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**AMELIORATIVE EFFECT OF BEE POLLEN AND BEE PROPOLIS ON  
CATALASE ACTIVITY AGAINST ANTITUBERCULOSIS DRUGS  
RIFAMPICIN AND ISONIAZID IN SPRAGUE DAWLEY RATS**

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**ABSTRACT**

Bee pollen and propolis are the medicinal and health promoting products of apiculture. The present study investigates the protective role of bee pollen and propolis against anti-tuberculosis drugs (Rifampicin and Isoniazid) in Sprague Dawley Rats by analysing the catalase (CAT) activity. Male SD rats were segregated randomly into twelve groups n=6 for 30 days treatment. The activity of catalase (CAT), in rifampicin treated, isoniazid treated and both the drugs administered in combination, was reduced in the liver, kidney and testis tissues as compared to control groups. The results indicated that co-administration of bee pollen and bee propolis with drugs helped to modulate the toxic effects caused by drugs by restoring tested values to near normal.

**Keywords: Bee pollen, propolis, catalase, drug, antituberculosis**

**INTRODUCTION:**

**Bee pollen**

In the hive, bee pollen is considered as a primary source of protein [9] that comprise of essential amino acids, carbohydrates,

lipids, fatty acids [23], phenolic compounds [14], enzymes, coenzymes, vitamins [8], macronutrients, micronutrients and ash [1, 13, 17].

### Propolis

Propolis is a sticky glue, dark coloured product collected by honey bees naturally from the secretions of plants, exudates from plant wound, lipophylic material on leaves and leaf buds, mucilages, gums, resins, from living plants. It is widely used to treat and prevent ulcers, colds, wounds, rheumatism, sprains, heart disease, diabetes and dental caries [12, 24]. Chemical properties of propolis depends on its topographical location, host plant and honey bee species [22].

### Anti-tuberculosis drugs:

Rifampicin and isoniazid are the drugs associated with high toxicity at organ level. These are the first line of drugs used for the treatment of tuberculosis caused by microbial infection (*Mycobacterium tuberculosis*).

### MATERIAL AND METHODS:

#### Drugs

Rifampicin and Isoniazid drugs were purchased from HiMedia.

#### Bee pollen

Bee pollen was collected from Langstroth beehives maintained in an apiary at Majri village near old Panchkula, Haryana. Aqueous extract of bee pollen was prepared for further experimentation.

### Propolis

Propolis was collected from hives kept in an apiary at village Majri near old Panchkula,

Haryana. Ethanolic extract of propolis was prepared by methodology [16].

### Experimental Design

All experiments and protocols reported here strictly followed the principle laid down by the Institutional Animal Ethical Committee (IAEC) of Panjab University, Chandigarh vide letter no PU/IAEC/2013/18.

### Experimental groups

Male Sprague Dawley rats 160-200 g body weights, were divided into 12 groups of six animals (30 days treatment) each:

- **Group 1 (C):** Control- Rats were given tap water orally
- **Group 2 (O):** Bee pollen treated- Rats were given 100mg/kg body weight of bee pollen extract orally, once daily
- **Group 3 (D1):** Rifampicin treated- This group was given rifampicin dissolved in DDW at a dosage of 100mg/kg body weight orally, once daily
- **Group 4 (D2):** Isoniazid treated- Rats were given isoniazid dissolved in DDW at a dosage of 50mg/kg body weight orally, once daily
- **Group 5 (D12):** Rifampicin+isoniazid treated- This group was given rifampicin 100mg/kg body weight and Isoniazid 50mg/kg body weight orally, once daily
- **Group 6 (D10):** Bee pollen+rifampicin treated- Dose was

the same as given in group 2 and group 3

- **Group 7 (D2O):** Bee pollen+isoniazid treated - Dose was the same as given in group 2 and group 4
- **Group 8 (D12O):** Bee pollen+rifampicin+isoniazid treated- Dose was the same as given in group 2 and 5
- **Group 9 (R):** Propolis treated- Rats were given 200mg/kg body weight propolis extract orally, once daily
- **Group 10 (D1R):** Propolis+rifampicin treated- Dose was the same as given in group 9 and 3
- **Group 11 (D2R):** Propolis+isoniazid treated- - Dose was the same as given in group 9 and 4
- **Group 12 (D12R):** Propolis+rifampicin+isoniazid treated- Dose was the same as given in group 9 and 5

