May 21, 2001

Methionine

Livestock

Executive Summary

The NOSB received a petition in 1995 to add all synthetic amino acids to the National List. After deliberation of a review prepared by the TAP in 1996 and 1999, the NOSB requested a case-by-case review of synthetic amino acids used in livestock production, and referred three forms of methionine to the TAP.

All of the TAP reviewers found these three forms to be synthetic. Two TAP reviewers advised that synthetic methionine remain prohibited. The one reviewer who advises the NOSB to recommend adding synthetic methionine to the National List agrees that it is not compatible with organic principles and suggests limitations on its use until non-synthetic sources are more widely available.

The majority of the reviewers advise the NOSB to not add them to the National List for the following reasons:

1) Adequate organic and natural sources of protein are available [§6517(c)(1)(A)(ii)];
2) Methionine supplementation is primarily to increase growth and production, not to maintain bird health, and this is counter to principles embodied in the OFPA requirements for organic feed [§6509(c)(1)];
3) Pure amino acids in general and synthetic forms of methionine in particular are not compatible with a sustainable, whole-systems approach to animal nutrition and nutrient cycling [§6518(m)(7)].

Methionine is an essential amino acid needed for healthy and productive poultry. It is generally the first limiting amino acid in poultry diets. Synthetic ("pure") amino acids are produced either synthetically or from genetically engineered sources and involve the use of highly toxic and hazardous chemicals such as hydrogen cyanide, ammonia, and mercaptaldehyde. Synthesis of DL-methionine, and DL-methionine hydroxy analogs also result in significant pollution of the environment. These sources of methionine do not occur in nature.

Most amino acids are metabolized from protein, even in conventional feeding situations. Adequate levels of essential amino acids can be obtained in the diet of poultry fed adequate levels of intact protein from natural sources. Synthetic amino acids are used to improve feed conversion efficiency and lower feed costs.

Although there may be limitations in the current supply of diverse organic protein sources, a requirement for natural, non-GMO sources of methionine will stimulate market development in organic and approved feedstuffs. Other natural sources, such as fish meal, crab meal, and yeast are also available, and would be more compatible with organic standards than synthetic ones. Clarification of the status of some of these alternatives is needed. If synthetic substances are allowed to substitute for organic feed, that undermines the incentive to produce organic feedstuffs.

Humans have raised poultry for centuries without synthetic amino acids. Synthetic amino acids have become part of the standard poultry diet only over the past 50 years or so as production has moved from extensive pasture-based nutrition to high-density confinement systems.

Reliance on a higher protein diet to achieve necessary amino acid balance may result in higher excretion of uric acid that can form ammonia in the litter. Under an organic management system where there is access to the outdoors, suitable densities, and integrated management of manure and crop production this is not a problem. "Excess" nitrogen is not a waste problem in an organic system; it is a valuable resource that needs to be managed in an integrated and holistic way.

Methionine

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Identification

Chemical Names:
2-amino-4-methylthiobutyric acid and
α-amino-γ-methylmercaptobutyric acid

Other Names:
DL-methionine, D-methionine, L-methionine, Met, Acimethin

CAS Numbers:
59-51-8 (DL-methionine)
63-68-3 (L-methionine)
348-67-4 (D-methionine)

Other Codes:
International Feed Names (IFN):
DL-methionine: 5-03-86
DL-methionine hydroxy analog calcium: 5-03-87
DL-methionine hydroxy analog: 5-30-28

Poultry Production

Background:
This supplementary information was requested by the NOSB to be added to the 1999 Technical Advisory Panel general review of amino acids for use in livestock production. The NOSB tabled the decision in October of 1999 on amino acids for all livestock, and decided to consider only the use of methionine for poultry production. Supporting information for this use was received (Krengel, 2001) and this additional information is addressed in this review in addition to a more recent review of the literature.

Summary of TAP Reviewer Analysis [1]

Synthetic / Non-Synthetic:	Allowed or Prohibited	Suggested Annotation:
Synthetic (3-0)	Prohibit (2)	None.
	Allow (1)	Source must be non-GM. For poultry rations only. Only when alternatives are not available including ration diversity and acceptable animal and plant sources, or enzyme digested natural protein sources. Not to exceed 0.1% by weight in any feed source directly fed to poultry.

Characterization

Note: The description of composition, properties, and manufacturing process (how made) remains the same as provided in the 1999 TAP review. The sections on specific uses, action, combinations, regulatory status, and review under OFPA criteria 1,2,5,6, and 7 have been revised to consider poultry production.

Composition:
Amino acids have an amino group (NH_2) adjacent to a carboxyl (COOH) group on a carbon. The model amino acid for livestock production is methionine. The formula for methionine is $H_2NCH_3SCH_2CH_2COOH$.

Properties:

[1] *This Technical Advisory Panel (TAP) review is based on the information available as of the date of this review. This review addresses the requirements of the Organic Foods Production Act to the best of the investigator's ability, and has been reviewed by experts on the TAP. The substance is evaluated against the criteria found in section 2119(m) of the OFPA [7 USC 6517(m)]. The information and advice presented to the NOSB is based on the technical evaluation against that criteria, and does not incorporate commercial availability, socio-economic impact or other factors that the NOSB and the USDA may want to consider in making decisions.*

L-Methionine: Colorless or white lustrous plates, or a white crystalline powder. Has a slight, characteristic odor. Soluble in water, alkali solutions, and mineral acids. Slightly soluble in alcohol, insoluble in ether. MP 280-282°C. It is assymetric, forming both an L- and a D- enantiomer. Methionine hydroxy analog (MHA) is available in liquid form.

How Made:

Methionine may be isolated from naturally occurring sources, produced from genetically engineered organisms, or entirely synthesized by a wide number of processes. While methionine has been produced by fermentation in laboratory conditions, racemic mixtures of D- and L- methionine (DL-Methionine) are usually produced entirely by chemical methods (Araki and Ozeki, 1991). Methionine can be produced from the reaction of acrolein with methyl mercaptan in the presence of a catalyst (Fong, et al., 1981). Another method uses propylene, hydrogen sulfide, methane, and ammonia to make the intermediates acrolein, methylthiol, and hydrocyanic acid (DeGussa). The Strecker synthesis can be used with α-methylthiopropionaldehyde as the aldehyde (Fong, et al., 1981). A recently patented process reacts 3-methylmercaptopropionaldehyde, ammonia, hydrogen cyanide, and carbon dioxide in the presence of water in three reaction steps (Geiger et al., 1998). Other methods are discussed in the 1999 Crops Amino Acid TAP review. DL-methionine hydroxy analog calcium and DL-methionine hydroxy analog forms are considered to be alpha-keto acid analogues in which the amine group has been replaced by a hydroxy (OH) group. These forms are converted to the amino form in the bird by transamination in the liver, using non-essential amino acids such as glutamic acid (Cheeke 1999; Leeson 1991). These forms are produced by reacting hydrogen cyanide with an aldehyde that has been treated with a sulfite source to form a cyanohydrin. The aldehydes used are prepared from either hydrogen sulfide or an alkyl mercaptan with an aldeyhde such as acrolein and are then hydrolyzed using sulfuric or hydrochloric acid (USPO 1956).

