

# An Overview on the Effects of Propolis Administration in Different Branches of Livestock Production

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## Abstract

Recently, the increase in the awareness of nutrition with natural products has gradually increased the popularity of honey bee products. Popularity of honey bee products like honey pollen, propolis, bee bread, royal jelly, bee venom and apilarnil are beekeeping products. Propolis is one of the most popular bee product and has anticancer, anti-inflammatory, antibiotic, antioxidative, antibacterial, antiviral, antifungal, anesthetic, immunostimulant and cytotoxic effects. Approximately 300 compounds have been identified in the content of propolis, including polyphenols, phenolic aldehydes, sesquiterpene quinines, coumarins, amino acids, steroids, and inorganic compounds. These properties have been used in folk medicine for centuries. The use of propolis in the livestock sector has become popular with the restriction on the use of antibiotics and synthetic drugs in this sector. Various studies were carried out to determine the effects of propolis administration in different branches of livestock sector. This study aimed to reveal the effects of propolis administration in animal husbandry by analyzing the current studies and provide brief information on the subject.

## Introduction

Honey is the most widely produced bee product in Türkiye. However, honey bees produce variety of other products with high economic value such as royal jelly, pollen, bee bread, beeswax, apilarnil and propolis. These products are both highly nutritious and are used extensively as a preventive and supplementary product in the field of alternative medicine, which is quite popular all over the world (Silici, 2015). Honey bees prepare propolis by mixing the bark, leaves and plant secretions with their salivary enzymes and beeswax. Bees use this resinous product for many purposes in the hive such as narrowing the hive entrance hole, closing the cracks in the hive, fixing the frames, disinfection of the honeycomb cells and mummification of the pests that are killed inside the hive. Around 35°C and 40-70% humidity are required inside the hive for a bee colony to survive and grow. On the other hand, these requirements are significant risk factors since the temperature is extremely suitable for the growth of various viruses, bacteria, and fungi in the hive. The propolis produced by the bees protects the hive against such harmful microorganisms and regulates the

humidity and temperature of the hive (Nımballan, 2021; Yücel et al., 2015). The color of propolis can vary from light yellow to dark brown, depending on the source of the resin. Propolis is a soft, flexible, and very sticky substance at temperatures of 25-45 °C. When the temperature drops to 15 °C, it is partially frozen or near freezing, and is in a hard and brittle state. Its stickiness increases above 45 °C, it becomes liquid at 60-70 °C. However, in some samples, the melting point can reach 100 °C (Krell, 1996). The chemical structure of propolis was revealed by the studies carried out at the beginning of the 20th century. The content of propolis may vary depending on the plant source collected, bee species, bee breed, and ecological conditions. The composition of propolis varies according to its source, it generally consists of 50% resin, 30% wax, 10% essential and aromatic oils, 5% pollen, 5% other organic compounds and mineral substances, and flavonoids, which are the active substances of many drugs, antioxidants, substances with biological activity, antibiotics, antimycotics, antiviral effective substances are some of the compounds propolis possesses (Kılıç Karabaş et al., 2020; Doğan and Hayaoğlu, 2012; Kumova et al., 2002). The amount and distribution of these substances in

propolis and their pharmacological properties have been demonstrated by various studies.

Propolis has been used for different purposes in public health throughout human history. About 300 compounds have been identified in the content of propolis, polyphenols, phenolic aldehydes, sesquiterpene kinins, coumarins, amino acids, steroids and inorganic compounds in propolis samples are some of them (Khan, 2017). Propolis collected from nature by bees is an extremely important substance for human health and life. People have benefited from propolis collected from nature in the treatment of various infections from ancient times to the present. It was reported that propolis was used as an ointment in surgical interventions mixed with petroleum jelly to heal wounds and tissues in wars instead of medical wax (Kumova et al., 2002). With all the above-mentioned features, propolis has been widely used in traditional and complementary medicine for many years.

The European Union banned the use of antibiotics in animal production as growth and development enhancers in 2006 with the discovery of residues in animal products caused by antibiotic use (Saeed et al., 2017). This decision has driven scientists and manufacturers to look for new natural alternative additives that can be used instead of antibiotics to prevent economic losses due to the ban on the use of antibiotics. Antibacterial (Silici & Kutluca, 2005), antiviral (Vynograd et al., 2000), anti-inflammatory, analgesic, and tissue regenerative (De Castro, 2001), antioxidant (Banskota et al., 2000), and cytostatic and hepatoprotective (Banskota et al., 2000; Khan, 2017) effects of an ethanolic extract of propolis have been reported in many studies. With all its stated properties, propolis stands out as a strong alternative substance that can be used in the livestock sector instead of antibiotics. This study discusses the usability and effects of this product as an alternative natural substance in the animal production sector.

