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Bee Propolis: From Honeybee Hive Defense to Natural Feed Additive for Livestock and Poultry

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★ Key message

- Bee propolis is a bee-processed plant resin rich in phenolics, flavonoids and terpenoids.
- It may support antioxidant defense, microbial balance and immune response in ruminants and poultry.
- Its field use requires standardization, safe feed-grade extraction, dose validation and economic evaluation.

Abstract

Bee propolis is a resinous natural product prepared by honeybees from plant exudates, wax, pollen and bee enzymes. Owing to its phenolics, flavonoids, terpenoids, vitamins and minerals, it has gained interest as a phytogenic feed additive in livestock and poultry nutrition. Its antioxidant, antimicrobial and immunomodulatory properties may support gut health, immune function and productive performance. In ruminants, propolis may influence rumen fermentation, nutrient utilization, calf health, milk quality and methane-related fermentation pathways. In poultry, it may improve immunity, growth, laying performance and egg quality. Nano-propolis is also emerging as a promising form because of its improved solubility and biological activity. However, propolis composition varies with botanical origin, geography, season, extraction method and dose. Therefore, it should be viewed not as a miracle additive or direct antibiotic replacement, but as a promising natural feed additive requiring standardization, quality control and further animal trials before wider field use.

Keywords: Bee propolis, phytogenic feed additive, ruminants, poultry, antioxidant, antimicrobial, nano-propolis.

Introduction

Inside a honeybee hive, propolis acts as a natural wall, disinfectant and protective shield. Bees use this sticky resinous material to seal cracks, regulate the hive entrance, disinfect comb surfaces and protect the colony from microbes and intruders. Because of this role, it is often called the **"defense of the hive."** Today, propolis is gaining attention in animal nutrition as a possible phytogenic feed additive for supporting gut health, immunity and production performance in livestock and poultry.

The demand for natural feed additives has increased due to concerns over antimicrobial resistance, food safety and reduced dependence on synthetic antibiotic growth promoters. In this context, plant extracts, herbs, essential oils and bee-derived products are being explored as supportive nutritional tools. Bee propolis is unique because it is a bee-processed plant resin collected from buds, exudates and resins, then mixed with wax, pollen and bee enzymes. This gives it a rich profile of bioactive compounds, especially phenolics, flavonoids and terpenoids, which are associated with antioxidant, antimicrobial, anti-inflammatory and immunomodulatory properties.

In ruminants, propolis has been studied for its effects on rumen microbes, fermentation pattern, ammonia nitrogen, methane emission, digestibility, calf health, milk yield and milk quality. In poultry, it has been linked with immune response, laying performance, egg quality and general health. However, propolis should not be viewed as a miracle additive or complete antibiotic replacement. Its effect depends on botanical origin, season, extraction method, dose, animal species and diet. Therefore, bee propolis is best described as a promising natural phytogenic feed additive requiring proper standardization before routine field use.

What is Bee Propolis?

Propolis is a resinous material produced by honeybees, especially *Apis mellifera*. Bees collect sticky substances from plant buds, bark, exudates and resins, then mix them with beeswax, pollen and salivary secretions. Its colour may vary from red to brown depending on botanical and geographical origin.In the hive, propolis helps seal openings, strengthen the structure, regulate entrance size and maintain hygiene. It also protects against ants, mites and microbial contamination. When small intruders cannot be removed, bees may cover them with propolis to prevent decomposition and microbial spread. This natural antimicrobial role explains its growing interest in animal feeding.

What Makes Propolis Biologically Active?

Raw propolis is a complex mixture, commonly described as containing about 50% resinous substances, 30% wax, 10% oils, 5% floral pollen and 5% mechanical admixture. Its biological activity is mainly linked to phenolic compounds, flavonoids and terpenoids. It also contains vitamins, minerals and trace elements such as zinc, magnesium, copper, iron,

manganese, nickel and calcium.

Phenolics and flavonoids provide antioxidant activity by scavenging free radicals, chelating metal ions and reducing lipid peroxidation. Propolis compounds may also interfere with microbial cell membranes, nutrient transport and nucleic acid synthesis, explaining their antimicrobial potential. These properties make propolis useful for exploring gut health, rumen modulation and immune support.However, propolis composition varies widely with plant source, geography, colour, season and extraction method. Therefore, for scientific and commercial use, propolis should be characterized by its active compounds rather than judged only by colour or crude appearance.

