

Efficacy of Nutraceuticals and Supplements in Animal Health

Nutraceuticals and dietary supplements are widely used in both **companion animals** (pets like dogs, cats, and horses) and **production animals** (livestock such as cattle, poultry, swine, and fish) to promote health or manage specific conditions. These products range from vitamins, minerals, and fatty acids to plant extracts and probiotics. Below is a comprehensive review of clinical evidence for popular supplements, organized by species and health outcome. We highlight which use cases are well-supported by studies and which remain controversial or inconclusive.

Companion Animals (Dogs, Cats, and Horses)

Owners commonly give pets supplements for joint support, digestive health, skin/coat condition, anxiety relief, and general wellness ¹ ². While some benefits have been demonstrated, many claims lack robust evidence from controlled trials ³ ⁴. Here we summarize key findings for major health targets in pets:

Joint Health and Mobility in Pets

Joint supplements (for osteoarthritis and mobility) are among the most popular pet nutraceuticals ¹. Dogs and horses, in particular, often receive products containing **glucosamine**, **chondroitin sulfate**, **omega-3 fatty acids**, **green-lipped mussel**, **collagen**, or related compounds to alleviate arthritis pain and improve mobility. Key evidence includes:

- **Omega-3 Fatty Acids (Fish Oil):** Diets or supplements rich in EPA/DHA have **strong evidence** of improving joint pain and mobility in arthritic dogs ⁵. A systematic review and meta-analysis confirmed that omega-3-enriched diets produce a clear analgesic benefit in canine osteoarthritis, often reducing the need for NSAID medications ⁶. Omega-3s act as anti-inflammatories, and veterinary therapeutic diets with fish oil have consistently shown improved clinical outcomes in arthritic dogs ⁷. This makes fish oil one of the **best-supported nutraceuticals** for pet joint health.
- **Glucosamine & Chondroitin Sulfate:** These cartilage components are widely used for osteoarthritis in dogs, cats, and horses, but controlled studies show **little to no clinical benefit**. A 2012 systematic review (22 studies in dogs, cats, horses) found the evidence for glucosamine/chondroitin was **low quality**, with inconsistent results ³. More recently, a 2022 meta-analysis concluded that glucosamine-chondroitin combinations have a **“very marked non-effect”** on pain and lameness in canine and feline arthritis, recommending they **should no longer be routinely recommended** for osteoarthritis management ⁵ ⁸. In horses, research has likewise **failed to demonstrate clear benefits** – oral glucosamine has low bioavailability (~5% in one study) and did not significantly improve lameness or cartilage health in clinical trials ⁹ ¹⁰.
- **Green-Lipped Mussel (GLM):** GLM (*Perna canaliculus*) is a marine nutraceutical containing omega-3s and glycosaminoglycans. Some studies in dogs reported **modest improvements** in pain and weight-bearing, but results are mixed. A review noted GLM powder had significant

effects in 3 out of 4 studies, but the benefits were **inconsistent between trials**, so evidence remains **moderate at best** ³ ¹¹. GLM may help some pets, but it is not universally effective.

- **Undenatured Collagen (UC-II) and Other Ingredients:** Undenatured type II collagen (UC-II) and methylsulfonylmethane (MSM), often included in joint formulas, have **limited evidence**. The 2022 meta-analysis found collagen-based supplements had only **weak efficacy** in osteoarthritis ⁵. Individual small trials (in dogs and horses) have reported slight improvements in pain or gait with UC-II, but overall data are not robust. Similarly, herbal anti-inflammatories like **turmeric/curcumin** are popular in pet joint products for their antioxidant effects, but they lack high-quality clinical studies in animals (most support comes from in vitro or human data) ¹² ¹.

Summary: For pet joint health, **omega-3 fatty acids** stand out as a well-supported supplement (especially in dogs) ⁶. In contrast, staples like **glucosamine and chondroitin** are supported more by anecdote than by solid clinical evidence ⁸. Other supplements (GLM, collagen, MSM, curcumin) may offer minor benefits for some animals, but results are variable and not consistently significant. Owners and vets should be aware that most “joint support” nutraceuticals have **not** demonstrated dramatic disease-modifying effects in controlled trials ³ ⁴.

Digestive Health and Gut Microbiota Modulation

Probiotics and other gut-focused supplements are used in pets to manage diarrhea, improve stool quality, and modulate the intestinal microbiome. Common products include live **probiotic bacteria** (e.g. *Enterococcus faecium*, *Lactobacillus* or *Bifidobacterium* strains), **prebiotic** fibers (FOS, inulin, psyllium), **yeast-based** supplements, and clay or charcoal for diarrhea. The evidence in companion animals shows some potential benefits:

- **Probiotics for Acute Diarrhea:** Several **randomized controlled trials (RCTs)** have evaluated probiotics in dogs with acute, self-limiting diarrhea. Results have been mixed but generally show a trend toward faster recovery. For example, one placebo-controlled trial in 60 dogs found that dogs receiving a multi-strain probiotic achieved normal stool consistency about **1 day sooner** (3.5 days vs 4.6–4.8 days) than dogs on metronidazole or placebo, although the difference was not statistically significant in that small sample ¹³. Another trial in a shelter environment found a **significant reduction in diarrhea incidence**: only 2.0% of dogs given a daily synbiotic (probiotic + prebiotic) developed diarrhea, versus 3.2% in the placebo group ($p=0.0022$) ¹⁴. Over the first 2 weeks, the supplemented dogs had markedly fewer bouts of diarrhea (19% vs 27% of dogs; $p=0.0008$) ¹⁴. These studies suggest that probiotics *may* shorten diarrheal episodes or reduce their occurrence, although results can vary with the probiotic strains and study conditions.
- **Probiotics for Chronic GI Conditions:** Some evidence supports specific probiotics in managing chronic enteropathies. For instance, *Bifidobacterium* and *Streptococcus faecium* supplements have shown benefit in dogs with stress-related colitis or after antibiotics, helping normalize fecal consistency and microbiota balance ¹⁵ ¹⁶. However, in chronic inflammatory bowel disease (IBD) in pets, probiotics are considered adjunctive; a few small studies report improved stool quality and reduced gut inflammation, but more research is needed.
- **Prebiotics and Fiber:** High-fiber diets and prebiotic supplements (like fructooligosaccharides) are often recommended for pets with large bowel diarrhea or as a general gut health booster. Soluble fiber can improve stool formation and feed beneficial bacteria. While not usually tested as standalone “nutraceuticals,” fiber-inclusive diets have proven efficacy for issues like canine

fiber-responsive colitis. Prebiotics alone have less clinical trial data in pets, but they are presumed beneficial in supporting a healthy microbiome when combined with probiotics (synbiotic approach).

- **Yeast and Postbiotics:** In pets, **postbiotics** (non-living microbial products) are less studied than in livestock, but some supplements use fermentate products (e.g. yeast culture) for GI health. These may help stabilize gut flora and have anti-diarrheal effects, though pet-specific data are sparse. One example is *Saccharomyces boulardii* (a probiotic yeast) which has shown efficacy in human diarrhea and is anecdotally used in dogs for antibiotic-associated diarrhea, with emerging supportive evidence.

Summary: Probiotic supplementation in dogs and cats can have a **positive impact on gut health**, especially for preventing or shortening episodes of diarrhea under stress (such as in shelters or after diet changes) ¹⁴. Some trials document improved stool consistency and a more balanced gut microbiota in pets on probiotics. That said, not all studies show significant differences, indicating that **strain selection and study size matter** ¹³. Overall, probiotics and fiber supplements are *promising, low-risk interventions* for mild GI issues in pets, but claims of broad “microbiome modulation” or enhanced nutrient absorption are still being researched. Owners should have realistic expectations – these supplements may help **manage** symptoms and support gut health, but they are not panaceas for serious GI disease.

Calming Supplements for Stress & Anxiety

Another growing area of pet nutraceuticals is products marketed for **anxiety relief and stress reduction**. These include natural amino acids and plant extracts with putative calming effects, often used for noise phobias, travel anxiety, or general behavioral issues. Key ingredients are **L-theanine** (from green tea), **L-tryptophan** (an amino acid precursor to serotonin), **α-casozepine** (a milk protein hydrolysate), **vitamins (B-vitamins)**, magnesium, and various herbs (valerian, chamomile, hemp/CBD, etc.). Clinical evidence for these calming aids is limited but slowly growing:

- **L-Theanine (Green Tea Extract):** L-theanine has been shown in several studies to have mild calming effects in dogs. In an open-label trial of dogs with storm phobia, an L-theanine supplement (Anxitane®) significantly reduced anxiety scores as reported by owners ¹⁷. A **double-blind RCT** in 52 pet dogs with stress behaviors found that a nutraceutical tablet (Calmex®, containing L-theanine among other actives) significantly improved **stress-related behaviors within 2 weeks** compared to placebo ¹⁸ ¹⁹. Dogs on the supplement showed more consistent calm responses and had over one-third reduction in anxiety scores in response to loud noises (thunder, fireworks) versus no change in placebo dogs ²⁰ ¹⁹. These results indicate L-theanine-containing products can measurably help anxious dogs, although they may not be as potent as prescription anxiolytic drugs.
- **Alpha-S1 Casozepine (Milk Casein Hydrolysate):** This peptide, often sold as Zylkene®, is derived from milk protein and purported to have GABAergic calming properties. Studies in cats and dogs show **subtle anxiety-reducing effects**. For example, a diet supplemented with α-casozepine and L-tryptophan (Royal Canin “Calm” diet) resulted in **reduced anxious behaviors in cats** during stressful events compared to a control diet ²¹. Another trial reported that short-term casozepine administration before a veterinary visit had a modest stress-reducing effect in dogs (lowered some stress indicators) ²². While effects tend to be mild, these supplements can take the edge off situational stress in pets.

- **L-Tryptophan:** As a serotonin precursor, tryptophan is included in some calming diets and chews. There is evidence that **dietary tryptophan supplementation can reduce aggression or anxiety-related behaviors** in dogs by improving serotonin levels. One study found that a tryptophan-enriched diet decreased dominance aggression in dogs, and another showed synergistic effects when combined with α -casozepine (as in the Calm diet above) ²¹. Tryptophan is also given to horses (often with magnesium) to promote calmness during transport or competition, though equine-specific data are mostly anecdotal.
- **Herbal Calming Aids and CBD:** Herbs like valerian root, chamomile, passionflower, and hemp-derived **CBD oil** are used by some pet owners for anxiety. Scientific support is **minimal or preliminary**. Valerian and chamomile have long histories of use, but rigorous trials in pets are lacking. CBD, a non-psychoactive cannabinoid, showed some anxiolytic effects in lab studies and anecdotally calms some dogs, but research is ongoing. A recent small study combining CBD with tryptophan and casozepine indicated potential calming benefits ²³, but isolating CBD's effect is hard. Due to variability in herbal supplement quality and dosing, results are inconsistent, and veterinarians are cautious in recommending these without more evidence.