The experimental rats were kept under alike conditions for 30 days with permitted access to water and food. The rats were sacrificed under light anaesthesia and cervical dislocation after the last treatment. The tissues (liver, kidney and testes) were removed and weighed for preparing tissue homogenate. Tissue samples were rapidly removed, dissected, washed with ice-cold saline. 10% homogenates were prepared in ice-cold phosphate-buffered saline (PBS,

pH 7.4) using homogenizer at 3000 r.p.m in ice till total disruption of cells. Post-mitochondrial supernatant was prepared by centrifugation at 10,000 g for 20 minutes at 4°C in cold centrifuge. The animals were sacrificed at the end of 30 days for further analysis.

## OXIDATIVE STRESS PARAMETER

### Catalase (CAT)

Catalase enzyme protects the cell from oxidative damage by producing reactive oxygen species (ROS) by converting hydrogen peroxide to water and oxygen. Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) is an important mediator of oxidative stress and cell injury resulting from drug induced toxicity. Hydrogen peroxide generates cytotoxicity by forming hydroxyl radicals which attack membrane lipids and proteins thus releasing lipid peroxides leading to high oxidative stress. This increased oxidative stress causes fluctuations in the activity of enzyme like catalase (CAT).

## RESULTS:

### Catalase activity in liver

In the present study, activity of CAT in control group was found to be 0.179±0.006 μmoles of H<sub>2</sub>O<sub>2</sub> decomposed/min/mg protein in 30 days treatment group (**Table 1**). Administration of bee pollen as well propolis did not cause any significant change in the CAT activity. Anti-tuberculosis drugs (rifampicin, isoniazid)

alone and in combination caused significant decrease in CAT activity in post mitochondrial supernatant of liver (Figure 1).

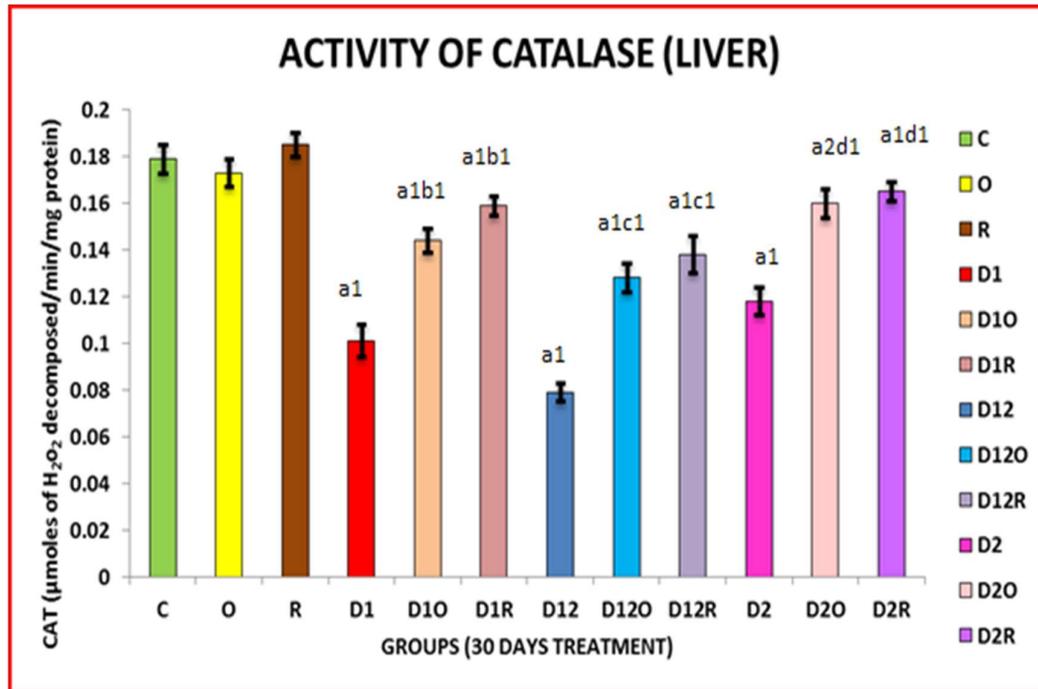


Figure 1: Activity of catalase in liver of male SD rats (30 days treatment)