Specific Uses:

The requested use for methionine in poultry production is as a feed supplement. For optimum health and performance, the animal's diet must contain adequate quantities of all nutrients needed, including amino acids. The essential amino acid furthest below the level needed to build protein is known as the limiting amino acid. A shortage of the limiting amino acid will constrain animal growth, reduce feed efficiency, and in extreme cases cause a nutritional deficiency. Supplementation with isolated amino acids increases feed conversion efficiency, thus lowering feed costs per unit of weight gain or production (Pond, Church, and Pond, 1995). Methionine is considered to be the first limiting amino acid in corn-soy poultry diets, followed by lysine and arginine (Baker 1989, NRC 1994, Cheeke 1999). An extensive literature has been published that documents the efforts to optimize the balance of amino acids in poultry diets in order to lower costs, reduce need for animal or fish proteins, replace soy meal with less expensive or more locally available plant proteins, and utilize plant proteins more efficiently (De Gussa 1995, 1996; North 1990; Neto, et. al. 2000; Cino 1999; Emmert 2000; DiMello 1994; Weibel 2000).

Amino acids are also used in livestock health care. Methionine is used as a urine acidifier because excretion of its sulfate anion lowers urine pH. Its sulfate anion may also displace phosphate from magnesium-ammonium-phosphate hexahydrate (struvite, double phosphate, or triple phosphate if calcium is also present) crystals and uroliths, which form best at a pH above 6.4-6.6. As a result of these effects, methionine is used to assist in dissolving and/or preventing uroliths, kidney stones, bladder stones, or urologic syndromes thought to be caused by struvite uroliths or crystals (Lewis, Morris, and Hand, 1987). Methionine is also used to assist in the treatment and/or prevention of hepatic lipidosis because of its need for body fat mobilization and transport.

Action:

Amino acids form protein. Of the 22 amino acids found in body proteins, the National Research Council lists 13 as essential in poultry diets, and these must be consumed in feed. These 13 are: arginine, glycine, histidine, isoleucine, leucine, lysine, methionine, cystine, phenylalanine, proline, threonine, tryptophan, and valine (NRC 1994). Five that are deemed critcial in poultry rations are methionine, cystine, lysine, tryptophan, and arginine (North, 1990).

Animals convert dietary protein into tissue protein through digestive processes. Proteins are metabolized by animals through two phases: catabolism (degradation from body tissue to the free amino acid pool) and anabolism (synthesis into body tissue). Amino acids utilized as proteins are primary constituents of structural and protective tissues, including skin, feathers, bone, ligaments, as well as muscles and organs.

Combinations:

Amino acids are combined in feed rations of grains, beans, oilseeds, and other meals with antioxidants, vitamins, minerals, antibiotics, and hormones (Pond, Church, and Pond, 1995). Methionine is a precursor in the diet to cystine, and the amount needed in the diet depends on the amount of cystine also present. Requirements for methionine are frequently cited in terms of methionine plus cystine, because methionine converts to cystine as needed.

Status

OFPA, USDA Final Rule

Amino acids do not appear on the list of synthetics that may be allowed according to the OFPA [7 USC 6517(c)(1)(B)(i)]. This list of permitted synthetics includes vitamins and minerals, livestock paraciticides, and medicines. Medicines can not be administered in the absence of illness (7USC 6509(d)(1)(C), and growth promoters including hormone, antibiotics, and synthetic trace elements may not be used to stimulate growth or production of livestock [7USC 6509(c)(3)]. Feed must be produced organically, and cannot contain synthetic nitrogen in the form of urea [7 USC 6509(c)]. Under the requirements of the USDA rule at 7CFR 205.237, synthetic substances added to feed must be listed under 205.603 or else will be prohibited at date of implementation.

Regulatory

Regulated as a nutrient / dietary supplement by FDA (21 CFR 582.5475). The Association of American Feed Control Officials (AAFCO) set the standard of identity for DL-methionine as containing a minimum of 99% racemic 2-amino-4-methylthiobutyric acid (AAFCO, 2001). The AAFCO model regulation states that "the term Methionine Supplement may be used in the ingredient list on a feed tag to indicate the addition of DL-Methionine" (AAFCO, 2001). AAFCO also lists a feed definition for DL-Methionine hydroxy analogue calcium (min. 97% racemic 2-amino-4-methylthiobutyric acid, 21 CFR 582.5477) and DL-Methionine hdyroxy analogue, (min. 88% racemic 2-amino-4-methylthiobutyric acid, 21 CFR 582.5477).

Status among Certifiers

Current published standards shows that two U.S. certifiers clearly prohibit amino acids (OCIA 2000; CCOF Intl. 2001) and some explicitly allow (FVO 2001; Oregon Tilth 1998; QAI 1999 - for nonruminants). Various other state and private certifiers either explicitly or implicitly allow the use of essential amino acids. The status among U.S. certifiers remains unresolved awaiting a recommendation by the NOSB.

Historic Use

The history of use in organic production is not clear due to lack of specific mention in most agency standards. The widepread use of crystalline (pure) amino acids in formulated rations has expanded greatly since 1980 for non-organic poultry production. Most current use in organic poultry production appears to be as a supplement for broilers (meat chickens) and turkeys as well as for laying hen feed rations.

International

CODEX - The Codex Draft Guidelines for Livestock production, approved May 2000 (Alinorm 01/22 Appendix II Annex 1. B. item 18) state that:

- feedstuffs of mineral origin, trace elements, vitamins, or provitamins can only be used if they are of natural origin. In case of shortage of these substances, or in exceptional circumstances, chemically well-defined analogic substances may be used;
- synthetic nitrogen or non-protein nitrogen compounds shall not be used.

This draft is considered to be at step 8 of the Codex process, and will go the Codex Alimentarius Commission in July 2001 for adoption (Joint FAO/WHO Standards Programme). This was considered to prohibit urea, (Lovisolo, 2001) and appears to also prohibit synthetic amino acids.[1]

EU 2092/91 - The European Standards do not include amino acids among permitted feedstuffs (European Union, 1999).

[1] Non-protein nitrogen compounds include substances such as urea and ammoniated materials (AAFCO, 2001). In the technical literature, non-protein nitrogen is considered to include "free amino acids, amino acid amides, glucosides containing nitrogen, nuleotides, urea, nitrates, ammonium salts and other low-molecular weight compounds containing nitrogen" (Boda, 1990).

IFOAM - Amino acids are prohibited for use in feed by IFOAM (IFOAM, 2000). IFOAM also supported the interpretation of the CODEX prohibition of non-protein nitrogen to extend to pure amino acids (Schmid, 2001).

