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Propolis in Livestock Nutrition

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Abstract

Our article provides the first demonstration about two theories concerning how it is produced. In his theory, Küstenmacher showed that in the summer, when plants profusely secrete oily balsamic substances on the surface of pollen, bees regurgitate them onto the comb and the walls of the hive, thereby producing propolis. Rosch showed that in late summer and autumn, bees collect resinous plant-derived substances and process them into propolis. As a substance of plant origin, propolis has a variable composition, depending on the plant species from which intermediates for its preparation are derived and the wealth of soil on which these plants grow. Propolis shows beneficial health effects, especially antibacterial, anti-inflammatory and anticancer activities, which make it a very important component of medication or supplement for human and animal healthcare. For this reason, propolis is one of the most widely used natural added to fodder. Since 1995, propolis has been recognized as a dietary supplement in Argentina.

Keywords: Propolis; Supplement; Feeding; Health benefits

Introduction

Propolis is widely recognised in the world as one of bee products, but little is known about its formation and origin. The knowledge that an average person has on the possibility of using propolis in everyday life is insufficient as well. Propolis is a very complex product with a number of applications in maintenance of animal health. It is also used as a natural product of plant origin in human therapies.

Experimental

Production of propolis

Propolisis is otherwise known as "bee glue". The name originates from a Greek word "propolis", i.e. the "bulwark of the city", which implies the first line of defence against threats. In a bee colony, the entrance to the hive lined with propolis is an equivalent of such a city bulwark [1]. Propolis is claimed to serve as an antibacterial and antiviral "disinfection mat" in the bee colony, which is crossed by bees returning to the hive. This propolis "mat" has repellent properties, protects bees against ants and mites and simultaneously regulates the size of the hive outlet [2]. Bees use propolis for disinfection of the honeycomb or mummification of larger intruders, which are stung after entering the hive and cannot be removed by bees out of the hive. In this way, the bee colony is protected against infection and threats posed primarily by microorganisms.

In literature, two theories of propolis formation proposed by Küstenmacher and Roschare reported [3]. Küstenmacher claimed that propolis was formed through extraction of the pollen envelope due to the difference in the pressures between the crop and the proventriculuslumen. A balsamic-oily substance is formed in this process (Figure 1), which bees regurgitate onto honeycombs and next mix with beeswax, thereby producing propolis [4]. In contrast, Rosch argued that bees collected balm, rich in bacteriostatic and antifungal substances, from the surface of buds or secretory shields of birch, poplar, or alder leaves. The balm mixed with saliva and beeswax gives rise to propolis.

The authors of this study claim that both theories are correct. This is confirmed by the appearance of the bee colony nest during dandelion flowering and particularly during blooming of goldenrod or sunflower. Pollen grains of these plants bear a balsamic-oily substance (Figure 1).

In order to purify nectar carried in the crop, bees regurgitate the substance onto honeycombs or hive walls. Next, they use it for production of very sticky, light-coloured propolis. During the flowering period of the aforementioned plants, all parts of the hive are coated with a thin yellow layer of propolis, which supports Küstenmacher's theory.

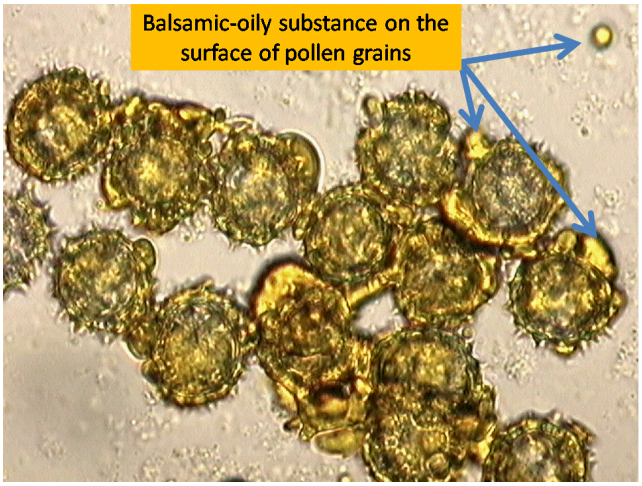

Figure 1: Pollen grains with a balsamic-oily substance.

In turn, in autumn, bees collect resinous substances of plant origin and transform them into propolis, which confirms Rosch's theory (Figure 2). In the conditions prevailing in the temperate climate, propolis is likely to be a mixture of these two intermediates, i.e. pollen balm and resinous substances.

However, it should be borne in mind that bees do not only collect balsamic substances of plant origin. During intense collection of propolis, bees may also collect road asphalt or roofing tar, which can be used for sealing the hive. Therefore, the biological activity of some propolis extracts can be significantly reduced.

Propolis composition

Propolis contains ca. 300 compounds, which have been described in various propolis samples [3,5-7]. In general, propolis is composed of 50% of resinous substances, 30% of wax, 10% of oils and aromatic substances, 5% of floral pollen and 5% of mechanical admixtures [8]. It contains active substances, e.g. salicylic acid, benzoic acid, cinnamic acid esters, phenolic compounds, flavonoids, triterpene alcohols, lipid compounds, bio elements and enzymes [9-19]. Plant phenols have been found to have antioxidant activity; therefore, addition of propolis to food products or feed may stabilise them [20]. In turn, flavonoids contained in propolis are potent antioxidants with the ability to "scavenge" free radicals from organisms [21,22]. The presence of the above-mentioned compounds implies high biological activity of propolis, which makes it one of the most active bee products (Table 1). Hence, it has wide application in medicine, veterinary medicine and livestock rearing.