Table 1. Major bioactive components of propolis and their possible functions

Component group	Examples/description	Possible role
Phenolics	Gallic acid, p-hydroxybenzoic acid and related compounds	Antioxidant and microbial modulation
Flavonoids	Flavones, flavanones, flavanols and related compounds	Free-radical scavenging and antimicrobial action
Terpenoids	Mono-, di-, sesqui- and triterpenes	Antibacterial and biological activity
Vitamins	B-complex, vitamin C and vitamin E	Antioxidant and metabolic support
Minerals	Zn, Mg, Cu, Fe, Mn, Ni and Ca	Enzymatic and physiological functions

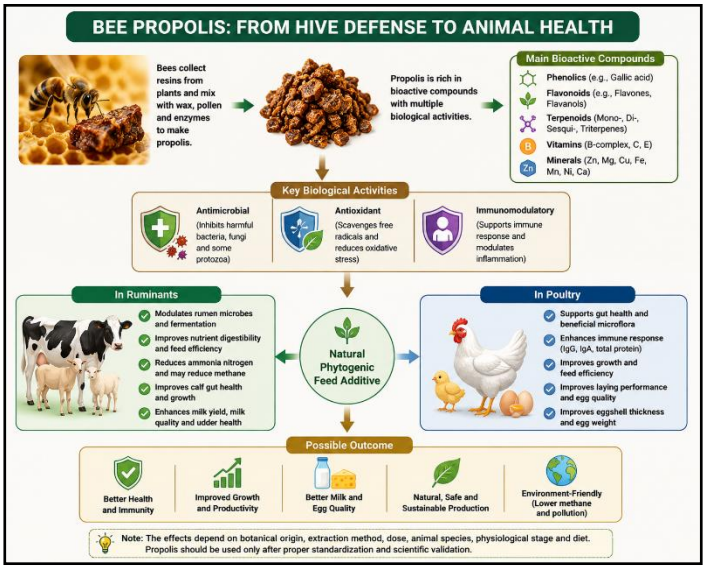

Figure 1. *Conceptual pathway showing how bioactive compounds in bee propolis may support livestock and poultry health. The effects are source-, dose-, extract- and species-dependent; therefore, propolis should be used only after proper standardization and scientific validation.*

How is Propolis Collected and Extracted?

Beekeepers usually collect propolis using traps or mats placed inside the hive. Bees naturally fill small cracks and openings with propolis, especially before winter or when they need to strengthen and protect the hive.Raw propolis cannot be used directly in a predictable way because it contains wax, resins and insoluble impurities. Therefore, extraction is required to obtain the biologically active fraction. Common solvents used in research include ethanol, methanol and water. Other solvents may extract different chemical groups, but for practical animal feeding, safe feed-grade extraction methods are necessary.

A typical extraction process involves cooling raw propolis, crushing it into fine powder and mixing it with solvent for several days. The extract is then filtered to remove insoluble material. The final extract may contain concentrated phenolics, flavonoids and other bioactive compounds. A methanol extract, ethanol extract, water extract, crude propolis and nano-propolis cannot be considered identical. For practical feeding, methanol extract should be viewed mainly as a research extract, while safe feed-grade extracts need further development and validation.

Why Animal Nutritionists are Interested in Propolis

Animal nutrition is no longer limited to supplying energy, protein, minerals and vitamins. Modern feeding strategies also focus on gut health, immunity, oxidative balance, product quality and environmental sustainability. Feed additives are therefore used not only for production but also for improving animal resilience.

Propolis is gaining attention because it contains natural compounds that may reduce oxidative stress, influence microbial populations and support immune function. In ruminants, these actions may influence rumen fermentation, nutrient digestibility and methane production. In poultry, they may influence gut health, immunity, egg quality and growth. In India, where dairy animals and poultry often face heat stress, variable feed quality, infectious pressure and economic limitations, natural feed additives are of practical interest. However, Indian propolis may differ chemically from Brazilian, Egyptian or European propolis because botanical origin strongly affects composition. Hence, Indian propolis should be evaluated under Indian feeding, climatic and management conditions before broad recommendation.