### Use of Propolis in Poultry Farming

The positive effects of propolis in poultry farming were reported in various studies. In a study conducted on Ross breed broilers, researchers reported that with propolis administration, daily weight gain and feed efficiency ratio increased, while death rates decreased significantly (Shalmany & Shivazad, 2006). Similarly, Zhi-Jiang et al. (2004), reported that 0.1% propolis supplementation to the ration increased the body weight in broilers by 2.03% compared to the control group. In a similar study conducted in ducks from egg hatching to 60 days of age, it was reported that the live weight increased by 10.5% and 13.5% as a result of the addition of 20 and 40 mg propolis to kg/diet (Bonomi et al., 2002). Similar results in terms of body weight gain and feed efficiency were also reported in quails by Denli et al. (2005).

In another study conducted on laying hens, it was reported that the addition of propolis to the diet decreased egg cholesterol and triglyceride levels and increased serum HDL (high-density lipoprotein) levels (Silici & Güçlü, 2018). In addition, propolis administration was reported to increase eggshell quality when used on laying hen rations (Tatli Seven, 2008). Mahmoud et al. (2015), reported that propolis causes an increase in calcium digestibility and absorption with different acids such as benzoic, 4-hydroxy-benzoic acids, and this increase may be the reason for this increase in eggshell quality. In a similar study, different doses of propolis were added to laying hen rations and performance parameters were monitored. Researchers reported that the live weights of laying hens increased with the addition of propolis, but there was no difference in other parameters (Özkök et al., 2013). In another study examining the effects of 250, 500, and 1000 mg/kg propolis supplementation in layer hen rations on performance, egg production, and quality of laying hens, 250 mg/kg dietary propolis supplementation was reported to improve feed efficiency, egg production, and egg mass significantly (Abdel-Kareem & El Sheikh, 2015).

Propolis contains bioactive substances with high antioxidant activity. Tatli Seven (2008), reported that the use of propolis was significantly effective in reducing oxidative damage caused by heat stress, increasing growth performance, and increasing egg shell thickness and egg weight in layer hens. Comparable results were reported for Ross breed broilers exposed to heat stress by Mahmoud et al. (2015). Propolis was reported to improve the performance of turkeys by increasing immunity, when exposed to an herbicide called Paraquat, which is used in agriculture and causes inflammation and oxidative stress (Abass et al., 2017).

It has been reported that propolis used in chicken rations also increases blood total protein, albumin and globulin levels (El-Neney & Awadien, 2014; Abdel-Kareem & El Sheikh, 2015). Moreover, Çetin et al. (2010), determined that the application of propolis resulted in an increase in serum IgG and IgM levels and red blood cell counts in White Leghorn chickens, and they reported that the addition of propolis to the 3 g/kg diet was effective in enhancing immunity in chickens. Similar results were also reported for layer hens by Freitas et al. (2011). Eyng et al. (2014), used 0, 1000, 2000, 3000, 4000 and 5000 ppm doses in 1-21 day old male chicks to investigate the effect of ethanolic extract of propolis added to the rations of broiler chickens on small intestine morphology and digestive enzymes activity. Propolis with ethanolic extract at a dose of 1000-5000 ppm added to the starter feeds of broilers decreased the performance due to the decreased sucrase activity at their stage. However, 3000 ppm propolis extract improved the small intestine morphophysiology of 21-day-old chickens, but did not affect the performance or carcass yield of 42-day-old chickens.

Tekeli (2007), investigated the possibility of using natural herbal extracts and propolis as growth factors as an alternative to antibiotics due to the ban on the use of antibiotics in broiler feeds. In the third experiment of the study 0, 500, 1000, 2000 ppm doses of propolis were used, and it was observed that especially 1000 ppm propolis increased feed consumption, live weight gain, feed conversion ratio and intestinal villi length, and was important in terms of being an alternative to antibiotics. In the fourth experiment, doses of *Zingiber officinale* and propolis were used separately and in combination. It was observed that 240 ppm of *Zingiber officinale* and 1000 ppm of propolis showed similar effects with antibiotics in terms of body weight gain, feed consumption and feed conversion ratio.