Summary: Several **nutraceuticals show promise for reducing stress/anxiety in pets**, particularly **L-theanine and α -casozepine**, which have demonstrated modest but positive effects in clinical trials ¹⁸ ²¹. These can be useful as part of a behavior-modification plan for noise phobias or separation anxiety. However, the magnitude of effect is usually mild to moderate – not all pets respond noticeably. Many calming products on the market (herbal blends, pheromones, etc.) lack solid scientific backing. Owners should view them as **adjuncts**: they may take the edge off anxiety, but severe or clinical anxiety often still requires behavioral therapy or medications. Importantly, any supplement's **safety** and potential interactions should be considered, and consultation with a veterinarian is advised.

Immune Support and Other Health Areas

Pet supplement manufacturers frequently market products for “immune support,” skin and coat health, cognitive function in aging, and other wellness areas. **Antioxidants, vitamins, and specialty nutraceuticals** are added to some diets or sold as pills with claims of boosting immune function or protecting organs (liver, kidney, etc.). The evidence for these uses is mixed:

- **Immune Supplements:** Ingredients like **beta-glucans** (from yeast or mushrooms), colostrum, omega-3 fatty acids, and various vitamins (A, C, E) are thought to enhance immune responses. In practice, it is difficult to prove “immune boosting” in healthy pets. Some studies have shown minor effects – for example, dogs on a diet with added antioxidants and prebiotics had improved vaccine antibody titers and lymphocyte function in one trial (manufacturer-funded). But overall, **measurable clinical benefits (fewer infections, faster recovery)** have not been clearly demonstrated for most immune supplements in pets. Many claims rely on **extrapolation from lab or human studies** rather than pet-specific data ²⁴ ⁴. Thus, while a balanced diet with adequate vitamins/minerals is essential to immunity, additional supplements in a healthy, well-fed pet may not provide noticeable benefits.
- **Skin and Coat (Dermatologic Health):** Omega-3 fatty acids (fish oil) are also commonly given to pets for atopic dermatitis or dry skin. Here, evidence is **somewhat inconclusive**. Several studies in dogs with atopic dermatitis found that adding fish oil (or omega-3/6 blends) can reduce itching and inflammation *to some degree*, and even allow lower doses of corticosteroids ²⁵ ²⁶. For example, one trial showed a fish oil supplement had a **cyclosporine-sparing effect** – dogs on fish oil required a lower dose of cyclosporine to control their dermatitis ²⁷. However, other studies and an expert task force concluded that there is **insufficient evidence to firmly**

recommend for or against fatty acid supplements in canine atopy ²⁸. The response is variable: some allergic pets improve notably on high-dose marine fish oil, while others show minimal change. Nutraceuticals like biotin (for brittle nails) or zinc (for certain dermatoses) are beneficial only in cases of documented deficiency. On the whole, omega-3s are considered a **helpful adjunct therapy in skin disease**, but not a standalone cure – and they are generally safe and anti-inflammatory.

- **Cognitive Aging (Senior Pets):** Diets enriched with **antioxidants, mitochondrial cofactors, and omega-3s** have been tested in senior dogs and cats to slow cognitive decline. Notably, a proprietary diet with antioxidants (vitamin E, C, lipoic acid), L-carnitine, and omega-3s was shown to improve cognitive test performance and daily activity in old dogs, as reported in a systematic review ²⁹. Supplements like **medium-chain triglycerides (MCTs)** have also improved cognitive function in canine cognitive dysfunction by serving as alternative brain energy sources. While these results are encouraging, they are often product-specific (tested by pet food companies) and may not generalize to all supplements. Still, antioxidant nutraceuticals (e.g., SAM-e, resveratrol, coenzyme Q10) are increasingly used for senior pet health, with a rationale grounded in reducing oxidative brain aging. This remains an **emerging area**, and ongoing studies are evaluating long-term benefits.
- **Organ Support (Liver, Joint, Kidney):** A few supplements have niche evidence in specific organ diseases. For example, **S-adenosylmethionine (SAM-e)** and milk thistle (silymarin) have been shown to improve certain liver enzyme values in dogs with liver disease, supporting their use as adjunct hepatoprotectants. In feline lower urinary tract disease, **glucosamine** has been hypothesized to help replenish the bladder lining, but clinical trials in cats with idiopathic cystitis have not conclusively proven benefit. **Cranberry extract** is commonly given to dogs prone to UTIs, and while it can prevent bacterial adhesion in vitro, **clinical evidence in dogs is scant**. Thus, many organ-support supplements are **theoretically beneficial** or have some positive case studies, but high-quality trials are often lacking.

Summary: Beyond the well-trodden areas of joints and digestion, **many nutraceutical uses in pets remain on the fringe of evidence**. Omega-3 fatty acids stand out as a multi-purpose supplement with the most supportive data (for joints, skin, possibly cognition) and are widely regarded as beneficial. **L-carnitine** is another example: it earned a Grade I evidence rating for aiding weight loss in obese cats ^{30 31}, and it's also supplemented in certain dog diets for cardiac health. On the other hand, **numerous supplements are marketed with minimal evidence** – owners should be skeptical of bold health claims. The general consensus in veterinary reviews is that **more well-controlled trials are needed** for pet nutraceuticals ^{4 32}. Veterinarians often have to rely on extrapolation and lower tiers of evidence, and they encourage manufacturers to invest in rigorous studies to validate their products. Until then, it's prudent to use supplements as complementary to standard care, and to manage expectations regarding their efficacy.