- C (Control), O (Pollen), R (Propolis), D1 (Rifampicin), D1O (Rifampicin+Pollen), D1R (Rifampicin+Propolis), D12 (Rifampicin+Isoniazid), D12O (Rifampicin+Isoniazid +Pollen), D12R (Rifampicin+Isoniazid +Propolis), D2 (Isoniazid), D2O (Isoniazid+Pollen), D2R (Isoniazid +Propolis) as treatment groups
- P value: a1 ( $p \leq 0.001$ ); a2 ( $p \leq 0.01$ ); a3 ( $p \leq 0.05$ ) statistically significant difference w.r.t. control.
- P value: b1 ( $p \leq 0.001$ ); b2 ( $p \leq 0.01$ ); b3 ( $p \leq 0.05$ ) statistically significant difference w.r.t. Rifampicin treated group.
- P value: c1 ( $p \leq 0.001$ ); c2 ( $p \leq 0.01$ ); c3 ( $p \leq 0.05$ ) statistically significant difference w.r.t. Rifampicin+Isoniazid treated group.
- P value: d1 ( $p \leq 0.001$ ); d2 ( $p \leq 0.01$ ); d3 ( $p \leq 0.05$ ) statistically significant difference w.r.t. Isoniazid treated group

Table 1: Activity of catalase (µmoles of H<sub>2</sub>O<sub>2</sub> decomposed/min/mg protein) in experimental male SD rats (30 days treatment)

TREATMENT GROUPS	C	O	R	D1	D1O	D1R	D12	D12O	D12R	D2	D2O	D2R
LIVER	0.179 ±0.006	0.173 ±0.006	0.185 ±0.005	0.101 ±0.007 <sup>a1</sup>	0.144 ±0.005 <sup>a1b1</sup>	0.159 ±0.004 <sup>a1b1</sup>	0.079 ±0.004 <sup>a1</sup>	0.128 ±0.006 <sup>a1c1</sup>	0.138 ±0.008 <sup>a1c1</sup>	0.118 ±0.006 <sup>a1</sup>	0.160 ±0.006 <sup>a2d1</sup>	0.165 ±0.004 <sup>a1d1</sup>
% change w.r.t. control		-3.35	3.35	-43.58	-19.55	-11.17	-55.87	-28.49	-22.91	-34.08	-10.61	-7.82
% change w.r.t. drug					42.57	57.43		62.03	74.68		35.59	39.83
KIDNEY	0.261 ±0.009	0.223 ±0.006	0.215 ±0.005	0.143 ±0.007 <sup>a1</sup>	0.180 ±0.006 <sup>a1b1</sup>	0.189 ±0.004 <sup>a1b1</sup>	0.139 ±0.006 <sup>a1</sup>	0.185 ±0.006 <sup>a1c1</sup>	0.180 ±0.006 <sup>a1c1</sup>	0.158 ±0.007 <sup>a1</sup>	0.188 ±0.005 <sup>a1d1</sup>	0.197 ±0.009 <sup>a1d1</sup>
% change w.r.t. control		-14.6	-17.6	-45.2	-31	-27.6	-46.7	-29.1	-31	-39.5	-28	-24.5
% change w.r.t. drug					25.87	32.17		33.09	29.50		18.99	24.68
TESTIS	0.125 ±0.006	0.131 ±0.006	0.125 ±0.006	0.075 ±0.006 <sup>a1</sup>	0.111 ±0.002 <sup>a3b1</sup>	0.105 ±0.007 <sup>a3b1</sup>	0.070 ±0.006 <sup>a1</sup>	0.120 ±0.007 <sup>a3c1</sup>	0.110 ±0.008 <sup>a2c1</sup>	0.080 ±0.007 <sup>a2</sup>	0.104 ±0.006 <sup>a2d2</sup>	0.097 ±0.009 <sup>a1d3</sup>
% change w.r.t. control		4.8	0.0	-40	-11.2	-16	-44	-4	-12	-36	-16.8	-22.4
% change w.r.t. drug					48.00	40.00		71.43	57.14		30.00	21.25