Canada - Canadian standards allow essential amino acids, but explicitly prohibit ones from genetically engineered sources and state that the material may have some additional requirements. Operators are instructed to consult with their certification body for approval (Canadian General Standards Board, 1999).

OFPA 2119(m) Criteria

(1) *The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems.*
The primary chemical interaction is the dietary intake by animals. While many of the interactions may be regarded as beneficial, excess methionine in a diet may cause deficiencies in other amino acids and induce toxicity (D'Mello, 1994). Methionine, while often one of the most limiting amino acids, is also one that readily goes to toxic excess. Small excesses of methionine can be deleterious (Buttery and D'Mello, 1994). Errrors in feed formulation or excess supplemental methionine can actually depress growth and development at levels of 40 g/kg (4.0%) (Baker, 1989, NRC 1994). Excess methionine exacerbates deficiencies of vitamin B-6, which results in depressed growth and feed intake (Scherer, 2000). Growth depressions resulting from excess supplemental amino acids include lesions in tissues and organs (D'Mello, 1994). Methionine is "well established as being among the most toxic of all amino acids when fed at excess levels in a diet" (Edmonds and Baker, 1987 cited in Scherer, 2000).

(2) *The toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment.*
While it is nutritionally essential, methionine excesses are far more toxic to poultry than similar excesses of tryptophan, lysine, and threonine (National Research Council, 1994). Force feeding methionine to excess can result in death to chicks (National Research Council, 1994). However, NRC acknowledges that such toxicities are unlikely in practical circumstances for poultry, in that an amino acid toxicity requires a particularly high level of an amino acid relative to all others. Supplemental levels fed to poultry are usually fed at lower levels, ranging from 0.3 - 0.5% of the diet. Susceptiblity of an animal to imbalances and excesses is influenced by the overall protein supply, and animals that are fed relatively high levels of protein are more tolerant (Buttery and D'Mello, 1994).

A dosage of 2 g / mature cat / day (20 to 30 g / kg dry diet) for 20 days induces anorexia, ataxia, cyanosis, methemoglobinemia and Heinz body formation resulting in hemolytic anemia (Maede, 1985). Rat studies of methionine is significantly toxic in excess (Regina, et al., 1993). High levels of methionine were found to be toxic to hepatic cells and liver function of the rat models. The results of this study indicated that the biochemical reason for the extreme sensitivity of mammals to excess dietary methionine is thought to be due to the accumulation of toxic catabolites, most notably, S-adenosylmethione, resulting in liver dysfunction. L-methionine has an acute LD_{50} of 4,328 mg/kg (rat) (NIEHS, 1999b). NIEHS carcinogenicity and teratogenicity are not available, but reports positive mutagenicity (NIEHS, 1999b).

Methionine is stable in crystalline form at standard temperature and pressure.

(3) *The probability of environmental contamination during manufacture, use, misuse or disposal of such substance.*
Synthetic production of DL-methionine involves a number of toxic source chemicals and intermediates. Each of the several manufacturing processes used to produce DL-methionine was rated as either "moderately heavy" to "extreme" (Fong, et al., 1981). Newer processes have not replaced many of the feedstocks. Several of the feedstocks are likely to result in ruptured storage tanks, leaking chemicals, and releases into the environment. The methionine production process is listed by EPA as a hazardous air pollutant (40 CFR 63.184).

Methyl mercaptan can react with water, steam, or acids to produce flammable and toxic vapors (Sax, 1984). The EPA rates methyl mercaptan fires as highly hazardous and can cause death by respiratory paralysis (EPA, 1987). Acrolein has a toxicity rating of 5 (on a scale of 1 to 6 with 6 being most toxic) (Gosselin, 1984) and it is also an aquatic herbicide (Meister, 1999). The acrolein process involves several steps that render it synthetic as well (1994). Acrolein itself is an extreme irritant.

Hydrogen cyanide is produced by further processing of methane and ammonia. Hydrogen cyanide is a gas that is highly toxic. Hydrogen cyanide has a toxicity rating of 6 and is one of the fastest acting poisons known to man (Gosselin, 1984). Exposure causes paralysis, unconsciousness, convulsions, and respiratory arrest. Death usually results from exposure at 300 ppm concentrations for a few minutes. Manufacture of hydrogen cyanide is a significant source of atmospheric release of cyanide (Midwest Research Institute, 1993). Ammonia is a corrosive agent. Methane is a central nervous system depressant (Gosselin, 1984).

(4) The effect of the substance on human health.
Methionine is essential in small amounts in the human diet, and is sold over-the-counter as a dietary supplement. The L- form of methionine is used extensively in human medicine for a variety of therapeutic purposes, including pH and electrolyte balancing, parenteral nutrition, pharmaceutical adjuvant, and other applications. It is in fact one of the top 800 drugs in human medicine (Mosby, 1997). Methionine may cause nausea, vomiting, dizziness, and irritability and should be used with caution in patients with severe liver disease (Reynolds, 1996).

The D- form of methionine is not well utilized by humans (Lewis and Baker, 1995). Individuals may have allergic reactions to the D- isomers or a racemic mixture of DL-methionine. While a number of amino acids are considered GRAS for human consumption and as feed supplements, DL-methionine is not (see 21 CFR 172, 21 CFR 184, and 21 CFR 570.35). DL-methionine is unique among amino acids cleared for food use in that it is the only one listed that explicitly says it is not for use in infant feed formulas (21 CFR 173.320). When heated to decomposition, methionine emits dangerous and highly toxic fumes (NIEHS, 1999).

(5) The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock.
Interactions and Imbalances
Protein is required for body development in all growing birds, and layers also need a good proportion since eggs consist of 13-14% protein. Broilers also need high energy diets as they are commericially raised to grow rapidly to reach about 4.4 lbs in 8 week at a desired food conversion rate of 1.8 (consuming less than 8 lbs of feed total) (Sainsbury, 2000). This is a 50-55 fold increase inbody weight by 6 weeks after hatching, which leads to a high amino acid requirement to meet the need for active growth (NRC 1994). The dietary requirement for protein is actually a requirement for the amino acids contained in the dietary protein. Protein quality is related to the proper balance of essential amino acids in the diet. The presence of nonessential amino acids in the diet also reduces the necessity of synthesizing them from the essential amino acids (NRC 1994).

Amino acids in the body are constantly in flux between three states: stored in tissue, oxidized from tissue to free amino acids, and digested and excreted as uric acid. If some nonessential amino acids are low, they may be synthesized from others in the free amino acid pool, or degraded from those stored in tissue. Deficiencies or excesses of a particular amino acids can cause problems in availability of other amino acids (Buttery and D'Mello 1994; Baker 1989). Intact proteins (as in natural grains) are more slowly available in the digestive system, while pure sources of amino acids are more bioavailable than intact-protein sources (Baker, 1989). Excesses of some amino acids in an unbalanced source of crude protein can reduce feed intake and depress amino acid utilization (Pack, 1995). Depressed feed intake and growth at excess intake levels of protein has recently been attributed to insufficient supply of vitamin B-6 which is required to metabolize the sulfur amino acids (Scherer and Baker 2000).

