The impact of using bee pollen in poultry systems: Apiculture

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Abstract

The use of antibiotic growth promoters in poultry production has resulted in the development of drug resistance, and destruction of the normal beneficial intestinal flora. Therefore, the task of poultry industry is to find alternative solutions to ensure safe products. The aim of this review article was to understand the potential use of bee pollen in poultry production system regarding its impact on performance, carcass traits, immunity, bacterial community, and blood parameters. Bee products such as pollen have been used in traditional medicine and have recently appeared as possible feed additives. Bee pollen is considered the most important substance in the hive, as a basic feed for bees. It consists of a mixture of proteins, amino acids, fats, carbohydrates, and multiple vitamins, minerals, and enzymes. The chemical composition of bee pollen depends mainly on the plant species, geographic region, and season of collection. Bee pollen has many uses in human medicine and livestock production. It has been used to improve general health, and may also act as an antibacterial, antifungal, antioxidant, anti-radiation, anti-carcinogenic, anti-inflammatory, hepato- and cardio-protective, and antidiabetic. Dietary supplementation of bee pollen could increase performance parameters as a growth promotor, enhancing carcass quality. In addition, bee pollen can enhance the immune response, reduce the pathogenic bacterial count, and enhance important blood parameters. .

Key words: *bee pollen; chickens; performance; carcass traits; immunity*

Introduction

Improper and frequent use of antimicrobials has contributed to the development of resistance that consequently affects the health of animals, consumers, and product quality, in addition to promoting an unsafe environment (CDC, 2021). Antimicrobial resistance to most available antibiotics is a global concern. Therefore, in recent years, research have been focused on the use of natural antibiotics alternatives such as phytobiotics (Abd El-Ghany, 2020a,b; Abd El-Ghany and Eraky, 2020; Abd El-Ghany, 2022, 2023; Abd El-Ghany and Babazadeh, 2022).

Several naturally available phytobiotic products, including bee pollen, have shown potential to replace antibiotics. These products can contribute to the development and sustainability of food security strategies, especially in developing countries (FAO, 2018). Bee pollen is a plant-derived natural substances that is

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formed in the male reproductive organ of flowering plants as a fine powdery material (Haščík et al., 2011). It is an agglomerate of plants that is collected by bees and mixed with nectar and secretions from the bee's hypo-pharyngeal glands (Attia et al., 2014). There are about 2.5-250 μm grains of bee pollen present in the plant anthers (Komosinska-Vassev et al., 2015). Pollen is harvested from different plants, resulting in a variable chemical composition (Hsu et al., 2021). Moreover, bee pollen has sweet and floral tastes depending on the plant species from which the bees collect the pollen.

It is important to note that bee pollen should be processed after collection to prevent microbial growth and retain physicochemical traits (Palla et al., 2018). Moreover, humidity, temperature, and pressure of oxygen may affect its viability. Retaining the nutritional value of bee pollen can be achieved through many techniques, including drying (Thakur and Nanda, 2018; Luo et al., 2021), freeze drying (Ghosh and Jung, 2020), pulverization (Kostić, 2019), and vacuum to extract impurities (Mayda et al., 2020), as well as storage in bags at 4°C (Zuluaga-Dominguez and Quicazan, 2019) and in dark areas at ±20°C (Araujo et al., 2017).

Bee pollen has high nutritional value due to its rich content of bioactive compounds (Figure 1). The wide variation in pollen composition is the result of differences in botanical and geographical origin (Oliveira et al., 2013; Thakur and Nanda, 2020). The main components of bee pollen are carbohydrates (13–55%), crude fibre (0.3–20%), protein (10–40%), and lipids (1–10%) (Martiniakova et al., 2021). Minerals, trace elements, vitamins, carotenoids, phenols, flavonoids, sterols, and terpenes are also present in minor amounts (Feás et al., 2012). Besides, bee pollen contains a wide variety of other health-promoting compounds of functional foods, including prebiotics, pro-