- C (Control), O (Pollen), R (Propolis), D1 (Rifampicin), D1O (Rifampicin+Pollen), D1R (Rifampicin+Propolis), D12 (Rifampicin+Isoniazid), D12O (Rifampicin+Isoniazid +Pollen), D12R (Rifampicin+Isoniazid +Propolis), D2 (Isoniazid), D2O (Isoniazid+Pollen), D2R (Isoniazid +Propolis) as treatment groups
- All the values are expressed as Mean ± S.D. (n=6)
- Units: Catalase µmoles of H<sub>2</sub>O<sub>2</sub> decomposed/min/mg protein
- P value: a1 (p≤0.001); a2 (p≤0.01); a3 (p≤0.05) statistically significant difference w.r.t. control.
- P value: b1 (p≤0.001); b2 (p≤0.01); b3 (p≤0.05) statistically significant difference w.r.t. rifampicin treated group.
- P value: c1 (p≤0.001); c2 (p≤0.01); c3 (p≤0.05) statistically significant difference w.r.t. rifampicin+isoniazid treated group.
- P value: d1 (p≤0.001); d2 (p≤0.01); d3 (p≤0.05) statistically significant difference w.r.t. isoniazid treated group.

In D1, D2 and D12 group, CAT activity was recorded as 0.101±0.007<sup>a1</sup>, 0.118±0.006<sup>a1</sup> and 0.079±0.004<sup>a1</sup> µmoles of H<sub>2</sub>O<sub>2</sub> decomposed/min/mg protein in 30 days of treatment (Table 1) with significant reduction (p≤0.001) in CAT activity with

respect to control. Significant increase (p≤0.01) was observed in 30 days treatment where CAT activity in bee pollen plus drug treated groups was recorded to be 0.144±0.005<sup>a1b1</sup>, 0.160±0.006<sup>a2d1</sup> and 0.128±0.006<sup>a1c1</sup> µmoles of H<sub>2</sub>O<sub>2</sub>

decomposed/min/mg protein in D1O, D2O and D12O respectively. On co-administration of propolis with anti-tuberculosis drugs (rifampicin and isoniazid) alone and in combination, significant increase ( $p \leq 0.001$ ), CAT activity was observed as  $0.159 \pm 0.004^{a1b1}$ ,  $0.165 \pm 0.004^{a1d1}$  and  $0.138 \pm 0.008^{a1c1}$  and

$\mu$ moles of  $H_2O_2$  decomposed/min/mg protein in D1R, D2R and D12R respectively in 30 days treatment. Significant increase of 57.43%, 39.83% and 74.68% was noticed on administration with propolis when compared with CAT activity of their respective drug treated groups.

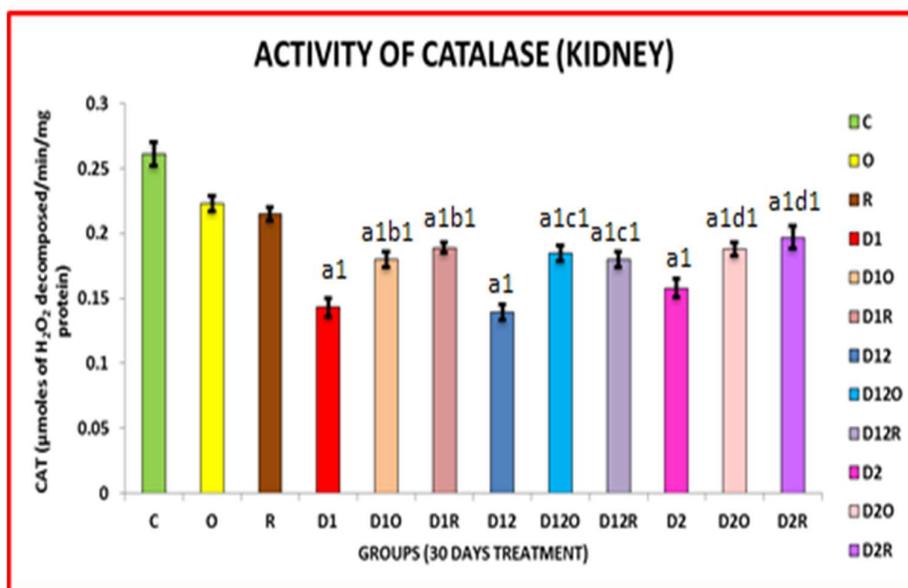


Figure 2: Activity of catalase in kidney of male SD rats (30 days treatment)

