International Journal of Basic and Applied Biology
p-ISSN: 2394-5820, e-ISSN: 2349-2539, Volume 3, Issue 1; January-March, 2016, pp. 4-7

http://www.krishisanskriti.org/Publication.html

Ameliorative Properties of Bee Pollen: A Review

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Abstract—*Honey bees have the ability to collect pollen from flowers and to use it as food for their larvae. Bee collected pollen is one of the major hive products containing considerable amount of flavonoids and various phenolic compounds that have been known to be capable of scavenging free radicals thereby protecting lipids from being oxidized during free radical damage (Moreira et al., 2008). Recently bee pollen has attracted interest as a functional food with health benefits and has opened a new gateway for alternative therapies in medical field (Bobonova et al., 2013). The diverse biological properties of pollens are due to their composition variation related to their presence in different geographical areas. In the present review we summarize the various ameliorative properties of bee collected pollen.*

Keywords*: Honey bees, Bee pollen, Flavonoids, Biological properties*

1. INTRODUCTION

Many researchers on the basis of results obtained in their studies have demonstrated that bee pollen exerted its biological effects through its strong antioxidant and anabolic properties which could be useful in preventing free radical mediated oxidative damage in the tissues. Bee pollen is a good source of healthy compounds such as phenolics, terpenes and flavonoids (Stoia *et al.,* 2015) that are relevant for clinical applications against inflammatory diseases also (Nagai *et al.,* 2002; Yamaguchi *et al.,* 2007; Lee *et al.,* 2009; Khalil and El-Sheikh, 2010; Kaur *et al.,* 2013). Aqueous extract of pollen exhibits maximum amount of saponins and flavonoids that are known for their antiinflammatory, immunomodulatory, antibacterial, antioxidant and radical scavenging properties (Morais *et al.,* 2011; Singla, 2015) and thus, bee products have been reported to have many health related medicinal benefits (Dudov *et al.,* 1994; El-Khatib *et al.,* 2002; Qin and Sun, 2005; Singla *et al.,* 2014; Kalafova *et al.,* 2014). The antimicrobial activity of bee pollen, propolis and bee wax obtained from two locations in Slovakia has been reported by Kacaniova *et al.* (2012) against pathogenic bacteria, microscopic fungi and yeasts. Studies of Campos *et al.* (2000) showed the high antioxidant and antiradical activity of pollen which seemed to be due to flavonoids and their glycosides (Markham and Campos, 1996). Gupta *et al.* (2011) reported that bee pollen was the richest source of proteins, essential amino acids, essential fatty acids, vitamin complexes, lipids, trace elements, phenols and even polyphenols which were responsible for its antioxidant property and such a pollen rich diet had great potential for human use.

2. BIOLOGICAL PROPERTIES

Here under are reviewed several experimental studies documenting the anti-inflammatory, antinociceptive and other biological activities of bee pollen in different toxicity models.

Medeiros *et al.* (2008) evaluated the anti-allergic property of bee pollen (200 mg/kg b.wt; p.o) and the flavonoid myricetin (5 mg/kg b.wt; p.o) in murine model of ovalbumin (10 mg/kg b.wt; i.v) induced allergy. Treatment with bee pollen showed inhibition of paw edema, IgG and IgE1 ova-specific production, leukocyte migration to bronchoalveolar lavage and eosinophil activity in lungs. In addition, treatment with myricetin also inhibited pulmonary cell migration and IgE and IgG1 ova-specific production indicating that myricetin is one of the flavonoids of bee pollen responsible for anti-allergic reactions.

Murakami *et al.* (2008) performed a study to investigate the efficacy and safety of 12-week intake of honey bee collected pollen lump extract-supplemented food in 47 patients with benign prostatic hyperplasia. The study was planned in 3 food trial groups: a placebo group (0 mg/day); a lower-dose group (160 mg/day); and a high-dose group (320 mg/day) (Groups P, L and H respectively). Outcomes measured were the change during the 12-week intervention period in subjective symptom scores and 2 urodynamic parameters: maximum flow rate and residual urine volume. Maximum flow rate values were significantly increased in Group H ($p \leq 0.05$) but not in Groups L or P. While residual urine volume was significantly increased in Groups L and P ($p \leq 0.05$ each) and decreased in Group H. The results indicated that intake of sufficient dose of honey bee collected pollen lump extract could be effective in improving some benign prostatic hyperplasia associated symptoms.

Saric *et al.* (2009) performed experiments to study the oxidant/antioxidant status, estrogenic/anti-estrogenic activity and gene expression profile in mice fed with bee pollen as a food supplement (100 mg/kg b.wt) given daily for 14 days in comparison to commercial food pellet diet. Analysis of differential gene expression profile after feeding bee pollen

enriched diet revealed under expressed gene expression of Hspa9a, Tnfsf6 (liver) and down regulated gene expression of Casp1 and Cc121c (brain) which were important in the apoptosis pathway and chemotaxis. Results also revealed the modulated enzyme activities of superoxide dismutase, catalase and glutathione peroxidase in mice brain, liver and erythrocyte lysates as well as reduced hepatic malondialdehyde level and 25% anti-estrogenic property. These findings indicated that bee pollen was noticeable source of healthy and protective compounds.