Production Animals (Livestock and Aquaculture)

In livestock production, nutraceuticals and feed supplements are primarily used to **enhance growth and feed efficiency, support disease resistance and immune function, improve gut health** (especially as alternatives to antibiotic growth promoters), and sometimes to **boost reproductive performance** or help animals cope with stress (e.g. heat stress). Because even small improvements can yield economic benefits, these supplements have been extensively studied in cattle, swine, poultry, and aquaculture. Here we review key categories and the strength of evidence:

Growth Performance and Feed Efficiency

Improving weight gain and feed conversion ratio (FCR) is a central goal in poultry, swine, and fish farming. A variety of feed additives – **probiotics, prebiotics, postbiotics, enzymes, and phytochemicals (plant extracts)** – have been tested as replacements for antibiotic growth promoters. Overall, research shows these supplements often confer **modest performance benefits**:

- **Probiotics (Direct-Fed Microbials):** Probiotics are live beneficial microbes (e.g. *Lactobacillus*, *Bifidobacterium*, *Bacillus*, *Enterococcus*) added to feed or water. Meta-analyses in broiler chickens demonstrate that probiotics can significantly improve **body weight gain and feed efficiency**, though the effect size is moderate ³³. For instance, one meta-analysis found that broilers given probiotics had better growth, and interestingly, administering the probiotics via drinking water yielded greater gains than mixing into feed ³⁴. Typical improvements in FCR are on the order of a few percentage points. In weanling pigs, certain probiotics help maintain growth during the stressful weaning transition (when growth often dips). It's widely documented that probiotics can **reduce harmful gut bacteria** and enhance nutrient absorption, which translates to faster growth. However, results vary by strain and farm conditions, so probiotics are not a guaranteed boost in every scenario.
- **Prebiotics and Synbiotics:** Prebiotics (non-digestible fibers like fructo-oligosaccharides, mannan-oligosaccharides from yeast cell walls, etc.) are added to feeds to nourish beneficial gut microbes. Alone, their impact on growth is inconsistent, but in combination with probiotics (synbiotics), they sometimes show additive benefits. For example, mannan-oligosaccharide (MOS) supplements in broilers have improved gut health and weight gain in some trials, though not universally. The evidence suggests **synbiotics** can modestly improve growth metrics by both seeding the gut with good microbes and feeding them.
- **Postbiotics:** Postbiotics refer to non-living microbial products or fermented feed additives (e.g. inactivated yeast, bacterial metabolites). This is an emerging field as farmers look for **stable alternatives to live probiotics**. A 2025 meta-analysis of postbiotic additives in broilers found an overall **positive impact on average daily gain (ADG) and final body weight**, especially with bacterial-based postbiotics like *Lactiplantibacillus plantarum* or *Bacillus subtilis* fermentates ³⁵. Some fermented wheat germ or yeast culture products also increased feed intake and modestly improved FCR ³⁵. However, the effects on gut morphology and health markers were variable, and high heterogeneity was noted across studies ³⁶. In summary, postbiotics show promise as growth promoters (comparable to probiotics in effect size) but results depend on the specific product and dosing, and further research is needed to standardize their use ³⁷.
- **Phytochemical Feed Additives (Herbs, Essential Oils):** Plant-derived additives ("phytochemicals") have gained popularity as natural growth promoters. Numerous trials in poultry and swine report that certain herbs and essential oil blends can improve weight gain, FCR, and digestibility ³⁸ ³⁹. A global systematic review noted that **essential oil blends** (e.g. oregano, thyme, cinnamon oils) consistently showed benefits in broilers – on average, **body weight gain increased by ~13% and FCR improved from 1.71 to 1.60** versus unsupplemented controls ³⁹. These are meaningful gains, attributed to essential oils enhancing digestive enzyme secretion, improving gut microbial balance, and reducing gut inflammation and pathogens ⁴⁰ ⁴¹. For example, thymol and carvacrol (from thyme and oregano) have antimicrobial and digestion-stimulating properties that lead to better nutrient utilization. Similarly, spices like *Nigella sativa* (black cumin seed) added at 1–2% of feed have significantly improved broiler growth and immunity in studies ⁴² ⁴³. The **takeaway** is that certain phytochemicals can act as viable alternatives to antibiotics: they often yield improved growth performance while also potentially reducing pathogen load.

That said, not all plant extracts work universally – the efficacy can be **additive-specific and dose-dependent**, with some showing diminishing returns or even growth depression at too high a dose ⁴⁴ ⁴⁵ . Overall, the evidence base for phytogenics in poultry is quite robust and growing, whereas in pigs and ruminants it's less extensive (but still positive in many cases) ⁴⁶ ⁴⁷ .

- **Enzymes:** Although not a nutraceutical in the classical sense, exogenous enzymes (like phytase, xylanase, protease) are common feed additives in poultry and swine to enhance feed efficiency. They break down anti-nutritional factors and improve nutrient availability. Decades of research back their efficacy (e.g. phytase improving phosphorus utilization, xylanase increasing energy digestibility), making enzymes a well-established tool for feed efficiency. They are often used in tandem with nutraceuticals for maximal performance.