- C (Control), O (Pollen), R (Propolis), D1 (Rifampicin), D1O (Rifampicin+Pollen), D1R (Rifampicin+Propolis), D12 (Rifampicin+Isoniazid), D12O (Rifampicin+Isoniazid +Pollen), D12R (Rifampicin+Isoniazid +Propolis), D2 (Isoniazid), D2O (Isoniazid+Pollen), D2R (Isoniazid +Propolis) as treatment groups
- P value: a1 ( $p \leq 0.001$ ); a2 ( $p \leq 0.01$ ); a3 ( $p \leq 0.05$ ) statistically significant difference w.r.t. control.
- P value: b1 ( $p \leq 0.001$ ); b2 ( $p \leq 0.01$ ); b3 ( $p \leq 0.05$ ) statistically significant difference w.r.t. Rifampicin treated group.
- P value: c1 ( $p \leq 0.001$ ); c2 ( $p \leq 0.01$ ); c3 ( $p \leq 0.05$ ) statistically significant difference w.r.t. Rifampicin+Isoniazid treated group.
- P value: d1 ( $p \leq 0.001$ ); d2 ( $p \leq 0.01$ ); d3 ( $p \leq 0.05$ ) statistically significant difference w.r.t. Isoniazid treated group

**Catalase activity in kidney**  
 CAT activity of control rat kidney in 30 days treatment group was found to be

$0.261 \pm 0.009$   $\mu$ moles of  $H_2O_2$  decomposed/min/mg protein in control rats (Table 1). Administration of rifampicin and

isoniazid alone and in combination caused significant decrease in the activity of catalase activity in 30 days treatment (**Table 1**). In 30 days treatment groups CAT activity in D1, D2 and D12 groups respectively was found to be  $0.143\pm 0.007^{a1}$ ,  $0.158\pm 0.007^{a1}$  and  $0.139\pm 0.006^{a1}$   $\mu\text{moles}$  of  $\text{H}_2\text{O}_2$  decomposed/min/mg protein with significant reduction ( $p\leq 0.001$ ) when compared with the CAT activity of control group in 30 days treatment.

In 30 days of treatment in D1O, D2O and D12O groups respectively significant

increase was found in bee pollen plus drug treated groups and it was recorded to be  $0.180\pm 0.006^{ab1}$ ,  $0.188\pm 0.005^{ald1}$  and  $0.185\pm 0.006^{ac1}$   $\mu\text{moles}$  of  $\text{H}_2\text{O}_2$  decomposed/min/mg protein respectively. In 30 days treatment groups CAT activity in rifampicin and isoniazid alone and in combination (D1R, D2R and D12R) there was significant increase in the CAT activity (32.17%, 24.68% and 29.50% respectively) with propolis treatment when compared to their respective drug treated group D1, D2 and D12 (**Figure 2**).