It is evident by above-mentioned studies that propolis is a promising natural alternative product that can be used in the poultry sector to enhance immunity, reduce oxidative stress, improve feed efficiency since live weight gain, and improve egg quality. In addition, propolis administration shows comparable effects on poultry when compared to antibiotics which created residue in animal products and endanger consumer health.

### Use of propolis in Ruminants

There have been limited studies carried out to investigate the effects of propolis administration on ruminant nutrition. In a current study, Slanzon et al. (2019), revealed that the incidence of diarrhea in calves decreased significantly with the supplementation of 4 mL of propolis daily to newborn calves' diets. Similarly, propolis was reported to be effective for both preventive and therapeutic purposes in neonatal calf diarrhea (Kwon et al., 1999). These findings were also confirmed by Yücel et al. (2015), who fed newborn calves by 2 cc of propolis / per day and reported that propolis was effective in the treatment of diarrhea in newborn calves and significantly increased growth and development. Kupczyński et al. (2012), also reported a significant decrease in diarrhea cases in calves with a daily application of 4 mL of propolis. Furthermore, it was reported by Manav and Yılmaz (2021), that the incidence of diarrhea in goat kids decreased significantly with propolis administration. The effectiveness of propolis in diarrhea treatment in young ruminants may be explained by its strong antimicrobial activity.

Propolis improves the general health status of animals and increases feed efficiency, thus increasing animal productivity. A significant increase in the daily live weight gain of newborn calves was revealed by Tolon et al. (2002), with the administration of propolis. Similar results were also reported by Yücel et al. (2015). Moreover, Kupczyński et al. (2012), investigated some health and performance parameters of calves with propolis supplementation and reported that calves fed with 4 mL of 10% propolis extract/day had a significantly superior 21st day body weight compared to the control

and 2 mL propolis groups. A significant increase was observed in calf starter feed consumption and in 5th week body weight with the addition of flavonoids extracted from propolis to calf diets (Yaghoubi et al., 2008). Furthermore, Slanzon et al. (2019), observed that the feed efficiency of the calves in the treatment group (694.2 g/d) was superior to that of the control group (654.5 g/d) after the supplementation of a daily 4 mL ethanolic extract of propolis.

Abd-Allah and Daghash (2019), examined the efficiency of flavomycin and propolis in dairy buffaloes and calves and reported that they both had similar positive effects on the performance of water buffalo calves. In a similar study conducted on sheep, it was reported that with the daily supplementation of 3 g of propolis in pregnant sheep's diets, significant increases were observed in milk yield and lamb live weight gains (Morsy et al., 2016). On the other hand, Zawadzki et al. (2011), reported that propolis administration significantly increased feed efficiency and daily live weight gain in feedlot-finished bulls. In addition, it was also reported that propolis application (5 g/kg diet) in pregnant Barki sheep significantly increased milk yield and lamb performance (Shedeed et al., 2019). These effects of propolis in enhancing the performance of young ruminants may be due to its strong antimicrobial effect, which preventing the development of pathogenic microorganisms that suppress growth by creating disease factors in calves, and reduces oxidative stress with its antioxidant effect (Abd-Allah & Daghash, 2019).

The effects of propolis on immunity, oxidative stress and certain blood parameters were also examined in many studies and propolis was found to be effective on these parameters. It was reported that antioxidant enzyme levels in blood samples decreased significantly and immune system function increased with propolis administration in pregnant sheep (Shedeed et al., 2019). Similarly, Yaghoubi et al. (2008), reported that propolis application reduces the effectiveness of bacteria and viruses that cause damage in newborn calves and decreases the IgM and IgG levels. On the other hand, Morsy et al. (2016), reported that an increase in total leukocyte, total protein, albumin and glucose levels were observed in the Santaine sheep that were fed propolis supplemented to their diets.

All these studies provide clear evidence that propolis is highly effective in increasing general health, enhancing immunity, preventing oxidative damage, increasing feed efficiency and weight gain and most importantly decreasing diarrhea which is responsible for the considerable amount of young ruminant losses in the livestock industry.

### Use of Propolis in The Fishery Industry

In aquaculture, it is extremely difficult to treat diseases and the eradication of diseases requires hard work. Various chemotherapeutic agents such as antibiotics, nitrofurans and sulfonamides have been

used for a long time for both preventive and therapeutic purposes against infections that occur for any reason and cause significant economic losses in the fishing industry (Arda et al., 2005). Recently, natural treatment methods became popular in order to prevent financial losses in treatments, to minimize fish losses and prevent the negative effects of chemotherapeutics. In recent years, studying the applicability of natural products that have been widely used by people for centuries in the treatment of various diseases, in the field of aquaculture and their pharmacological use has become an important field of study (Yonar, 2012; Yonar, 2010). Propolis is among the most prominent substances used for natural treatment (Silici, 2015), and the effects of propolis administration on the fish have been studied by many researchers.