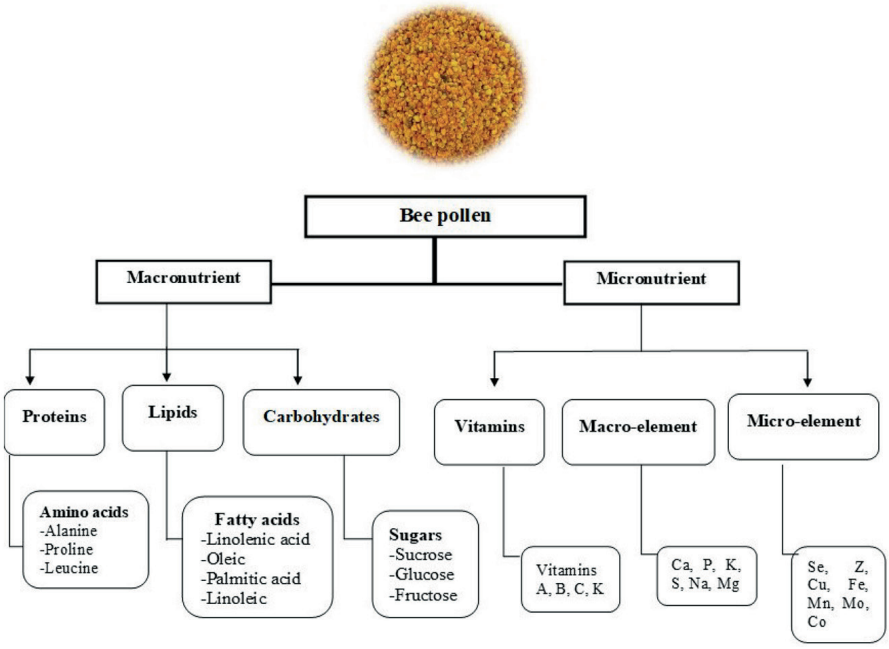

Figure 1. Different components of bee pollen

Table 1. The different impacts of bee pollen in the diets of broiler chickens

Concentration	Effects	References
1.5%	Increasing the weight of spleen	Wang et al. (2005)
0.001%	Increasing the weight of the intestine, gizzard, and liver	Wang et al. (2007)
0.04%	Improving body weight and growth performance	Haščík et al. (2012)
4.5%	Decreasing the count of Enterobacteriacae in intestine	Kročko et al. (2012)
0.5–1.5%	Improving growth performance and carcass traits	Oliveira et al. (2013)
0.6%	Increasing the length of small intestine Reducing bacterial intestinal colonization	Haščík et al. (2013)
1.5%	Increasing villus length and crypt depth	Fazayeli-Rad et al. (2015)
0.6%	Improving body weight gain and feed conversion ratio Increasing weights of the thymus, bursa, and spleen	Farag and El-Rayes (2016)
0.05–0.15%	Increasing average daily feed intake and weight gain	Hosseini et al. (2016)
0.2%, 0.4%, 0.6%	Improving body weight gain	Abdelnour et al. (2018)

biotics, fibre, lignans, triterpenes, carotenoids, bioactive peptides, and organic acids (Kostić et al., 2020). The chemical composition of bee pollen depends mainly on the source or the geographic origin of the plant, the type of soil, and climatic weather conditions during collection (Morais et al., 2011; Nogueira et al., 2012). Therefore identification of the botanical origin of bee pollen is important, since its biological, nutritional, antioxidant, and antibacterial characters are mainly related to this composition (Velásquez et al., 2017).