The requirement for sulfur containing amino acids of methionine, cystine, and cysteine can be misjudged due to inaccurate accounting for the availability of cystine in the diet (NRC, 1994).

Other cases have shown significantly higher weights and faster gains from amino acid (lys+met) supplementation (Slominski et al, 1999). Also, the digestibility of practical ingredients, such as corn and soybeans, appears to be on the order of 85% or more (NRC, 1994).

Amino acid requirements may be affected by environmental temperature extremes, basically because of the effect on feed intake, but amino acid supplementation will only affect weight gain if it improves feed intake (Baker 1989; NRC 1994). Interactions between deficiencies of methionine and several vitamins and minerals have also been documented, and suggest that other dietary factors in addition to total protein have an effect on the efficency of amino acid utilization (Baker, D.H. et.al, 1999).

Environmental Impact

Managing the nitrogen cycle is seen as a challenge to livestock producers (Tamminga and Verstegen, 1992; Tamminga, 1992; Morse, no date). Poultry layer operations are experiencing increased costs and regulations for manure management (Sloan, et al., 1995). Supplementation with amino acids may allow dietary protein and excretory nitrogen levels to be reduced with a minimum reduction in egg output and no loss in weight gain in broilers (Summers, 1993; Sloan et al., 1995, Ferguson, et.al 1998). Excess ammonia build up in poultry houses can be a hazard to workers and birds if not properly ventilated (Ferguson, 1998).

Feeding systems that reduce levels of protein fed using amino acid supplementation are not the only means identified to reduce nitrogen pollution from animal manure. Other potential solutions include lower animal densities; more frequent rotations; better manure storage, handling, and application techniques; use of enzymes; improved processing of the feed; and selection of more appropriate land and locations to graze and shelter animals (Archer and Nicholson, 1992; Tamminga, 1992; Tamminga and Verstegen, 1992). Increased digestiblilty of protein in feeds suplemented with microbial phytase provided better availabilty of most of the amino acids other than lysine and methionine and allowed for reduced P and Ca levels in feed, a goal in reducing phosphorus overload from poultry manure (Sebastian 1997). Another study found that reduced crude protein and energy content were needed in enzyme supplemented broiler diets, although availability of individual amino acids were not improved equally and were still deemed to need balancing (Zanella, et al 1999).

One grower reported success with innovative housing design that allows twice daily cleanout of manure, combined with a commercial composting operation (La Flamme, 2001). Manure from organic operations has potential added value to organic crop farmers seeking to avoid manure from conventional operations. Some markets in the EU require that imported crops are documented to be grown free of "factory farm" manure, requiring additional verification from U.S. certifiers (McElroy, 2001).

Impacts on Bird Health

A number of reports cite a benefit of methionine supplementation on reduced immunologic stress (Klasing, 1988; Tsiagbe et al, 1986). Immunologic stress is considered to be a response to microbial challenges, in these experiements due to injections of E. coli and Salmonella and other pathogens. This causes decreased feed rates and lower rates of growth. Chicks that received deficient levels of methionine were more subject to an impaired immune response. These experiments seem to be more applicable to a high density confinement system or high density production system in terms of bird treatment, and may not be very relevant to an organic system approach.

A problem exacerbated by excess methionine is hepatic lipidosis, a condition of excessive fat in the liver commonly associated with caged birds and is related to the fact that wild diets are much lower in fat than seed diets fed to captive species (Aiello, 1998). This can be mangaged by a well balanced diet, and is reportedly not a problem in free range birds in organic systems (Krengel, 2001). Enteritis is a disease frequently observed in poultry that do not have access to the soil and green growing plants (Titus, 1942). Well managed pasture would prevent this cause of the disease.

Reduced feathering has been reportedly linked to lack of methionine and cystine (Elliott, no date). Many other factors are also involved, including deficiencies of other amino acids, vitamins, zinc, feather pecking in cage systems, and cannibalism (Elliot, NRC 1994). Increased protein level is correlated with reduced feather loss and cannibalism (Ambrosen, 1997).

(6) The alternatives to using the substance in terms of practices or other available materials.

Birds raised on pasture with access to insects and worms historically did not need supplementation (Morrison, 1951), and smaller scale pastured operations have success without the need for synthetic supplements (Salatin, 1993). Pasture quality will vary according to field conditions and the season. However, free range poultry on well managed pasture are able to supplement their diets with insects, annelids, and fresh green forage (Smith and Daniel, 1982). The two most limiting amino acids, methionine and lysine, are found in richest sources in proteins of animal origin. Common natural sources of these amino acids have traditionally been fish meal and meat meal, especially for starter chicks and broilers (Sainsbury, 2000). The USDA organic program final rules do not allow the use of meat meal as feed for poultry or mammals and may or may not allow fish or crab meal (7CFR 205).

Diets can be formulated without supplemented synthetic acids to meet the objective of adequate methionine percentages, but this usually requires an increase in crude protein level of the diet (Hadorn, 2000). Many studies have been done to identify a cost effective method of lowering protein content by supplementing with methionine and lysine. Often the control treatments are non-supplement grain based diets. A comparison study using supplemented and non-supplemented diets found that adequate dietary methionine can be attained, at a cost of higher intake of protein and less protein efficicy ratio (Emmert 2000). Another study fed a control diet using only corn and soy to satisfy amino acid levels compared to reduced protein supplemented with methionine and lysine, and these treatments were considered successful because performance was not lowered in 4-5 experiments (Harms, 1998).

Rice and casein offer potential novel available sources of methionine (Lewis and Bayley, 1995). Yeast protein has long been known as a rich protein source relatively high in methionine+cystine (Erbersdobler, 1973; National Research Council, 1994), as well as phosphorous and B-complex vitamins (Morrison, 1951). As a natural feed supplement, NOSB should advise whether yeast is considered agricultural and required from organic sources or permitted as a natural substance. Other potential sources of available methionine for poultry appear to be sunflower meal and canola meal (Waibel et al., 1998). These natural sources are all currently of limited availability in organic forms. Alfalfa meal is reported to be a good additional protein source, though difficult to blend in commercial formulations. Optimally balancing these nutrients may be challenging to feed processors and livestock producers.