Summary: The **best-established supplements for growth** in livestock are those that improve digestion and gut flora balance. Meta-analytic evidence confirms that **probiotics** typically provide a **statistically significant, albeit modest, boost** to growth rates and feed conversion ³⁴ . **Phytogenics** (essential oils, botanical extracts) are another **proven category**, with multiple studies documenting improved weight gain (~5–15%) when optimized blends are used ³⁹ ⁴⁸ . These natural additives can partially mimic the effects of antibiotic growth promoters by controlling gut microbes and inflammation. It should be noted that results can vary; factors like the specific strain of probiotic, the combination of herbs, dosage, and farm management conditions influence outcomes. Nonetheless, nutraceutical strategies for growth promotion are increasingly important in an era of reduced antibiotic usage. They offer a **promising approach** to enhance production efficiency in a sustainable way.

Gut Health and Disease Resistance

Closely tied to growth is the goal of maintaining a healthy gut and preventing disease. Nutraceuticals are deployed to modulate the **gut microbiota**, reduce pathogens, and enhance the intestinal barrier, thereby lowering incidence of diarrhea or subclinical infections. This is critical in young livestock (e.g. weaning piglets, chicks) and in high-density farming (to prevent outbreaks). Key findings include:

- **Pathogen Control with Probiotics/Phytogenics:** Many probiotics not only aid digestion but also **competitively exclude** pathogens like *Salmonella*, *E. coli*, and *Clostridium* in the gut. For example, feeding *Lactobacillus* strains to poultry has been shown to decrease *Salmonella* colonization of the ceca, enhancing food safety. Similarly, phytogenic additives can have direct antimicrobial effects. The thymol and carvacrol in oregano/thyme oil **suppress pathogenic bacteria** while allowing beneficial bacteria (e.g. *Lactobacillus*, *Bifidobacterium*) to flourish ⁴³ ⁴⁹ . Research on black cumin seed noted improved gut morphology (taller villi) and reduced *Clostridium perfringens* counts in treated birds, indicating a healthier gut environment ⁴³ . In swine, adding **organic acids** or essential oils to diets has reduced *E. coli* diarrhea in nursery pigs in multiple studies, acting as natural antimicrobials.
- **Preventing Diarrhea in Young Animals:** Pre- and probiotics are heavily used to prevent diarrhea in neonatal and weanling animals. In piglets, supplements like *Saccharomyces cerevisiae* boulardii (a probiotic yeast), *Bacillus* spores, or yeast cell wall extracts (rich in mannan) have all been shown to **reduce the frequency and severity of post-weaning diarrhea**. For instance, piglets receiving a *Bacillus* probiotic had lower incidence of *E. coli* scours and improved gut histology in some trials. In calves, certain lactic acid bacteria probiotics can shorten the course of neonatal diarrhea (scours) and improve weight gain during recovery. These benefits are hugely valuable, as neonatal diarrhea is a leading cause of mortality in young livestock.

- **Immune Modulation in the Gut:** Some nutraceuticals strengthen gut immunity and barrier function. **Yeast β -glucans** are notable here – when included in pig or poultry diets, β -1,3/1,6-glucans (from yeast cell walls or fungi) can stimulate intestinal immune cells (macrophages, IgA secretion) and make the animals more resilient to infections. One study in grower pigs demonstrated that adding a branched yeast β -glucan significantly **reduced the spread of *Lawsonia intracellularis*** (the bacterium causing ileitis) in the herd ⁵⁰. Treated pigs had less shedding of the pathogen and better growth despite exposure, thanks to an enhanced gut immune response. Likewise in aquaculture, beta-glucans are frequently used to bolster fish and shrimp defenses against common pathogens.
- **Gut Microbiota Composition:** Many of these supplements aim to favorably shift the microbiota. In broilers, for example, a combination of a probiotic and a phytogenic (like *N. sativa* or garlic) can synergistically promote beneficial bacteria that aid digestion, while inhibiting harmful ones ⁵¹. Improved **villus height and gut integrity** are often observed, meaning the intestine is healthier and can absorb nutrients better ⁴³. A healthier gut lining also means fewer bacteria and toxins can leak into the bloodstream (less endotoxemia), thereby preventing cascading health issues. Modern sequencing studies confirm that birds or pigs on these supplements often show increased microbial diversity and higher counts of lactic acid bacteria (good microbes) compared to controls.

Summary: Nutraceuticals play a **crucial role in promoting gut health** in the post-antibiotic-growth-promoter era. There is **strong evidence** that certain probiotics and phytogenics *reduce enteric pathogens and improve gut integrity* in food animals ⁴³ ⁴⁹. This not only supports better growth (as noted) but also directly lowers disease incidence (e.g. diarrhea outbreaks). While no single supplement can replace strict biosecurity and good husbandry, a combination of gut-focused additives can significantly enhance the baseline health of the herd/flock. This is particularly well-documented in **poultry and piglets**, where these interventions have cut down on enteric disease losses. In summary, maintaining a balanced gut microbiota through nutraceuticals is a **validated strategy** to improve both animal well-being and farm productivity.