Yonar et al. (2018), investigated the effect of propolis on some immunological parameters in rainbow trout. For this purpose, propolis was injected intraperitoneally into fish 4 times at a dose of 2.5, 5 and 10 mg/kg fish weight. Blood samples were collected from the experimental and control groups on the 3rd, 9th, 15th, and 21st days, and oxidative radical production [nitrobluetetrazolium (NBT) activity], total protein, and total immunoglobulin levels were measured. At the end of the experiment, it was reported that there was a statistically significant increase in the oxidative radical production, total protein and immunoglobulin levels of the groups treated with propolis compared to the control group.

Segvic-Bubic et al. (2013), investigated the effect of low temperature stress in European sea bass fish, and reported that the group that fed with 2.5 g/kg propolis showed higher growth performance, and propolis administration was found to be highly effective against low temperature stress in fish. In a similar study 10 g/kg of diet propolis was supplemented to catfish diets and propolis was found to be significantly effective in increasing the growth performance and feed efficiency ratio (Nur et al., 2017). Comparably, Abbass et al. (2012), studied the effects of propolis and bee pollen supplementation on the growth and feed efficiency of Nil tilapia fishes and revealed that supplementation of propolis to these fish's diets increased their feed efficiency ratio and growth performance. In a 10-week feeding study conducted by Deng et al. (2011), in trout, it was determined that the growth rate, feed efficiency rate and protein efficiency rate did not change in the groups fed 1 g propolis/kg diet, but increased significantly in the groups offered 2 and 4 g propolis/kg diet. Moreover, Bae et al. (2011), supplemented 0.25%, 0.5%, 1%, 2% and 4% propolis to the diets of juvenile eels (*Anguilla japonica*) and determined that weight gain, growth rate, feed rate, feed rate at the end of 12 weeks of feeding, and protein efficiency rates were the highest in the diets supplemented with 0.5% propolis. In a study conducted by Yonar et al. (2012), the effect of propolis on malondialdehyde (MDA), glutathione (GSH) and glutathione-S-transferase (GST) enzyme activity in

common carp (*Cyprinus carpio carpio*) under different water temperature conditions was investigated. Fish were kept at 20, 24 and 28 °C and propolis (10 mg kg<sup>-1</sup> bait) was applied to these fish. It was determined that the MDA level of the fish at 20 °C and 28 °C increased significantly, while the GSH level and GST activity decreased. Furthermore, Keleştemur et al. (2012), determined that the blood total protein and BAUN values of the fish fed with the diet supplemented with propolis were significantly lower than the control group, and the blood cholesterol and VLDL triglyceride values were higher compared to the control group. While the difference between the creatinine values of the groups was not statistically significant. Another study was conducted to investigate the effect of propolis on some hematological parameters in rainbow trout (Orkinos mykiss) by Yonar and Silici (2010). Researchers reported that the differences were not significant in terms of hematocrit value ( $P>0.05$ ), hemoglobin amount ( $P>0.01$ ) and erythrocyte indices ( $P>0.001$ ) of the fish treated with propolis. However, the differences among groups for leukocrit and leukocyte values were reported to be statistically significant.

## Result

Türkiye has a significant potential for beekeeping and the production of bee products. However, aside from the use of other bee products other than honey in "Apitherapy" studies, the targeted level for their production has not been reached yet. The increasing awareness of the side effects of synthetic drugs which are widely used today and the resistance of disease agents to these drugs have led people to demand natural medicine products and food produced naturally and safely. Despite being used in folk medicine for centuries by people use of propolis in animal farming is a new field of study. Propolis is proven to be effective in increasing the feed efficiency and growth performance. Moreover, it also shows activity in the protection against disease agents, strengthening and building immunity as well as serving as an antioxidant agent in animal farming. All the above mentioned studies provide evidence that propolis can be a promising alternative to antibiotics and other synthetic drugs in different branches of animal production. Furthermore, propolis stands out as a significant substance in ecological agriculture where the use of antibiotics and synthetic drugs are restricted.

## Ethical Statement

Not applicable.

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## Conflict of Interest

The author declare no conflict of interest.

## Author Contributions

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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