Feed sources with high percentages of methionine are bloodmeal, fish meal, crab meal, corn gluten meal, and sunflower seed meal (National Research Council, 1994). If fish meal were permitted, there is a lack of supply that does not contain ethoxyquin, a synthetic antioxidant not permitted under the final rules. A limited supply of fish meal preserved with natural tocophorols has gone mostly into the pet food market (Mattocks, 2001). Corn gluten and sunflower seed meal are not currently very available in organic form, and feed formulators and nutritionists have reported difficulty in meeting NRC requirements for methionine based on currently available organic plant protein sources (Mattocks, Morrisson, Simmons, 2001). One feed mill operator feels he can meet even broiler needs with a combination of crab meal (at 75 lbs/ton or 3.75%) and organic corn gluten (Martens, 2001). Crab meal is a by-product of crab processing and not treated with preservatives but has limitations due to salt content. Another certified feed mill produces layer and range broiler rations without synthetic amino acids based only on plant products, including corn, soy, barly, oats, wheat, field peas, and flaxmeal. These products are labeled at a minimum of 0.3% met and 0.6% lysine, but reportedly achieve good results (White 2001, VOG).

NRC requirements for amino acids and protein are designed to support maximimum growth and production. The recommended levels for methionine in poultry depend on species, stage, and level of feed consumption. For chickens, recommendations for layers range from 0.25% to 0.38% and for broilers 0.32 - 0.50%. NRC notes that maximum growth and production may not always ensure maximum economic returns when protein prices are high, and that if decreased performance can be tolerated, dietary concentrations of amino acids may be reduced somewhat to maximize economic returns (NRC, 1994). Methionine is known to have a direct effect on egg weight (size) and rate of lay, and is used by some producers to manipulate egg production to meet market needs, such as to increase egg size in younger birds, reduce it in older birds, or produce more eggs in off peak market periods (NRC 1994; Harms 1998; Simmons 2001). A reduction in rate of gain in broilers (longer time to finish) would be an outcome of lower than optimal methionine levels. Unless the diet contained other forms of sulfur containing amino acids (cystine or cysteine), problems with inadequate feathering might be encountered (Simmons, 2001).

Temporarily confined poultry can be fed a practical organic corn / soybean ration. Depending on market conditions and on how other parts of the standards evolve, novel organic products can be developed as supplements. Among the potential alternative sources include organic dairy products such as casein (National Research Council, 1982 and 1994).

Macroorganisms commonly found in healthy pasture soils cannot be discounted as a source of nutrient cycling in free-range poultry systems. Given the natural feeding habits of poultry and other birds, the use of earthworms is a logical source of protein in chicken feed (Fisher, 1988). Earthworm populations in a pasture depends on a number of factors (Curry, 1998). The amino acid content of earthworms will vary depending on species and food source. However, earthworms have been found to accumulate and concentrate methionine found in the ecosystem in proportions greater than for other amino acids (Pokarzhevskii, et al., 1997). As a feed supplement, earthworms have been found to equal or surpass fish meal and meat meal as an animal protein source for poultry (Harwood and Sabine, 1978; Toboga, 1980; Mekada et al., 1979; and Jin-you et al., 1982 all cited in Edwards, 1998).

Earthworms can play a role in moderating nitrogen losses as well. Enzyme treatment of feedstuffs can improve amino acid availability and also reduce nitrogen pollution (Tamminga and Verstegen, 1992), as can changes in stocking density, rotations, and manure handling.

(7) Its compatibility with a system of sustainable agriculture.

In 1994 the NOSB recommended that feed and feed supplements be produced organically. When considering the review of feed additive vitamins and minerals, an NOSB statement of principles advised that non-synthetic viamins and mineral sources are preferable when available. The NOSB also advised that a farm plan should reflect attempts to decrease or eliminate use of feed additives when possible (NOSB, 1995).

A constraint to optimal production in modern organic systems that are not able to utilize pasture based systems appears to be adequate organic sources of the first limiting amino acid, methionine. The allowance of isolated amino acids facilitates the use of the lowest cost, non-diverse corn-soy ration. It is the basis of conventional confinement animal production systems which may be considered as antithetical to the principals of organic livestock production. The source and method of production of synthetic amino from non-renewable fossil fuels and toxic chemicals is also questionable in compatiblilty with system of sustainable agriculture.

The use of synthetic amino acids increases animal production by increased efficiency of protein conversion, which lowers feeding costs and reduces nitrogen content of the waste output. While this is not by itself unsustainable, synthetic amino acids discourage the integration of a whole-systems approach to cycling nutrients, particularly nitrogen, as part of an integrated crop-livestock production system. Allowance of synthetic sources of amino acids may discourage market development of organic plant sources, such as seed meals.

Increased efficiency of protein conversion reduces the amount of nitrogen excreted (Summers, 1993; deLange, 1993). The cycling of nutrients from animals is part of an integrated farming system, and the environmental effects of manure management requires looking at the big picture (Archer and Nicholson, 1992). What is viewed as a liability in confinement animal systems—nitrogen production—is seen in cropping systems as a limiting factor resource. Reduction of nitrogen pollution may require improved range or pasture management, and with that either more frequent rotations or lower stocking rates.

TAP Reviewer Discussion[2]

Reviewer 1 *[Eastern –Ph.D. Senior Research Chemist, reviewer in organic certification agency]*

Commercially available amounts of Methionine can only be produced synthetically. All current routes are modification of the Strecker synthesis, and they share the same raw materials: acrolein, methanethiol (methyl mercaptan), along with various sources of ammonia and cyanide (McPherson, 1966; Gerhartz, 1985). The fundamental raw materials are hydrocarbons, sulfur, inorganic salts, and Nitrogen (McPherson, 1966).

Methionine (Me) fed to livestock is a synthetic source of non-protein Nitrogen. Being an amino acid, it can be directly utilized in protein synthesis and, in effect, substitutes for protein derived from foodstuff. Me is metabolically linked with cystine and choline and is necessary for producing keratins used in feather growth (NAS Nutrition Req. of Poultry, 1994; Elliot no date). It is also considered the main limiting amino acid in modern poultry diets (NAS Nutrition Req. of Poultry, 1994). Me deficiency has become a problem in recent years due to the increasing use of low cost soybean protein and bird genetic selection for increase broiler growth or egg laying ability. High protein

[2] *OMRI's information is enclosed is square brackets in italics. Where a reviewer corrected a technical point (e.g., the word should be "intravenous" rather than "subcutaneous"), these corrections were made in this document and are not listed here in the Reviewer Comments. The rest of the TAP Reviewer's comments are edited for any identifying comments, redundant statements, and typographical errors. Text removed is identified by ellipses […].Additions to the TAP review text were incorporated into the review. Statements expressed by reviewers are their own and do not reflect the opinions of any other individual or organizations.*

diets are necessary for fast growth but low feed cost are needed in business plans seeking to increase market share for Organic poultry products. In order to address the need for synthetic Me in Organic poultry management, several questions need to be considered:

- Is synthetic Me necessary to grow healthy poultry?

- Are there food-based protein that can economically provide balanced protein (including Me), maintaining both bird health and producer economic viability?

- Is a management system that relies on a critical synthetic feed additive consistent with the principles of Organic Agriculture?