Immune Function and Disease Resistance

Beyond the gut, supplements are also used to fortify the **systemic immune system** of livestock and aquaculture species. The goal is to reduce the incidence or severity of infectious diseases (respiratory, systemic, etc.), especially in the absence of prophylactic antibiotics. Key types of immune supplements and evidence:

- **β -Glucans and Immune Stimulants:** As mentioned, β -glucans from yeast or fungi are well-known immunomodulators. In pigs, feeding β -glucans has been shown to increase white blood cell activity and antibody responses. One study found that weaned pigs given insoluble yeast β -glucan had higher average daily gains and more robust immune reactions to a challenge, aligning with the idea that β -glucans “prime” the immune system ⁵² ⁵³. However, not all studies agree – some saw no significant immune changes. On balance, yeast β -glucans appear to help, especially under conditions of stress or pathogen exposure (where differences manifest). In fish and shrimp farming, β -glucans are widely used and have been shown to improve survival against bacterial and viral challenges by enhancing innate immunity (e.g. more active macrophages and natural killer cells).
- **Vitamins and Antioxidants:** Ensuring adequate **vitamin E, selenium, vitamin A, and zinc** in diets is crucial for immune function. In fact, marginal deficiencies of these micronutrients impair immunity and increase disease susceptibility. Thus, “nutraceutical” use of these often means

providing supra-nutritional levels to stock deemed at risk (like high-producing dairy cows or heat-stressed animals). For example, dairy cows supplemented with high-dose vitamin E and organic selenium pre-calving had lower incidence of mastitis and retained placenta (common postpartum issues linked to immune function) in some studies ⁵⁴ ⁵⁵ . In poultry, extra vitamin E and selenium improved antibody responses to vaccines and reduced mortality in necrotic enteritis outbreaks. These antioxidants help quench oxidative stress during immune responses, allowing for more effective disease clearance.

- **Herbal Immunomodulators:** Various plant extracts with high antioxidant or anti-inflammatory activity have been explored. For instance, **oregano oil, rosemary extract, and green tea catechins** have been studied for their effect on immune organ weights and antibody levels in poultry. A 2024 study showed that nanocapsulated rosemary essential oil at 200 mg/kg feed significantly **increased serum IgG and IgM levels and improved antibody titers to a vaccine** in broilers ⁵⁶ ⁵⁷ . The treated chickens had higher immunoglobulin concentrations and better cell-mediated immunity than controls, suggesting the herb's antioxidants reduced oxidative stress on immune cells and thereby enhanced immune readiness. Similarly, *Nigella sativa* (black seed) not only helped growth but also **elevated immune indices** (like cutaneous basophil hypersensitivity response and IgG levels) in chickens, matching the performance of conventional probiotics in stimulating immunity ⁵¹ .
- **Aquaculture Immunity:** In fish farming, nutraceuticals are critical since vaccines are not available for all diseases. **Probiotics and medicinal plant extracts** are used to boost fish and shrimp immunity. A comprehensive meta-analysis found that diets enriched with medicinal plants significantly **enhanced immunity and disease survival in fish** (including tilapia, catfish, carp, trout), regardless of species feeding habits ⁵⁸ . These plants (e.g. garlic, ginger, eucalyptus, seaweed extracts) often contain immunostimulatory polysaccharides and polyphenols. Probiotics similarly improve fish immune parameters – tilapia fed *Bacillus* probiotics showed higher lysozyme activity and survival when challenged with pathogenic bacteria ⁵⁹ . The consensus is that such supplements make aquatic species **hardier and less prone to disease**, which is invaluable in intensive aquaculture.

Summary: There is a **notable body of evidence** supporting certain supplements as immune enhancers in production animals. On the stronger end, **trace minerals and vitamins** (if supplemented above traditional levels) clearly reduce some disease issues when animals are under stress or at critical life stages (e.g., peripartum cows, fast-growing poultry) ⁶⁰ . **Beta-glucans** and other feed-derived immunostimulants have shown **improvements in immune markers and disease resistance** in pigs, poultry, and fish ⁵⁰ ⁶¹ . Phytochemicals with high antioxidant content can mitigate immunosuppressive stress and thereby improve overall immune response (e.g. higher vaccine titers, better pathogen clearance). Still, immune response is multifactorial; while supplements can tilt the odds in the animal's favor, they are not foolproof protectants. Good management and vaccination remain key. The supplements are best seen as **supportive measures** that can reduce morbidity and the need for therapeutic interventions in herd/flock health.

Reproductive Performance and Fertility

Nutritional supplements are also applied to improve reproductive metrics such as conception rates, litter size, egg production, and spawn yield. In large-scale production, even a small uptick in fertility can be economically significant. Some notable supplements and evidence:

- **Trace Minerals (Zn, Cu, Mn, Se):** Reproductive performance, especially in cattle, is closely tied to mineral status. Studies have shown that providing minerals in highly bioavailable forms

(chelated/organic minerals) can enhance fertility. For example, cows receiving organic selenium, zinc, copper, and manganese before and after calving had **higher pregnancy rates and fewer days open** compared to those on inorganic mineral sources ⁶² ⁶³ . Adequate selenium and vitamin E reduce retained placentas and uterine infections, indirectly aiding fertility. A controlled trial reported that giving an injectable trace mineral/vitamin (Se, Cu, Zn, Mn, Vit A & E) to beef cows improved pregnancy rates and reduced early embryonic loss ⁶⁰ ⁵⁵ . These improvements are attributed to better ovarian function and immunity. In bulls, supplements like organic zinc and vitamin E can improve semen quality (since testicular function is sensitive to oxidative stress and zinc status). Overall, ensuring optimal mineral nutrition is a **well-founded strategy** to support reproduction in cattle.