Figure 2: Bee collecting resinous substances of plant origin.

Type of pharmacological activity	Pollen, corbiculae, bee bread	Propolis	Royal jelly	Honey	Venom	Wax	Bee brood
Antibacterial activity	++	+++	+	++	+	+++	+
Stimulation of regeneration processes	+	+++	++	++	+++	++	++
Activation of detoxification processes	+++	+	+++	++	+	+	++
Reactivation of metabolic processes	+++	++	+	++	+	+	+++
Replication of immunomodulatory fractions	++	+++	++	++	+	+	++
+ + + highly active, + + active, + weakly active							

Table 1: Pharmacologicalproperties of bee products determined by [23].

Due to the plant origin of propolis, its composition is variable and dependent on such factors as the species of plants providing intermediates for propolis production or the fertility of soil on which plants supplying the intermediates grow [24,12]. Investigations of the propolis activity carried out in different latitudes have yielded conflicting results [25]. Therefore, analyses of substances of plant origin should include information about the location of acquisition thereof and their composition.

Results and Discussion

Application of propolis

Ancient Romans already knew the properties of propolis. Pliny claimed that propolis could be used as a drug, as it was able to remove any substances and objects from the body, including stings, reduced swelling, alleviated tendon pain and accelerated healing of wounds, even those that seemed unhealable [26]. Propolis also exerts beneficial antibacterial, anti-inflammatory and anti-cancer effects, which promotes increasing application thereof in the treatment of humans and animals [27,28]. It may become even more important, given the growing drug resistance of microorganisms. Thanks to its antibiotic properties, propolis is considered as an alternative to the use of synthetic antibiotics in livestock diet [29-31], since the phenomenon of bacterial resistance to antibiotics is reported more frequently than in the case of natural antibiotic substances [32]. Propolis fights diseases caused by *Salmonella, Staphylococcus aureus*, or *Escherichia coli* [33] and exhibits antibacterial, antifungal and antiviral activity [34].

A spray ethanol propolis extract (EPE) can be used as an egg disinfectant instead of chemical disinfectant agents, as it does not have a negative impact on quail chick hatching [9]. Coating of consumable eggs with EPE reduces evaporation, thereby preventing deterioration of the quality of stored eggs [35].

Propolis in nutrition

In nutrition of laying hens, addition of propolis at a dose of 30 mg/l water or 5 g/kg feed increases the laying performance and egg shell thickness, which increases the weight of eggs [2,27,36-38]. Supplementation of broiler feed with propolis was found to result in greater weight gain and higher feed conversion efficiency [39,40,37,6]. Furthermore, the mortality rate was lower in a group of birds that received propolis supplementation [6]. Administration of EPE to chicks caused a significant increase in the total protein fraction and myofibrils in muscles [41].

It is worth emphasising again that propolis is an alternative to antibiotics, since supplementation of feed while rearing broilers in the conditions of heat stress prevents occurrence of oxidative stress [27,40,20,38,37].

Propolis also increases immunity, as addition of 3 g of propolis/kg of feedin laying hens elevated the level of IgG and IgM in blood serum and increased the erythrocyte count in peripheral blood [42,43]. Addition of 20 mg of a propolis extract per 100 g of chicken feed every day for 15 days resulted in an increase in total plasma protein, γglobulins, IgG and IgA [44]. Daily consumption of 20 mg of a propolis extract by chickens for 15 days was found to decrease the levels of cholesterol and transaminases (ALT, AST) and to increase the level of proteins and amino acids in peripheral blood [41,45]. Simultaneously, propolis was assumed to have an anabolic effect and activate the immune response of the organism [46,8,44].

It was found in *in vitro* investigations that propolis added to human albumin produced conformational changes in proteins and increased the activity of ceruloplasmin. This enhances iron homeostasis and defence mechanisms in oxidative stress [5].

Turkeys were shown to respond well to propolis addition, as its 40-60 ppm content in feed accelerates birds' growth and increases feed conversion and digestibility [47].

Not only poultry responds positively to propolis supplementation in nutrition. Addition of propolis to lamb diet increases weight gain, feed conversion and digestibility and the percent content of meat [48]. It also improves weight gain and feed conversion in pregnant cows [49].

Noteworthy, there is no toxic effect of substantial propolis doses on fishes. In order to demonstrate a toxic effect of propolis, the rainbow trout received it for 8 weeks at the doses of 0 g; 0, 5 g; 1, 5 g; 4, 5 g; and 9 g/kg feed. The propolis doses neither exerted toxic effects nor caused significant changes in the parameters of fish growth [24].

Conclusion

It should be emphasised that propolis is one of the few natural products/drugs that have been in the focus of interest since ancient times. It is one of the most widely used natural additives, since it enhances health and improves production performance of animals [50]. Therefore, propolis was listed as a drug in the British pharmacopoeia as early as in the 17th century [29]. In 1995, the National Food Institute in Argentina listed propolis as a dietary supplement [51-54].

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