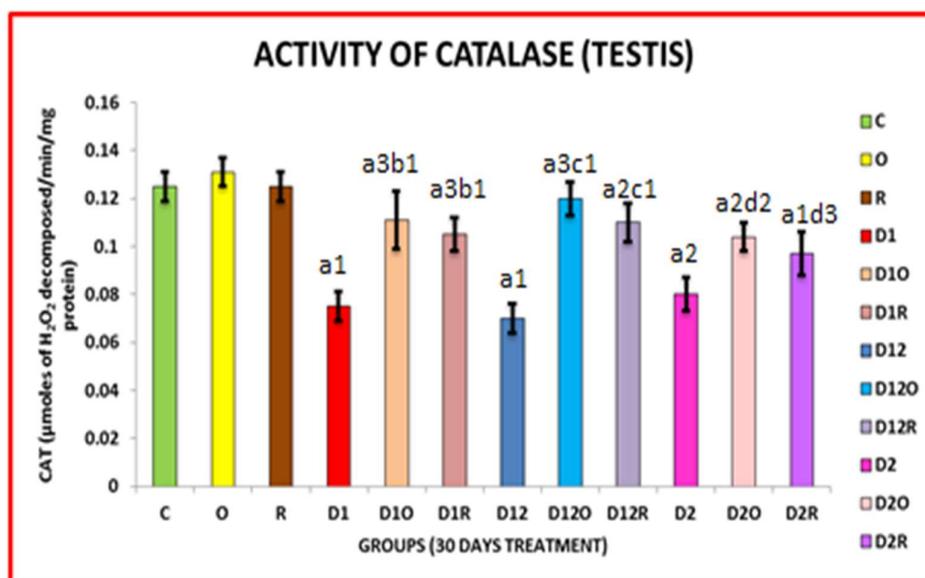


Figure 3: Activity of catalase in testis of male SD rats (30 days treatment)

- C (Control), O (Pollen), R (Propolis), D1 (Rifampicin), D1O (Rifampicin+Pollen), D1R (Rifampicin+Propolis), D12 (Rifampicin+Isoniazid), D12O (Rifampicin+Isoniazid +Pollen), D12R (Rifampicin+Isoniazid +Propolis), D2 (Isoniazid), D2O (Isoniazid+Pollen), D2R (Isoniazid +Propolis) as treatment groups
- P value: a1 ( $p\leq 0.001$ ); a2 ( $p\leq 0.01$ ); a3 ( $p\leq 0.05$ ) statistically significant difference w.r.t. control.
- P value: b1 ( $p\leq 0.001$ ); b2 ( $p\leq 0.01$ ); b3 ( $p\leq 0.05$ ) statistically significant difference w.r.t. Rifampicin treated group.
- P value: c1 ( $p\leq 0.001$ ); c2 ( $p\leq 0.01$ ); c3 ( $p\leq 0.05$ ) statistically significant difference w.r.t. Rifampicin+Isoniazid treated group.
- P value: d1 ( $p\leq 0.001$ ); d2 ( $p\leq 0.01$ ); d3 ( $p\leq 0.05$ ) statistically significant difference w.r.t. Isoniazid treated group

### Catalase activity in testis

In control group after 30 days CAT activity was  $0.125 \pm 0.006$   $\mu\text{moles}$  of  $\text{H}_2\text{O}_2$  decomposed/min/mg protein in 30 days treatment (**Table 1**). In bee pollen and propolis administered groups (O & R) there was no significant change in CAT activity. Administration of rifampicin and isoniazid caused significant decrease ( $p \leq 0.01$ ) in the activity of catalase activity in testis after 30 days treatment (**Figure 3**). In D1, D2 and D12 groups, CAT activity was found to be  $0.075 \pm 0.006^{a1}$ ,  $0.080 \pm 0.007^{a2}$  and  $0.070 \pm 0.006^{a1}$   $\mu\text{moles}$  of  $\text{H}_2\text{O}_2$  decomposed/min/mg protein with significant decrease ( $p \leq 0.001$ ) when compared with control rats in 30 days treatment. Further, in 30 days treatment, group D1, D2 and D12 showed 40%, 36% and 44% reduction in CAT activity with respect to CAT activity in control group of rats. On co-administration with bee pollen in 30 days treatment CAT activity in D10, D20 and D120 groups was recorded as  $0.111 \pm 0.012^{a3b1}$ ,  $0.104 \pm 0.006^{a2d2}$  and  $0.120 \pm 0.007^{a3c1}$   $\mu\text{moles}$  of  $\text{H}_2\text{O}_2$  decomposed/min/mg protein respectively. Bee pollen in these three drug treated groups caused significant increase of catalase activity when compared with respective drug treated groups, but was still significantly less than the CAT activity of control rats. On co-administration of propolis in drug treated groups a significant

increase was recorded in D1R, D2R and D12R groups with CAT activity as  $0.105 \pm 0.007^{a3b1}$ ,  $0.097 \pm 0.009^{a1d3}$  and  $0.110 \pm 0.008^{a2c1}$   $\mu\text{moles}$  of  $\text{H}_2\text{O}_2$  decomposed/min/mg protein respectively in 30 days treatment with significant increase when compared with their respective drug treated groups. In 30 days treatment groups D1R, D2R and D12R of testis showed 40%, 21.25% and 57.14% increase when compared with respective drug treated groups.