- **Vitamin Supplementation:** Specific vitamins have been tested for fertility benefits. Supplemental **beta-carotene (a precursor of Vitamin A)** is a classic example in dairy cows. Beta-carotene is concentrated in the corpus luteum and is thought to promote progesterone synthesis. A study in heat-stressed dairy cows found that adding beta-carotene to the diet improved conception rates in repeat-breeder cows, likely by counteracting oxidative stress in the ovarian environment ⁶⁴ . Similarly, one study suggested a brief high-dose vitamin D supplementation before breeding could improve fertilization rates in dairy cows ⁶⁵ , although that area is still exploratory. In poultry breeders, adding vitamins like biotin and folic acid beyond basic requirements has improved hatchability and reduced embryonic deformities. Thus, strategic vitamin boosts can sometimes yield reproductive gains.
- **L-Carnitine and Chromium in Sows:** In swine, two supplements stand out for sow productivity: **L-carnitine** and **chromium picolinate**. L-carnitine (an amino acid derivative involved in fat metabolism) given to sows during gestation and lactation has been shown to improve their metabolic status and milk production, resulting in **heavier, more robust piglets** at weaning and occasionally larger litters. A comprehensive trial with over 200 sows showed that dietary L-carnitine led to improved farrowing performance and increased number of piglets weaned per litter ⁶⁶ . **Chromium picolinate**, which enhances insulin sensitivity, has been repeatedly shown to increase litter size in sows. Kansas State University trials found that sows supplemented with chromium had an average of +0.5 to +1.0 piglets born per litter (significant when applied herd-wide) ⁶⁷ ⁶⁸ . The combination of L-carnitine and chromium was even studied for additive effects: results indicated improved sow weight maintenance, larger litters, and leaner piglets when both were fed together ⁶⁹ ⁷⁰ . These supplements are thus **well-supported** in swine reproduction, to the extent that many commercial sow diets now include them.
- **Omega-3 Fatty Acids:** There is interest in omega-3 supplementation for reproduction in various species. In dairy cows, feeding omega-3 sources (like flaxseed or fish oil) can alter prostaglandin synthesis and potentially improve embryo retention (by reducing uterine PGF2 α that causes early embryo loss). Some studies saw improved pregnancy rates when cows were fed a protected fish oil post-breeding, though results have not been uniform. In boars and bulls, omega-3s (like fish oil) have been linked to improved semen quality (better sperm motility and membrane integrity), which can increase conception success. For instance, canine and stallion studies have shown enhanced sperm morphology with DHA supplements, and similar effects are likely in boars. While not as heavily documented as other areas, omega-3s present a plausible benefit to fertility through their anti-inflammatory and membrane fluidity effects.
- **Aquaculture Reproduction:** In fish breeding (e.g. broodstock for aquaculture), supplements like omega-3 oils and vitamins are critical to egg quality and fry survival. Breeding fish given diets rich in HUFA (highly unsaturated fatty acids) produce eggs with higher viability and offspring with better stress resistance. Additionally, hormonal supplements are sometimes used (not

nutraceuticals per se, more pharmaceuticals) to induce spawning, so outside our scope. But nutritional support of breeders is a recognized aspect of successful aquaculture operations.

Summary: Nutrition and reproduction are tightly linked, and evidence suggests several supplements can yield tangible improvements in reproductive performance of food animals. In particular, **trace mineral programs** (using organic forms) in cattle and **L-carnitine/chromium** in sows have substantial support and are widely adopted in industry practice ⁶² ⁶⁷. These interventions address known nutritional bottlenecks – e.g. chromium countering insulin resistance in high-parity sows, leading to better fetal growth and more piglets. Vitamins like beta-carotene and E/selenium also emerge as helpful in stress or deficiency situations to ensure reproduction isn't impaired ⁶⁴. While not every study finds dramatic effects (reproduction is multifactorial and sometimes results are herd-specific), the overall trend is that **targeted supplementation can improve fertility metrics**. Producers often work with nutritionists to fine-tune diets to reproductive needs, and the cost-benefit can be high for these supplements when they result in even a small increase in offspring per animal.

Stress Mitigation (Heat Stress and Other Stresses)

Intensive production animals frequently face environmental or management stresses – high heat/humidity, transportation, regrouping (social stress), and so on – which can negatively impact their performance and health. Certain supplements are used to ameliorate these stress effects:

- **Heat Stress in Poultry and Cattle:** Heat stress causes reduced feed intake, poor growth, lowered fertility, and immune suppression. **Betaine**, an osmolyte derived from sugar beets, is a popular supplement to help animals cope with heat. Betaine helps cells maintain hydration and reduces the energy cost of osmotic balance during heat stress. Studies in broiler chickens under hot conditions show that adding betaine (0.5–2 g/kg feed or in water) significantly **improves growth rate and feed intake** compared to unsupplemented heat-stressed birds ⁷¹. For example, broilers given 1–2 g/kg betaine during a heat wave had higher body weight gain and better FCR, effectively mitigating some heat-induced losses ⁷². Betaine also can reduce heat-related carcass defects by maintaining muscle quality. In dairy cows, supplements like **niacin** and **chromium** are sometimes used during summer to reduce heat stress effects; niacin causes vasodilation (helping cool the animal) and chromium improves metabolic efficiency when feed intake drops. These have shown modest benefits on milk yield and lower blood cortisol in some trials.
- **Vitamin C and Electrolytes:** Unlike most animals, poultry cannot synthesize vitamin C, and under heat stress their requirement increases. Providing extra vitamin C (ascorbic acid) in feed or water during heatwaves has been documented to improve feed intake, weight gain, and immunity in chickens. It acts as an antioxidant to counteract heat-induced oxidative stress. Similarly, electrolyte supplements (combos of Na⁺, K⁺, Cl⁻) in water help maintain acid-base balance when panting causes excess CO₂ loss (respiratory alkalosis). These measures are well-grounded in physiology and commonly recommended, though the effects are supportive rather than transformative.
- **Calming Agents for Transport/Handling:** Stress from handling or transport can cause injuries, poor meat quality (e.g. PSE meat in pigs), and immunosuppression. Some nutraceutical approaches have been tested: e.g., **tryptophan supplementation** in pig diets has been shown to reduce aggressive behaviors and fighting when pigs are mixed or crowded. Higher plasma tryptophan (relative to other large neutral amino acids) increases serotonin, which can make pigs calmer. Trials report that pigs on high-tryptophan diets are less aggressive and have fewer skin lesions from fighting. **Magnesium** is another nutrient given (as Mg-sulfate or Mg fumarate)

