for all amino acids. The forth group is different for each amino acid and gives each amino acid its unique properties. These groups are arranged three dimensionally around the alpha carbon in a way that approximates a triangular-based pyramid or tetrahedron. The alpha carbon sits at the center of the tetrahedron and each side group sits at one of the four points. By exchanging the position of two side groups, it is possible to produce two unique arrangements of the side groups relative to one another: the D and L forms (technically called enantiomers). Chemically, there is no difference between the D and L forms, but enzymes are sensitive to the alternate three-dimensional configurations. Only L-amino acids are incorporated into naturally occurring proteins.

Feed grade amino acids produced by bacterial fermentation (e.g. lysine, threonine, tryptophan) are all in the L form. Methionine, however, is produced in a chemical process, which favors neither the D form nor the L form. Consequently, DL-methionine is a 50:50 mixture of D-methionine and L-methionine (a racemic mixture). When feed supplemented with DL-methionine is fed, the tissues of the animal are presented with both L-methionine and D-methionine. Both enantiomers are rapidly transported across the intestinal wall by a sodium dependent transporter. Both forms cross the intestinal barrier at the same rate, and neither is lost in the transport process. Once the D-methionine reaches the liver or kidney, it is converted by a two-step enzymatic process (oxidative deamination followed by transamination) into the L form, which is used by the tissues to synthesize proteins.

It is reasonable to question the efficiency of converting D-methionine to the L form, and, therefore, the bioefficacy of DL-methionine versus L-methionine for animal production. There is a substantial body of scientific research supporting a similar bioefficacy for DL-methionine and L-methionine. One of the earliest reports showing that D-methionine is metabolically equal to L-methionine in chicks came from Grau and Almquist (1943). These workers showed that the L and the D isomers of

methionine are metabolically equal. There are many other reports in the scientific literature showing the equivalence of these two forms. (Fell et al. 1959) (Leveille et al. 1960) (Featherston et al. 1962) (Bauriedel, 1963).

The most recent paper using poultry is that of Dilger and Baker (2007). In this report, chicks were fed a starter diet containing 23% crude protein diet, based on corn and soybean meal from hatch to 7 days. On day 8 the birds were fed purified diets formulated to determine the bioefficacy of DL-methionine compared to L-methionine. As mentioned earlier, DL-methionine contains a 50:50 mixture of D and L methionine, due to the fact that it is produced from a chemical synthesis. Growth was increased by the addition of methionine, demonstrating that the basal diet was methionine deficient. When growth of chicks fed DL-methionine was compared to growth of birds fed L-methionine, no difference was found ($P>0.63$.) In another portion of this report, a corn/soybean meal diet with peanut meal was fed to chicks. As was reported in the purified diet trial, there was no difference in weight gain, feed intake or feed conversion when chicks were fed either DL-methionine or L-methionine. These workers said "it may be concluded that there is no evidence to suggest differences in effectiveness between L-Met and DL-Met in purified or practical-type low-protein diets of varying sulfur amino acid (SAA) content fed to chicks from 8 to 20 d of age"

In 2010, Cheil Jedang Bio published a research trial comparing L-methionine, DL-Methionine and liquid methionine hydroxyanaloge (LMH) in layer diets. Dietary treatments consisted of a basal diet, containing 0.61% total sulfur amino acids, the basal diet supplemented with 0.13% LMH, the basal diet supplemented with 0.11% DL-methionine, and the basal diet supplemented with 0.11% L-methionine. There were no dietary treatment effects on any egg quality parameters measured. Egg mass was not different between hens fed the control diet and hens fed the LMH supplemented diet (58.25 g/d and 57.84 g/d respectively). Egg mass was not different between hens fed the DL-methionine supplemented diet and hens fed the L-methionine supplemented diet (59.47 g/d and 59.81g/d) but both were greater ($p<0.05$) than the control and LMH groups.

Many other studies document the fact that DL-methionine is equally as efficacious in growing animals as is L-methionine. The table below contains a listing of many of these research reports.

Author	Journal	Title	Specie
Tipton *et al.*, 1966	Poultry Science	A Comparison of D-, L-, DL-Methionine and methionine Hydroxy Analogue Calcium in Chick Diets	broiler
Smith, 1965	Poultry Science	The Utilization of L-Methionine, DL-Methionine and Methionine Hydroxy Analogue by the Growing Chick	broiler
Katz and Baker, 1975	Poultry Science	Efficacy of D-, L- and DL-Methionine for Growth of Chicks Fed Crystalline Amino Acid Diets	broiler
Robinson *et al.*, 1978	Journal of Nutrition	Utilization of Dietary Sulfur Compounds by Fingerling Channel Catfish: L-Methionine, DL-Methionine, methionine Hydroxy Analogue, Taurine and Inorganic Sulfate	aquaculture
Baker and Boebel, 1980	Journal of Nutrition	Utilization of the D- and L-Isomers of Methionine and Methionine Hydroxy Analogue as Determined by Chick Bioassay	broiler
Schmidt,	PhD thesis	Determination of the	turkey

1981		relative potency of methionine compounds for turkeys	
Elkin and Hester, 1983	Poultry Science	A Comparison of Methionine Sources for Broiler Chickens Fed Corn-Soybean Meal Diets Under Simulated Commercial Grow-Out Conditions	broiler
Noll *et al*., 1984	Poultry Science	Biopotency of Methionine Sources for Young Turkeys	turkey
Degussa, 1985	Trial report No. 03 53 850135_12	Comparison of D-, L- and DL-Methionine and D-, L-, and DL-MHA	broiler
Degussa, 1985	Trial report No. 03 53 853652_37	Comparison of Alimet versus L-Methionine and DL-Methionine	broiler
Degussa, 1985	Trial report No. 03 53 853652_40	Efficacy of D-, L- and DL-methionine in chicks	broiler
Esteve-Garcia and Austic, 1993	Journal of Nutrition and Biochemistry	Intestinal absorption and renal excretion of dietary methionine sources by the growing chicken	broiler
Sveier et al, 2001	Aquaculture Nutrition	Dietary inclusion of crystalline D- and L-methionine: effects on growth, feed and protein utilization, and digestibility in small and large Atlantic salmon (Salmon salar L.)	aquaculture

Ribeiro et al., 2005	Brazilian Journal of Poultry Science	Methionine Sources do not Affect Performance and Carcass Yield of Broilers Fed Vegetable Diets and Submitted to Cyclic Heat Stress	broiler
Forster and Dominy, 2006	Journal of the World Aquaculture Society	Efficacy of Three Methionine Sources in Diets for Pacific White Shrimp, Litopenaeus vannamei	aquaculture
Dilger and Baker, 2007	Poultry Science	DL-Methionine Is as Efficacious as L-Methionine, but Modest L-Cystine Excesses Are Anorexigenic in Sulfur Amino Acid-Deficient Purified and Practical-Type Diets Fed to Chicks	broiler

In conclusion, it is clear that feeding L-methionine provides no advantage when compared to DL-methionine in poultry and fish.