Leja *et al.* (2007) and Graikou *et al.* (2011) reported strong antioxidant ability of pollen extract, measured in terms of radical-scavenging property and activity against free hydroxyl radical, which corresponded to the level of phenylpropanoids, flavonoids and phenolic acids. Rebiai and Lanez (2012) reported the strong antioxidant activity of Boufarik bee pollen due to its high content of phenolic compounds (46 ± 8.22 mg of gallic acid equivalent/g pollen) and total flavonoids (30.46 ± 8.22 mg of gallic acid equivalent/g pollen) estimated by using molybdate ion reduction method.

Hassan *et al.* (2012) investigated the protective effect of Egyptian date palm pollen (240 mg/kg b.wt; p.o for 30 days) against cadmium chloride (5 mg/kg b.wt; p.o every alternate day for 30 days) induced testicular dysfunction in adult male rats. Treatment with date palm pollen significantly restored the reduction in sex organ weight, decline in sperm count and their motility as well as depleted level of testosterone and tissue glutathione induced by $CdCl_2$ challenge.

Cabrera and Montenegro (2013) studied the antibacterial properties of Chilean bee pollen extract against human infectious agents *viz. Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus* and *Streptococcus pyogenes* using minimal inhibitory concentration (MIC) and agar diffusion method and also on agricultural pathogens *viz. Alternaria alternata, Botrytis cinerea* and *Fusarium oxysporum* using the poisoned food technique. It was seen that *Escherichia coli* and *Pseudomonas aeruginosa* were resistant to the extract but *Staphylococcus aureus* and *Streptococcus pyogenes* were sensitive. Results of MIC were 82.4 mg/ml for *Escherichia coli,* 41.2 mg/ml for *Pseudomonas aeruginosa* and 20.6 mg/ml for *Staphylococcus aureus* and *Streptococcus pyogenes.*

Hajkova *et al.* (2013) observed that the administration of pollen at a concentration of 0.2%, increased the length of villi in small intestine and at 0.5% concentration, denser and higher number of villi per unit area appeared in the jejunum of Wistar rat. Also using quantitative morphometrical methods, results showed that pollen enriched diet given orally for 90 days at a concentration of 0.2% caused increase in epithelial layer of small intestine and at a concentration of 0.5% significantly ($p \leq 0.001$) increased the epithelium volume and decreased the soft tissue volume thus affecting the mucosa of small intestine in a concentration-dependent manner. This improved the absorptive process of mucosal surface which could positively affect the usability of the received nutrients in the food.

Khider *et al.* (2013) reported the use of Egyptian bee pollen from three different plant sources *viz. Zea mays*, *Trifolium alexandrinum* and *Phoenix dactylifera* as antimicrobial agent, antioxidant and dietary supplement in the food industry due to the high content of proteins, carbohydrates, amino acids, phytochemicals, vitamins, minerals, carotenoids, flavonoids and polyphenolic compounds. Moita *et al.* (2013) conducted a study to evaluate the anti-inflammatory and antioxidant potential of *Echium plantagineum* L. bee pollen and concluded that the extract was able to scavenge the reactive species of nitric oxide (•NO) and superoxide (O2•−) and reduce the markers of oxidative stress in cells at low concentrations.

Al-Quraishy *et al.* (2014) evaluated the antagonistic effect of palm pollen extract (150 mg/kg b.wt; p.o) against *Eimeria papillata* (coccidian parasite) induced metabolic disturbance in Swiss albino mice. Results showed that elevated plasma enzyme activities of lactate dehydrogenase and alkaline phosphatase as a consequence of *Eimeria papillata* infection were effectively lowered down by administration of palm pollen extract. The authors recommended its use as an excellent food supplement, which could fight infections.

Andritoiu *et al.* (2014) evaluated the influence of various bee products based diet formulations including honey, pollen, propolis, apilarnil, with/without royal jelly against carbon tetrachloride induced hepatotoxicity in Wistar rats. Biochemical determinants (enzymatic, protein and lipid profile, coagulation, blood count parameters and total bilirubin level) supported with the histopathological changes in liver, spleen and pancreas revealed that the tested formulations had a positive effect and helped in improving the mentioned changes towards normal range.

Metwaly *et al.* (2015) evaluated the protective effects of aqueous extract of palm pollen (150 mg/kg b.wt; for 5 successive days) against *Eimeria papillata* induced intestinal damage in male Swiss albino mice. It was observed that inoculation with 1.5×103 sporulated *Eimeria papillata* oocysts caused disturbances in the antioxidant system within jejunum tissue by enhancing the level of lipid peroxides and protein oxidation processes as well as by decreasing the activities of catalase and glutathione peroxidase with concurrent reduction in the level of glutathione. Also histopathological observations in the jejunum tissue revealed marked alterations in the form of inflammation, damage in some villi and vacuolization of the epithelium with concurrent decrease in the number of goblet cell. But administration of aqueous extract of palm pollen effectively reduced the oxidative stress status and jejunal histological injury score.

3. APPLICATIONS

The present review provided information that bee collected pollen has various ameliorative properties against various drug

related side effects. Not only this, such a direction in medicine is the need of the hour and motivates exploration of thus far unexplored naturals. Honey bee products including pollen hold good promise in this field.

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