The increasing need for Me is founded in the simplification of poultry diet to corn+ soybean + minerals that started in the 1950's (Baker, 1989). Corn is one of the best energy sources of the grains (Wright 1987). However, its protein level is low (~ 8%) and a corn based diet is low in Lysine (Wright 1987). Soybean is high in protein and is an economic source of Lysine. It is low in Me, however, and diets that use soybean to increase protein (for broiler growth or more eggs) can cause Me to become the limiting amino acid (Garcia, Pesti, and Bakalli 99; Waibel et. al. 1999).

The low concentration of Me in high-protein corn/soybean feed mixes has lead to wide use of synthetic Methionine supplementation in poultry feed mixes. Methionine is found in many feed mixes (both Organic and traditional) as an individual component and also contained in vitamin/mineral packs. Many poultry rations contain Me in both forms. Both the NAS and the Merck Veterinary Guide (8'ed 1998) set around 0.3 wt. % of total ration, which is higher than available in the average corn/soybean mix.

The NAS recommended Me level is set for maximum performance. The report states "The protein and amino acid concentrations prescribed as requirements herein are intended to support maximum growth and production" (NAS Nutrition Req. of Poultry, 1994 p. 10). The NAS report and the studies supporting Me supplementation reviewed primarily use growth rate to determine proper Me levels in the diet (either total weight or percentage of breast meat), (Tsiagbe et. al 1987; Edwards and Baker, 1999; Garcia et al 99, Waibel et al 1999; Degussa Feedback Nov 1995 and March 1996). Reduced growth rate can be a symptom of amino acid deficiency (D'Mello). However, this type of growth retardation is accompanied by other physiological changes that take place to compensate for the deficiency. These changes can be hematologically measured (Torun 1979). In true deficiency, total body nitrogen balance would also go negative (Wintrobe et. al. 1970). The above reports do not present evidence clearly showing that the unsupplemented slow growing birds studied are malnourished.

Lower than desired growth (or egg production) can also be due to less than optimal protein utilization in high protein rations. This is an economic consideration, not a health one.

True deficiency in sulfur-bearing amino acids can cause improper feathering (Elliot, no date). Elliot notes that Me supplementation can improve feathering. The paper does not give a minimum Me level, or describe how feathering is effected by the interactions of Methionine, Cystine, and Choline. Tsiagbe et. al 1987 b note that the immune response of chicks challenged with an antigen changes with supplemental Me. Me was observed to activate certain parts of the chick's immune system. The mechanism was unclear and the therapeutic effectiveness of Me supplementation was not studied. Enhancing poultry immune response to infectious diseases could be an important benefit of ration based Me; especially as aid in fighting Newcastle's Disease. The data seen so far, however, is equivocal. Therefore, this reviewer must conclude that the primary use of crystalline Me in the current petition is to balance corn/soybean rations for maximum feed utilization and poultry productivity.

As related in the body of this TAP review, pastured-based poultry can adequately maintain a proper diet (Salatin, 1993). Before the widespread availability of crystalline amino acid supplements, livestock nutritionists recommended mixing different types of food stuffs to achieve a supplementary relationship between the different proteins (Maynard and Loosli, 1962; Hart and Steenbock, 1919). This system used a combination of grains, roughage such as alfalfa, and a source of high quality protein such as gluten meal, whey, milk, or tankage. Hart and Steenbock found that swine fed corn + milk has initial better weight gains and produced less feces that swine fed corn + milk + alfalfa. The absence of roughage, however, led to long term deleterious health effects and shortened life span.

Dairy products (whey or powdered milk) contain good quantities of Me. Fresh and powdered organic cow's and goat are both available. Their availability should increase as more organic processed food products appear on the market.

Corn Gluten Feed (CGF) is also available and a good source of Me (crude protein usually 21 %). CGF has intermediate metabolizable energy (ME) and is low in lysine, tryptophane, and Calcium (Wright, 1987). It can successfully substitute for part of other high protein ration components (Wright, 1957). Corn gluten meal is a much better protein source. It is 60% protein, high Me, and is a good source of Me and cystine (Wright 87). It is low in lysine and tryptophane but is complemented by the amino acid balance in soybean.

Several other plant-based protein sources are discussed in the main body of this TAP review. All plant-based poultry rations with Me levels of 0.3% are currently on the market and have been shown to produce 4 lb. broilers in eighth weeks (White, 2001). Animal-based protein sources are also available. Animal-based protein is consistent with the specific needs of chickens and turkeys; both being natural omnivores. Crab meal is an excellent balanced protein source that is close to the birds' natural prey. Crab meal needs to be balanced with other feed ingredients to minimize salt in the diet and to keep the crab meal and mineral supplements within the 5% nonorganic ingredient limit (local certification agency requirements) (Martens, 2001).

Rations that supply adequate Me for maximum poultry growth and egg production appear to exist. Some of these diets will be initially more expensive than the corn/soybean + crystalline methionine ration. The production and distribution systems for Organic feed corn and soybeans are established and large scale. Except for crab meal and corn gluten meal that are currently being used in poultry feed, the other soybean substitutes are mostly being sold into other markets. As the poultry market develops for these rations, prices will certainly fall.

Some producers have argued that current bird genetics are optimized for corn/soybean rations, and that production would suffer if other protein sources were substituted for part of the soybeans. Producers of pastured ruminates and poultry are facing and solving similar problems. Older breeds of poultry still exist and people such as Tom Shelly of Virginia are actively working to breed back older traits into over-specialized poultry. Companies like Tysons also have active programs of collecting poultry genetics from around the world and this type of information could be used to guide breeding work. The switch from soybean + Me to soybean + other high Me protein source is not too large for current poultry genetics to handle, but if genetics need to be fine-tuned again, stock and breeders are available.

Methionine appears to present no human health problem. Crystalline Me is well utilized by poultry (Baker 1989) and risk to humans from poultry products or excretions is minimal (Kleeman et al 1985). Excreted Me also appears to pose no environmental problems. It is rapidly photo-degraded in surface water, and is readily metabolized by bacteria in sediments (Kiene and Visscher, 1987).

Several methionine feedstocks, however, present both environmental and human health difficulties. Hydrogen Cyanide is a poisonous, flammable gas that is unstable in the presence of moisture. The low boiling and flash points make Hydrogen Cyanide especially hazardous [25.7 ° C. and -17.8° C. respectively] (Klenk et. al. 1987). Acrolein is a flammable and toxic liquid. It is highly volatile (flash point - 26° C.) and can explosively polymerize if exposed to many contaminants (Ohara et. al. 1987).

Synthetic amino acid supplementation can lower nitrogen emissions of poultry excreta by reducing the crude protein (food) in the diet (Ferguson, 1998). Synthetic amino acids are more absorbable than protein bound amino acids and can be balanced to minimize the amount of amount of protein catabolized to correct for a limiting amino acid. Careful control of temperature and humidity can also be used to further reduce nitrogen loss due to metabolic activity to maintain body temperature.