Bee pollen could help in the treatment of many diseases such as corona virus (Attia et al., 2020; Ali and Kunugi, 2021), and can stimulate the immune system, and have anti-aging effects (Estevinho et al., 2012). The specific metabolites in bee pollen possess a wide range of therapeutic effects, including growth promotor, antibacterial, antifungal, antioxidant, anti-radiation, anti-carcinogenic, anti-inflammatory, hepatoprotective, cardioprotective, and antidiabetic (Wang et al., 2005; Yamaguchi et al., 2007; Sarić et al., 2009; Pascoal et al., 2014; Abdelnour et al., 2018; Li et al., 2018; Prakatur et al., 2020; Nemauluma et al., 2023a). Pollen is a highly valued food product with high biological potential due to its antioxidant properties (Kaškoniene et al., 2015).

Bee pollen is also regarded as a promising natural and safe antibiotic alternative due to the content of bioactive ingredients that positively influence on the different parameters in the poultry production system. It has proven to have positive influences on growth parame-

ters, immunity, gut health, and quality and safety of food production (Wang et al., 2007; Cheng, 2009; Hashmi et al., 2012; Haščík et al., 2013).

To the extent of our knowledge, there is limited information regarding the benefits of dietary addition of bee pollen for poultry. Accordingly, this review provides a comprehensive overview of the potential uses of bee pollen in the poultry production system, regarding its impacts on performance, carcass traits, immunity, bacterial community, and blood parameters. The different impacts of bee pollen supplementation in the broiler diet are illustrated in Table 1.

Performance

Bee pollen alone or in combination with other feed additives has shown a positive influence on the growth performance of poultry (Fazayeli-Rad et al., 2015; Hosseini et al., 2016; Adhikari et al., 2017; Haščík et al., 2017; İlçeli and Yıldız, 2021). Improved diet intake and live weights after including bee pollen in broiler diets have been reported (Liu et al., 2010; Attia et al., 2011; Haščík et al., 2012; Nemauluma et al., 2023a,b). The addition of bee pollen (0.10%) in the diet of broiler chickens had a positive impact on body weight by about 65.05 g (Angelovičová et al., 2010). The addition of 0.75% finely ground bee pollen to a feed mixture of broiler chickens from the first day of rearing had positive impacts on the average growth and feed conversion ratio at the end of production (Petričević et al., 2022). Similar results were obtained by Farag and El-Rayes (2016) who deduced that a concentrations of pollen supplementation (0.6%) in broiler feed mixtures induced high average daily gain and improved the feed conversion ratio. Also, Hosseini et al. (2016) reported a significant differences in the production indicators of chickens fed mixtures contain bee pollen (2%) compared to the control group. Additionally, significantly higher body weight values were reported in chickens fed mixtures with 1% pollen at the age of 35 days compared to the control (Abood and Ezzat, 2018). An improvement in performance of quails fed bee pollen was also reported (İlçeli and Yıldız, 2021). In laying hens, the dietary feeding with 0.5 to 1.5% bee pollen product resulted in an increase in egg quality traits (Demir and Kaya, 2020).

Bee pollen can play a key role in early nutrition of chicks and this positively reflects on growth and immune functions (Wang et al., 2007; Basmacioğlu Malayoğlu et al., 2010). Dietary supplementation with bee pollen may enhance the initial development of the gastrointestinal tract and the digestion process (Toman et al., 2015; Haščík et al., 2017). Additionally, bee pollen compounds have vital nutritional substances with beneficial effects for the growth performance and health of the host (Hsu et al., 2021). The enhancement in broiler performance may be due to increasing the length and weight of the small intestine (Wang et al., 2007) as well as the population of *Lactobacillus* spp. and *Enterococcus* spp. in the caecum (Babaei et al., 2016). The presence of enzymes, essential amino acids, unsaturated fatty acids, phospholipids, carbohydrates, vitamins, minerals, and hormones in bee pollen products may help in the assessment of the digestion process and improvement of body weight gain and feed conversion ratio (Attia et al., 2010; Farag and El-Rayes, 2016). The palatability and sweet flavour of bee pollen also increased feed intake of broilers (Haščík et al., 2011). Bee pollen has a strong antibacterial activity which may positively reflect on the metabolism and health of

birds (Viuda-Martos et al., 2008). The environments for intestinal microbial ecosystems are also improved by the dietary addition of bee pollen (Dias et al., 2013). Phenol constituents and antioxidants in bee pollen are possible growth promoters in chickens and rabbits (Sarić et al., 2009).