How Propolis May Influence the Rumen

The rumen is a complex fermentation chamber containing bacteria, protozoa, fungi and methanogenic archaea. These microbes convert fibrous feeds into short-chain fatty acids, microbial protein and other metabolites. Any additive that changes microbial activity can influence digestion and performance.

Propolis may influence the rumen because of its antimicrobial and antioxidant

compounds. Flavonoids and terpenoids may affect microbial membranes and nutrient transport systems. Research evidence indicates that propolis extracts can inhibit some rumen bacteria, while other bacterial species may be resistant. This suggests that propolis does not act uniformly against all rumen microbes. Instead, it may selectively influence certain microbial groups.

This selective action is important because rumen fermentation depends on microbial balance. If propolis suppresses undesirable microbial activity while supporting beneficial fermentation, it may improve nutrient utilization. However, if the dose is unsuitable, it may also disturb useful microbes. Therefore, dose standardization is essential.

Can Propolis Improve Feed Utilization and Reduce Methane?

Published studies suggest that propolis may improve ruminal fermentation and nutrient digestibility. It may increase short-chain fatty acid concentration, improve dry matter digestibility and influence ammonia nitrogen concentration. Short-chain fatty acids such as acetate, propionate and butyrate are the main energy sources for ruminants.

A reduction in ruminal ammonia nitrogen may indicate improved nitrogen use, but this must be interpreted carefully. Very low ammonia nitrogen may limit microbial protein synthesis, while excessive ammonia indicates inefficient nitrogen utilization. Therefore, the effect of propolis on rumen fermentation should be considered potentially beneficial but diet-dependent.

Methane production from ruminants represents both loss of dietary energy and contribution to greenhouse gas emission. Some evidence suggests that propolis may reduce methane by affecting protozoal and methanogenic populations or by changing fermentation pattern. However, methane response can vary with diet, animal type, propolis source, extract type and dose. Therefore, propolis should be described as a potential methane-modulating additive, not as a confirmed universal methane mitigation solution.

Propolis in Calf Health and Growth

Calf health is one of the most practical areas where propolis may have value. Young calves are vulnerable to diarrhea, poor gut development and disease challenge. Nutritional strategies that support gut health and immunity during the preweaning period can improve growth and reduce health problems.

In a published calf study, 24 Simmental calves were used to evaluate propolis ethanol extract during the preweaning period. Oral administration of propolis extract was associated with better body weight gain, improved feed conversion ratio, better fecal score and fewer diarrhea days compared with control calves. This finding is practically important because diarrhea is a major problem in calf rearing. It reduces growth, increases treatment cost and may

increase mortality. A natural additive that improves fecal consistency and supports early growth could be useful. However, field use should be based on standardized products, safe dose levels and veterinary guidance.

Propolis in Dairy Cows: Milk Yield and Milk Quality

Dairy cow productivity depends not only on feed intake and nutrient supply but also on udder health, immune status and oxidative balance. Propolis has been studied for possible effects on milk yield, milk composition and somatic cell count.

A study on methanol extract of Indian propolis in lactating cows. The study involved 24 cows from indigenous and crossbred groups, including Sahiwal, Haryana, Holstein Friesian crosses and Jersey crosses. Cows received different levels of methanol extract of Indian propolis. The results showed that higher levels were associated with improved milk yield, fat, protein, lactose and solids-not-fat. Somatic cell count was also reduced at higher levels.

This suggests that propolis may support milk quality and udder-health indicators. Lower somatic cell count is important because it reflects better udder health and milk hygiene. However, methanol extract is mainly a research preparation. Practical use requires safe feed-grade extracts and dose validation.

Propolis in Sheep, Lambs and Goats

Published studies also report beneficial effects of propolis in sheep, lambs and goats. In ewes, Brazilian red propolis supplementation was associated with changes in blood biochemical indicators such as total protein and globulin. In pregnant sheep, propolis supplementation reportedly improved milk yield and lamb live weight gain. In lambs, brown propolis in crude or ethanolic form improved carcass yield and altered meat fatty acid profile by reducing saturated fatty acids and increasing unsaturated fatty acids.

In suckling lambs, milk mixed with propolis extract improved weight gain and immune-related responses. In Saanen growing kids, propolis supplementation in milk replacer reportedly supported growth and health. These findings indicate that propolis may be useful in small ruminants, especially during sensitive stages such as pregnancy, lactation and early growth. Still, dose, form and source must be carefully considered.