Reduction in bird nitrogen emissions has been argued to decrease ventilation energy usage. Less energy used to ventilate poultry houses may be real (no data given). However, is the energy used to product the quantity (feed + synthetic AA + house energy) more or less than that needed to produce (more feed + house energy)? Each amino acid needs different amounts of energy (in fossil fuel equivalents FFE). For example, the Me feedstock Hydrogen cyanide requires reaction temperatures of 1300° to 1500° C. during production ((Klenk et. al. 1987). The reviewer can not estimate whether savings in ventilating poultry houses is greater than the energy used to make the synthetic amino acids in the feed. A few years ago, the Green plastics industry touted that plastics made from agricultural products used less FFE than plastics derived from petrochemicals. Detailed and conservative calculations showed the opposite to be true (Gerngross, 1999).

Simple Me supplementation will have no major effect on amount of manure birds produce or on global nitrogen cycling. Another amino acid will become the prime limiting and the food-based protein will be inefficiently utilized. The idea of a synthetic diet, however, puts Me into a larger context. Food utilization is inefficient. Individual organisms in an ecosystem are very poor utilizes of resources. Animals leave many nutrients behind as manure, seed is a small proportion of plants biomass, and large batch microbial fermentation creates so much heat that the organisms would die unless cooled by an outside energy source. Ecosystem (or agro-ecosystem) efficiency can only be seen when the whole system is considered. One organism's waste is another one's food.

The American Organic Standards principles of Organic Production and Handling state that "Organic agriculture is based on holistic production management systems which promote and enhance agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. Organic agriculture emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. These goals are met, where possible, through the use of cultural, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill specific functions within the system." (AOS standards Oct 1999).

A synthetic diet is an attempt to isolate a part of an agro-ecosystem and then fine tune this part into efficiency. This process requires external inputs. The use of an amino acid supplement like Me to increase feed utilization efficiency is food substitution. Fundamentally, there are many similarities between amino acid substitution by synthetic Me and nitrogen substitution by feeding synthetic non-protein NPK compounds like Urea (NAS, 1976; Featherston, 1967). Feeding urea to livestock is prohibited (7 CFR Part 250.237.b.4).

The evidence presented to this reviewer indicates that synthetic Methionine supplementation is currently used to increase feed utilization. Poultry rations composed of natural food stuffs can give adequate Me levels in both broilers and layers. Methionine should therefor be considered a prohibited synthetic substance.

If the NOSB decides to prohibit Methionine poultry supplements, this reviewer would request that a phase-out period be established to allow producers to find different protein sources (to enhance soybeans) without disrupting their own operations or the current markets for the alternative protein sources. I would also request that the petitioners for Me supplements further research the possible immune enhancing effect of Me. If it is efficacious against infectious poultry diseases, I would hope that they would re-petition for that [medical] use.

[Conclusion:]
Methionine should be prohibited. Suitable high protein feed sources are available. Methionine supplementation is primarily to increase growth and production, not to maintain bird health.

Reviewer 2 [*Midwest--veterinarian performing product research and development, including organic feed formulation*]

[Agrees that the database is accurate, and agrees with the evaluation of OFPA criteria with the following comments.]

[Criteria 3 -The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems;]
I agree with the criteria evaluation, and add the following: Methionine is widely used in the general poultry ration business. Its rates of inclusion are well understood and unlikely to be misused, misformulated, or cause detrimental interactions or results.

[Criteria 5 - The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility in the soil), crops and livestock]
I agree with the criteria evaluation with the following comments: The requirement of sulfur containing amino acids can also be misjudged due to outdated tables showing the typical nutrient content of feeds. This is especially true for the recent past corresponding to the increase in synthetic sulfur containing amino acids. The Clean Air Act provisions reducing atmospheric sulfur levels and minimal applications of sulfur containing fertilizers lead to less than optimal sulfur supplies needed for plants to make sulfur containing amino acids.

[Criteria 6 - The alternatives to using the substance in terms of practices or other available materials]

I agree with the criteria evaluation with the following comments:

Lower than predicted levels of sulfur containing amino acids in plants grown with lower than optimal levels of soil sulfur means that pastured animals may no longer be able to meet their requirements as once thought.

Pasturing is recognized as not feasible in many temperate climates on a year around basis. The short life span of broilers and cyclic nature of laying hens means meeting these animals' nutritional requirement strictly through access to pasture is impossible for some poultry producers.

Alternative animal protein sources are readily available in the feed industry. The suitability of these sources for organic production is of question. Much fish, crab, and shrimp meal result from harvesting natural populations of these animals. Are these natural supplies considered organic based on current knowledge of oceanic pollution? Organic aquaculture is not a large enough industry to support the needs of the poultry feed industry, nor does it appear that it will be for quite some time, if ever. The antioxidant additives used on high oil fish meal (menhaden, anchovy, etc.) are also questioned for organic suitability.

The decision may come down to 'the lesser of two evils'. Should synthetic amino acids be allowed or should natural proteins with some questions be allowed? Either way, they should be restricted to those species that specifically need them, more specifically poultry.

[Criteria 7 - Its compatibility with a system of sustainable agriculture]
I agree with the criteria evaluation with the following comments: Synthetic amino acid use discourages diversity of animal feed sources (e.g. typical corn - soybean diet).

[*Discussion]*
The letter [Kringel, 2001] overstates the hardships of ration diversity for poultry rations. Sources such as barley, wheat, and ground alfalfa are used in rations in my area. The alfalfa is only difficult for milling operations to mix. On farm mixers have no problem with it.

My experience in poultry rations is that some source of methionine is necessary for acceptable growth, egg production, and health. The use of synthetic methionine appears to be geared toward maximizing production in the majority of cases. The primary reason that most feed companies utilize it is that it allows them to use only corn and soybeans as grain sources in cheaper rations. This means fewer bins, large supplies of cheap grain, and easier blending.

Birds will survive with lower than NRC levels of methionine, but they will grow slower, produce less eggs, and have some disease problems such as pecking disorders.

Yeast is not a feasible option at this time due to availability. There are also some questions regarding the GM status of grains used in producing several types of yeast products suitable for animal feeding, primarily in the brewers and distillers yeast products.

Limiting the synthetic methionine included in rations to 0.1% would help alleviate my concern of limited ration diversity. Philosophically there may be some question. If it is good enough to use 0.1%, why not the full rate? Even so, I am in favor of the 0.1% level maximum as an annotation.

Genetics for modern lines of birds does seem to have a bearing on methionine requirement according to some poultry gurus I have talked to in the past. They say it is true of laying hens as well.