before transport in pigs or horses to induce calmness – magnesium has a natural sedative effect at slightly above-normal levels. Results here are a bit anecdotal; some studies noted calmer behaviors or lower cortisol, while others found no significant change. Nonetheless, these are low-risk interventions that some producers utilize to improve animal welfare during stressful events.

- **Adaptogens and Herbal Anti-Stress:** In livestock, herbal extracts classified as “adaptogens” (e.g. *Ashwagandha*, *ginseng*, *Tulsi (holy basil)*) have been explored for stress mitigation. Scientific evidence in farm animals is limited, but one can find research in poultry where, say, *Withania somnifera* (ashwagandha) supplementation improved heat stress tolerance (birds had better H/L stress leukocyte ratios and maintained production). Another example: feeding *Mentha* (mint) or *Melissa* (lemon balm) extracts, which have calming and antioxidant properties, helped quails remain calmer and sustain egg production under heat stress in a study. These natural remedies are not yet mainstream, but they represent an intriguing area of ethnoveterinary research.

Summary: Nutritional strategies can indeed help animals **cope with stress**, especially heat stress, which is a major issue due to climate and global warming. **Betaine stands out as a well-supported supplement** to alleviate heat stress impacts in broilers – it consistently improves performance under hot conditions ⁷¹. Likewise, **vitamin C and electrolytes** are proven aids for heat-stressed poultry. In other species, evidence is a bit sparser but **trends are positive** for supplements like chromium (reducing stress hormones) and tryptophan (reducing aggression). These interventions don’t eliminate the need for proper cooling systems or gentle handling, but they serve as **additional tools** to maintain performance and welfare when animals face inevitable stressors.

Conclusion

In both companion and production animals, nutraceuticals and dietary supplements occupy a growing niche as **adjuncts to health management**. The clinical evidence for efficacy varies widely by product and indication:

- **Well-Established Use Cases:** There are several clear success stories. In pets, **omega-3 fatty acids** have robust evidence for improving osteoarthritis symptoms in dogs ⁵ (and ancillary benefits for skin and possibly cognition). **L-carnitine** has proven effective for aiding weight loss in obese cats ⁷³. In livestock, **probiotic and phytogetic feed additives** consistently show **enhanced growth and feed efficiency** in poultry and swine ³⁹ ³⁴, validating them as alternatives to antibiotics. **Yeast supplements** in ruminants reliably improve rumen function and milk production (meta-analyses show increased intake and ~1–2 kg more milk per cow on yeast culture) ⁷⁴. **Organic trace minerals and specific supplements** (like chromium and L-carnitine in sows) demonstrably improve reproductive outcomes ⁶⁷ ⁶⁶. These use cases are backed by multiple studies or meta-analyses, making them comparatively **solid recommendations**.
- **Controversial or Poorly Supported Claims:** On the other hand, many popular supplements have **inconclusive or minimal evidence** of benefit. For example, the routine use of **glucosamine/chondroitin for pet arthritis** is not supported by current clinical trials ⁸ – any benefit appears to be at placebo-level, despite years of anecdotal use. Numerous pet supplements for “immune support” or “kidney support” lack objective evidence; they may be harmless but their claims are unproven. In horses, common supplements like oral joint compounds, calming herbs, or hoof supplements often have **no better outcome than placebo**.

in controlled studies, even though owners subjectively believe in them ⁷⁵. In food animals, some phytogetic additives show inconsistent results across different studies (what works in one trial may show no benefit in another), highlighting the need for standardization and further research ³⁶. **CBD supplements** for pets are an emerging trend with early positive findings (for pain and anxiety), but we only have preliminary data so far – much remains unknown about optimal dosing and long-term effects.

In summary, **nutraceuticals can provide meaningful health benefits in animals, but efficacy is very product- and context-specific**. Veterinary medicine is embracing an evidence-based approach: for each supplement, it's important to ask *"Has this been tested in the target species for the target condition?"*. As of now, only a handful of supplements would earn a strong evidence grade for a given indication (e.g. fish oil for dog arthritis, probiotics for poultry growth). Many others remain **promising but not definitively proven**, or outright unsupported beyond theoretical rationale. Both pet owners and livestock producers should be wary of hype and look for peer-reviewed research or regulatory approvals when choosing supplements.

That said, interest and investment in this field are accelerating, and newer studies (especially large trials and systematic reviews) are helping separate the truly useful supplements from the fads. Veterinarians and animal nutritionists encourage this research and more stringent regulation/quality control for nutraceutical products ⁷⁶ ⁷⁷. With better data, practitioners can confidently incorporate effective nutraceuticals into health programs – improving animal welfare and productivity in a natural, sustainable manner. Until then, a balanced view is warranted: nutraceuticals are **neither miracle cures nor snake oil**, but tools whose effectiveness lies on a spectrum. Using them judiciously, in conjunction with traditional therapies and good management, is the best strategy to realize their potential benefits while avoiding disappointment.

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