### DISCUSSION:

It was seen that rifampicin and isoniazid drug alone or in combination when fed in a diet with bee pollen and propolis showed increased enzyme activity of CAT in liver, kidney and testis tissue. Data was supported by studies earlier who reported the role of bee pollen (100mg/kg) against propoxur (20mg/kg) induced toxicity in female Wistar rats [10], [18] who studied the modulatory effects of propolis and pollen grains against hyperammonemia in rats. Several experimental studies also have supported the ameliorative role of propolis against drug induced toxicity like *in vivo* experiments to demonstrate the protective role of propolis in kidney tissue against toxicity by improving the biochemical parameters of renal tissue [3].

Anti-tuberculosis drugs like rifampicin and isoniazid are associated with various medication side effects as confirmed by the

findings that studied the frequency of side-effects associated with anti-tuberculous treatment in a group of patients with chronic renal failure and found high incidence of side-effects like neuropsychiatric, hepatic and gastrointestinal problems with anti-tuberculosis drugs in patients with chronic renal failure [20]. [2] reported that termination of therapy in up to 23% of patients was seen due to anti-tuberculosis medication side-effects like hepatitis, dyspepsia, exanthema and arthralgia, the main concern during the treatment of tuberculosis in developing countries. Some studies presented that the bee propolis administration could recover cellular membrane and organ functioning effectively, thereby maintaining all haematological parameters near to normal values [4, 5]. Studies also reported that the anti-tuberculosis drugs (rifampicin and isoniazid in combination) and bee pollen treated groups showed significant decrease in the level of lipid peroxidation while the activity of SOD, GR, GPx, GST and GSH were elevated representing reduced oxidative stress in the drug treated with bee pollen groups [6]. Bee pollen has shown the protective effect against damage and oxidative stress induced by anti-tuberculosis drugs (rifampicin and isoniazid in combination) in rat testis. Studies were designed to explore all possible data related to the ameliorative properties of a variety of

natural products against anti-tuberculosis drugs (Rifampicin and Isoniazid) [7].

#### **CONCLUSION:**

On the basis of these observations and the studies of previous workers it was proposed that decline in CAT activity in anti-tuberculosis drug (rifampicin, isoniazid) either alone or in combination groups (D1, D2 and D12) was due to formation of reactive oxygen species resulting in oxidative stress and causing tissue damage [11, 15, 19, 21]. Bee pollen and propolis were found to be effective in counteracting the toxic effects caused by anti-tuberculosis drugs. The present study revealed that the catalase activities of liver, kidney and testis were significantly increased by administration of propolis and bee pollen due to presence of bioactive elements like isoquercetin, myricetin, kaempferol which convert the reactive free oxygen radicals to inactive products, thereby playing a role as a natural antioxidant.

#### **DECLARATION OF INTEREST STATEMENT:**

The manuscript has been read and approved by all the authors, the requirements for authorship have been met and each author believes that the manuscript represents honest work. The authors declare no conflict of interest.