Carcass traits

Supplementation of broiler feed with bee pollen products could increase carcass and giblets weight in broiler chickens (Farag and El-Rayes, 2016; Nemauluma et al., 2023a,b). Hashmi et al. (2012) found an increase in the weight of the chicken carcass, thighs, breast, liver, stomach, and heart following bee pollen addition in an amount of 5 g/kg of feed mixture. Moreover, feeding on bee pollen in a concentration of 400 mg/kg feed resulted in an increase in carcass weight, giblet weight, and carcass yield of the treated broiler chicken when compared with the control group (Haščík et al., 2015).

The positive influence of bee pollen on the fatty acid composition of quail meat has been reported (Seven et al., 2016). Moreover, bee pollen in doses of 1500 and 2500 mg/kg of broiler feed increased the water content of breast muscle, decreased protein, fat, and energy, and showed a positive impact on the meat pH value (Haščík et al., 2013). Bee pollen could increase the cooling and freezing loss resulting from the increase in water content of meat (Haščík et al., 2013). Pollen or its extracts in the diet of poultry contain different antioxidants that prevent oxidation of lipids and consequently increase the stability of meat during storage thereby cooling and freezing. It has been also found that the dietary addition of bee pollen (12g/kg feed) positively affected the intestinal length of broiler chickens (Nemauluma et al., 2023b).

On the other hand, no significant effects on carcass traits were observed after treatment of broilers with bee pollen (Attia et al., 2014; El-Medany et al., 2017; Sarıkaya et al., 2018). Similarly, Haščík et al. (2019) showed no differences in chicken slaughter yield and breast and leg shares following supplementation with pollen extract in combination with probiotics. Similarly, Sevim (2021) reported no significant differences in the percentages of skinless carcass, thigh, drumstick, breast, liver, and heart between bee pollen treated growing quails and untreated birds. The contradiction among studies could be attributed to the differences in the concentration and the type of bee pollen used.

Immunity

It has been reported that bee pollen is rich in nutrients that assists cell differentiation and proliferation and stimulate immunity (Oliveira et al., 2013). Feeding on bee pollen increased the lymphoid organ weights (Farag and El-Rayes, 2016). Supplementation with bee pollen could increase the immunoglobulin (Ig) level (Oliveira et al., 2013; Fazayeli-Rad et al., 2015) and consequently enhance the immune response (Bobiş et al., 2010; Kieliszek et al., 2018). Sevim (2021) demonstrated an elevation in IgA and IgG levels in response to supplementation with bee pollen in a concentration of 10 g/kg in the diet of growing quails. Moreover, Zeedan et al. (2017) reported that feeding growing rabbits with a diet containing bee pollen significantly enhanced the levels of IgA and IgG. Polysaccharides in bee pollen could affect the production of T lymphocytes as the broken wall of bee pollen could improve the antibody titre against microorganism antigens at different levels (Wang et al., 2005).

Microbial community

Bee products including bee pollen are very promising natural antimicrobial agents against both Gram-positive and Gram-negative bacteria, as well as fungi and biofilm-forming microorganisms (Ratajczak et al., 2021). The minimal inhibitory concentration of bee pollen against *Staphylococcus aureus in vitro* was 0.175 (Bakour et al., 2019).