[Conclusion – Summarize why it should be allowed or prohibited for use in organic systems.]
The only valid reason I can find for this material to be allowed is that no good alternatives exist that meet current organic standards. The merits of the material itself would indicate that it should be prohibited. One possible compromise may be to place the material in the restricted use category similar to synthetic minerals and vitamins. Restriction annotations could include "only when alternative sources, such as diverse protein source ingredients or suitable animal proteins (e.g. fish, crab, shrimp, whey, etc.) are not available." This annotation leaves a big loophole. Feed producers can easily say that no alternatives are available, and who is going to subjectively decide what alternatives are suitable or adequate nutritionally?

A second alternative is to list a synthetic methionine use level restriction of 0.1% of the ration. This can be avoided by feed manufacturers simply by saying that a grain blend is to be used with some other feed source, such as pasture. Maybe a better restriction is 0.1% maximum in any feed or blend of feed used for poultry.

Another alternative is to table the decision on synthetic amino acids in general and immediately evaluate the aquatic sources of natural sulfur containing amino acids. A decision would have to be made as to what may be acceptable for these sources and whether these sources are more acceptable than the synthetic amino acids or less acceptable. One of these two materials appears to be necessary to raise poultry under the conditions encountered by many producers.

[*Additional Comments*]
My personal recommendation is that the natural aquatic animal sources are the better method for obtaining sulfur containing amino acids. I think that natural populations of aquatic life should be acceptable to the organic feed industry. Farm raised aquaculture should meet organic production standards for inclusion into organic rations.

After reading all the comments from various sources included in the information packet, I think the only real issue for aquatic sources is that of the antioxidants. One issue is that ethoxyquin is sometimes not listed on the label of some fish meal sources, so ration formulators may not even know that it is in the fish meal.

Cost of ingredients should never be a factor in determining their suitability for organic production.

The sources are quite available in all locations.

Salt content limiting crab meal inclusion rates can be worked around if the meal is combined in rations containing diverse ground feed sources – corn, soybean, wheat, barley, oat, sunflower, pea, alfalfa or clover, etc. – even for birds that do not have access to pasture. A 0.1% maximum inclusion rate of synthetic methionine would also help with the limitations caused by the salt content of crab meal.

I am in favor of allowing these aquatic sources, even if only for poultry rations, instead of synthetic amino acids.

The last issue I will raise, is the effect of this material's status on chelated trace mineral's possible status in organic production systems. Commercially available chelated trace minerals are primarily bound to proteins, peptides or individual amino acids.

[Recommendation Advised to the NOSB:]
[(a) The material is:] Synthetic
[(b) For Crops and Livestock, the substance should be:] Added to the National List.
[(c) Suggested Annotation, including justification:] Enzyme digested natural protein sources preferred, source must be non GM. For poultry rations only. Only when alternatives are not available including ration diversity and acceptable animal and plant sources. Not to exceed 0.1% by weight in any feed source directly fed to poultry.

Reviewer 3 [*Western-Midwestern veterinarian providing technical services to ranchers]*

Methionine is an amino acid, a necessary component of certain proteins needed by livestock. L-methionine is a synthetic amino acid, produced by various chemical methods.

The bottom line is that synthetic amino acids are prohibited in the national rule. They are also prohibited internationally. Feeding of synthetic amino acids is neither compatible with a system of sustainable agriculture nor does it follow the principles of organic agriculture. Both of these systems are based on a premise of access to the natural environment, with less reliance on off-farm inputs and better management of the ecosystem. This premise precludes the use of synthetics generally.

According to Dr. Jason Emmert, poultry nutrition professor with the University of Arkansas, poultry producers are able to supply methionine in natural feedstuffs and pasture access, without the need for supplemental methionine. Pasture access will provide fresh grass and animal protein in the form of insects and earthworms. Grain rations will have to have additional soybean meal added, bringing the protein level to 23-24% crude protein. These diets can be provided to poultry of all ages. Thus, many of the points regarding level of methionine recommended or age of bird needing additional supplementation are irrelevant to this discussion.

One issue brought up for the need to supply synthetic methionine is the nitrogen level of litter. Nitrogen is often the limiting factor in farming systems, especially organic farms. The availability of organic litter could be another product of organic poultry operations, adding diversity and income to the farm. It could also help the farm to diversify by using the litter as fertilizer for pasture or other crops.

In rereading the article about immunological stress, methionine deficient diets actually had less of a reduction in growth rate and feed efficiency in pathogen stressed chicks than methionine sufficient diets. [...] Too much of this research is done in strict confinement settings, with maximum growth rate in minimum time. Trying to apply research done in this production system to a sustainable (access to pasture, the outdoors, more natural feedstuffs, etc.) system can only be done to a certain extent.

There is the concern that the poultry genetics are limited. This concern is valid, but like many of the other concerns listed, such as the need for more organic sources of various feedstuffs, the new organic rule will give the opportunity for supporting businesses to be formed to supply the needed genetics, feeds, and other allowed products.

The supporting documentation and research for this TAP review indicates the great need for research investigating the unique management needs of organic farming systems. The articles referenced are about research geared for the confinement poultry industry whose goal is to produce maximum sellable product for the least amount of money in the least amount of time with little regard to the sustainability of this production system. I also feel that if we make an exception to the no synthetic amino acids ruling, we will hurt the public image of organic farming (quicker than it may happen anyway) and we also open the door to other exceptions. I feel it important to retain the "no" ruling now. It can be changed in the future if further research aimed at organic farms and their management strategies shows that adding a small amount of synthetics does indeed improve the life, health, and overall production of the organic chicken.

In summary, the references and accompanying materials cover the points for continuing to prohibit synthetic methionine or any other amino acid. Methionine can be supplied through natural products, in quantities sufficient to meet birds' nutrient requirements, at any age. This eliminates any necessity for synthetic methionine.

Conclusion

All of the reviewers agree that the forms of methionine unders consideration, DL methionine, L methionine, and the hydroxy anlaog described in this review are synthetic. Two of the three reviewers find their use to be incompatible with organic systems and recommend prohibition. The third finds that use should be allowed only when natural sources or dietary sources are unavailable, and feels they should be allowed due to the lack of alternatives that meet organic standards. All reviewers agree that an allowance for synthetic amino acid use discourages diversity of animal feed sources, and that natural intact protein sources are more compatible with organic principles.

By substituting a non-renewable synthetic input for organically grown crops as a source for nutrition, synthetic amino acids would thus reduce the amount of acreage, and the market created for organic feed and forage crops. Farmers who seek organic certification have less of an incentive to provide clean, fresh pasture as a primary source of animal nutrition if they have available synthetic amino acids. There is also some confusion in the livestock industry as to the organic status of natural alternatives, such as yeast, casein, and fish or crab meals. These alternatives are more in keeping with the NOSB recommendations for natural feed supplements than those from synthetic or potential GMO sources. A requirement for natural, non-GMO sources of methionine, and a clarification of the status of some of these alternatives will stimulate market development in organic and approved feedstuffs.

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*Note: * = included in packet compiled for NOSB*

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This TAP Review was completed pursuant to United States Department of Agriculture Purchase Order 40-6395-0.