Propolis in Poultry: Immunity, Eggs and Growth

Poultry birds are sensitive to microbial stress, oxidative stress, heat stress and feed quality. Natural antioxidants and antimicrobial compounds may therefore be useful in poultry nutrition. Propolis has been studied in broilers and layers as a natural additive to support immunity, production and egg quality.

In chickens, propolis extract was reported to increase total plasma protein, gamma globulins, IgG and IgA. These are important immune-related indicators. Propolis

supplementation has also been associated with increased serum IgG and IgM in laying hens. These findings suggest that propolis may support immune function.

In laying hens, propolis supplementation through drinking water or feed was reported to improve laying performance, eggshell thickness and egg weight. Another published study reported that dietary propolis improved feed efficiency, egg production and egg mass. For poultry producers, the practical interest lies in improving bird health and productivity while reducing overdependence on synthetic additives. However, response may differ with age, breed, housing, health challenge, diet and dose. Therefore, propolis should be considered a promising supportive additive, not a guaranteed performance enhancer.

Nano-Propolis: Small Particles, Bigger Possibilities

Nano-propolis is a newer form developed to improve solubility, stability and biological activity. Nanoparticles are usually smaller than 100 nm and may behave differently from larger particles. The literature also describes that nano-propolis can be prepared through encapsulation methods such as casein micelles or chitosan-based carriers.One limitation of crude propolis is poor water solubility. Nano-formulation may improve dispersibility and allow bioactive compounds to interact more effectively with microbial cells. Nano-propolis may also penetrate bacterial outer membranes more easily and show stronger antibacterial and antioxidant activity.

In broilers, nano-propolis supplementation through drinking water was reported to improve selected blood parameters and relative weights of organs such as heart, gizzard, spleen and bursa. Since spleen and bursa are important immune organs, these findings suggest possible immune-supportive effects. However, nano-propolis is still an emerging area. Before field use, its safety, dose, residue profile, cost and regulatory status must be evaluated.

Table 2. Reported effects of propolis in ruminants and poultry based on selected studies

Animal category	Form/dose reported	Reported effect
Preweaning calves	Propolis ethanol extract	Improved body weight gain, feed conversion, fecal score and reduced diarrhea days
Lactating cows	Methanol extract of Indian propolis	Improved milk yield and composition; reduced somatic cell count at higher levels
Feedlot cattle	Propolis extract containing flavonoids	Improved body weight and feed conversion compared with monensin-supplemented diet
Pregnant sheep/ewe	Propolis supplementation	Improved milk yield and lamb performance

Animal category	Form/dose reported	Reported effect
Lambs	Brown propolis or ethanolic extract	Improved carcass yield and altered meat fatty acid profile
Laying hens	Propolis in water/feed	Improved laying performance, eggshell thickness and egg weight
Chickens	Propolis extract	Increased plasma protein, gamma globulins, IgG and IgA
Broilers	Nano-propolis in drinking water	Improved selected blood parameters and immune organ weights

✓ Practical message for farmers and nutritionists

- Do not mix crude propolis directly into feed without technical guidance.
- Use only safe, standardized and feed-grade propolis preparations.
- Dose, source, extraction method and product quality are critical for response.
- Propolis may support gut health, immunity, milk quality and egg quality, but it should complement—not replace—good farm management.

! Scientific caution

- Natural products are not automatically safe or effective under every condition.
- Propolis composition varies with plant source, geography, colour, season and extraction method.
- Ethanol extract, methanol extract, water extract, crude propolis and nano-propolis should not be treated as identical products.
- More Indian field trials, safety evaluation and economic analysis are needed before broad recommendation.

Conclusion

Bee propolis is a hive-derived natural product with antioxidant, antimicrobial and immunomodulatory potential due to its phenolics, flavonoids, terpenoids, vitamins and minerals. In ruminants, it may support rumen fermentation, nutrient utilization, calf health and milk quality, while in poultry it may improve immunity, egg quality and general performance. However, its effects depend on source, extraction method, dose and animal condition. Therefore, propolis should be viewed not as a miracle additive, but as a promising natural feed additive requiring standardization, quality control and further animal trials before wider use.

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