A reduced *Enterobacteriaceae* count in the small intestine and caecum was reported in chickens following feeding on diets containing bee pollen products and this result supports their antibacterial properties (Kumova et al., 2002; Kročko et al., 2012; Haščík et al., 2013; Petričević et al., 2022). Basim et al. (2006) concluded that pollen has the ability to reduce the population of harmful microorganisms. Parallel results were obtained by Kačaniova et al. (2013) who detected that the highest *Enterobacteriaceae* count was in the control group of chickens not treated with bee pollen. The presence of the phenolic fraction in bee pollen assists the antimicrobial effect (Morais et al., 2011; Zeghoud et al., 2021). These compounds include phenolic acids, flavonoids, tannins, stilbenes, anthocyanins, rutin, quercetin, isoquercetin, myricetin, tricetin, luteolin, selagin, naringenin, kaempferol, hesperetin, isorhamnetin, *p*-coumaric acid, ferulic acid, cinnamic acid, caffeic acid, and gallic acid (Feás et al., 2012; Li et al., 2018). The recent work of Kaškoniene ◎et al. (2020) revealed an increase in radical scavenging activity by 1.27–2.40 fold, an increase in antibacterial activity against *Micrococcus luteus*, *Staphylococcus aureus*, and *Escherichia coli* by 1.08–16.9 fold, and of antifungal activity against *Penicillium roque* by 1.96–5.52 fold after bee pollen fermentation.

Blood parameters

Pollen showed beneficial properties on the cardiovascular system as well as reducing effects on cholesterol (Farag and El-Rayes, 2016; Demir and Kaya, 2020) and triglyceride levels (Zeedan et al., 2017; Ivana et al., 2018). Feeding with bee pollen could increase the white blood cell counts (Farag and El-Rayes, 2016). Furthermore, decreased calcium and increased phosphorus absorption were observed in broilers after the addition of bee pollen at level of 20 g/kg feed (Ivana et al., 2018). However, Demir and Kaya (2020) reported that feeding laying hens with bee pollen increased serum phosphorus and magnesium levels without affecting calcium concentrations. On the other hand, supplemental bee pollen did not affect serum glucose, triglyceride, cholesterol, or total protein levels in growing quails (Sevim, 2021).

Conclusion

Many essential substances needed for the growth and development of livestock are present in bee pollen products, and therefore they can be used as promising nutritional and therapeutic and alternatives. Bee keeping strategies need to be introduced particularly in developing countries to meet the demands for bee pollen and other related products.

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Učinak uporabe pčelinje peludi u sustavima proizvodnje peradi: apikultura

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Uporaba antibiotskih pospješivača rasta u proizvodnji peradi rezultirala je razvojem otpornosti na lijekove i uništavanjem normalne, korisne crijevne flore. Stoga je zadatak peradarske industrije pronaći alternativna rješenja koja će omogućiti dobivanje sigurnih proizvoda. Ovaj pregledni članak osmišljen je da bi se razumjela potencijalna uporaba pčelinje peludi u peradarskim proizvodnim sustavima s obzirom na njezin utjecaj na učinkovitost, značajke trupla, imunost, zajednice bakterija i parametre krvi. Pčelinji proizvodi, poput peludi, rabljeni su u tradicionalnoj medicini, a u novije vrijeme su se pojavili kao mogući dodatci hrani za životinje. Pčelinja pelud smatra se najvažnijom tvari u košnici i osnovna je hrana za pčele. Sastoji se od mješavine bjelančevina, aminokiselina, masti, ugljikohidrata te više vitamina, minerala i enzima. Kemijski sastav pčelinje peludi ovisi uglavnom o vrsti biljke u geografskoj regiji i sezoni skupljanja. Pčelinja pelud ima brojne primjene u ljudskoj medicini i stočarstvu. Koristi se za poboljšanje općeg zdravstvenog stanja, osim toga, može djelovati antibakterijski, antifugalno, antioksidativno, anti-radijacijski, anti-kancerogeno, protuupalno, štiti jetru i srce i ima antidijabetičko djelovanje. Dodatak pčelinje peludi u prehranu može povećati parametre učinkovitosti kao pospješivač rasta i povećati kvalitetu trupla. Uz to, pčelinja pelud može poboljšati imunološki odgovor, smanjiti broj patogenih bakterija i poboljšati neke važne parametre krvi.

Ključne riječi: *pčelinja pelud, pilići, učinkovitost, značajke trupla, imunost*