#### **REFERENCES**

- [1] Almeida-Muradian, LB., Pamplona LC, Coimbra S, Barth OM. Chemical

- composition and botanical evaluation of dried bee pollen pellets. *J. Food Compo. Analy.* 18(1) 2005 105-111.
- [2] Awofeso N. Anti-tuberculosis medication side-effects constitute major factor for poor adherence to tuberculosis treatment. *Bull World Health Org.*, 86(3) 2008 B–D.
- [3] Baykara M, Silici S, Özçelik M, Güler O, Erdoğan N, Bilgen M. *In vivo* nephroprotective efficacy of propolis against contrast-induced nephropathy, *Diagn. Interv. Radiol.*, 21 (2015) 317–321.
- [4] Bharti U, Kumar NR, Kaur J. “Modulatory Activity Of Bee Pollen Against The Toxicity Of Antituberculosis Drugs Rifampicin And Isoniazid In Testis Of Sprague Dawley Rats”. *Asian Journal of Pharmaceutical and Clinical Research*, 10 (9) (2017a) 161-163, doi:10.22159/ajpcr.2017.v10i9.19701.
- [5] Bharti U, Kumar NR, Kaur J. “Protective Effect of Bee Propolis Against Anti-Tuberculosis Drugs (Rifampicin And Isoniazid)-Induced Hematological Toxicity In Sprague Dawley Rats”. *Asian Journal of Pharmaceutical and Clinical Research*, 10 (3) (2017b) 188-90, doi:10.22159/ajpcr.2017.v10i3.15991.
- [6] Bharti U, Kumar NR, Kaur J. Bee Pollen attenuates Rifampicin and Isoniazid in Combination induced Oxidative Stress in Testis of SD Rats. *Research J. Pharm. and Tech.* 11(3) (2018) 1159-1163. doi: 10.5958/0974-360X.2018.00216.0
- [7] Bharti U, Kumar NR. Ameliorative Properties Of Natural Products Against Anti-Tuberculosis Drugs (Rifampicin And Isoniazid): A Review. *Journal of Advanced Scientific Research*, 11 (3) (2020) 30-36.
- [8] Campos M, Bogdanov S, Almeida ML, Szczesna T, Mancebo Y, Frigerio C, Ferreira F. Pollen composition and standardization of analytical methods. *J. Api. Res. Bee World*, 47(2) (2008) 154-161.
- [9] Campos M, Frigerio C, Lopes J, Bogdanov S. What is the future of Bee-Pollen? *J. Analy. Atomi. Spectro.*, 2 (2010) 131–144.
- [10] Eraslan G, Kanbur M, Silici S, Liman B, Altinordulu S, Sarica, ZS. Evaluation of protective effect of bee pollen against propoxur toxicity in rat. *Ecotoxic. Environ. Saf.*, 72(3) (2009) 931–937.
- [11] Hassan AS, Ahmed JH, Al-Haroon SS (2012). A study of the effect of *Nigella sativa* (Black seeds) in isoniazid (INH)-induced hepatotoxicity in rabbits. *Indian J. Pharmacol.*, 44(6) (2012) 678–682.
- [12] Hu FL, Hepburn HR, Li YH, Chen M, Radloff SE, Daya S. Effects of ethanol and water extracts of propolis (bee glue)

- on acute inflammatory animal models. *J. Ethnopharmacol.*, 100 (2005) 276–283.
- [13] Human H, Nicolson SW Nutritional content of fresh, bee-collected and stored pollen of *Aloe greatheadii* var. *davyana* (Asphodelaceae). *Phytochemistry*, 67 (2006) 1486–1492.
- [14] Kędzia B, Holderna-Kędzia E. New studies on biological properties of pollen. *Postępy Fitoterapii*, 1 (2012) 48–54.
- [15] Mahmoud AM, Morsy BM, Abdel-Hady DS, Samy RM. *Prunus armeniaca* leaves extract protects against isoniazid and rifampicin induced nephrotoxicity through modulation of oxidative stress and inflammation. *Int. J. Food Nutr. Sci.*, 2(4) (2015) 1-6.
- [16] Mani F, Damasceno HCR, Novelli ELB, Martins EAM, Sforcin JM. Propolis: Effect of different concentrations, extracts and intake period on seric biochemical variables. *J. Ethnopharmacol.*, 105(1-2) (2006) 95-98.
- [17] Nogueira C, Iglesias A, Feás X, Estevinho LM. Commercial bee pollen with different geographical origins: A comprehensive approach. *Int. J. Mol. Sci.*, 13(9) (2012) 11173–11187.
- [18] Omnia MA, Nabila MA, Nadia RR Biochemical effects of propolis and bee pollen in experimentally-induced hyperammonemia in rats. *Benha Vet. Med. J.*, 27(1) (2014) 8-24.
- [19] Patel J, Kumar RV, GS. Phytochemical evaluation and hepatoprotective activity of methanolic extract of fruits of *Cucumis melo* Linn. against isoniazid and rifampicin toxicity in rats. *IJBPT*, 7(2) (2016) 182-189.
- [20] Quantrill SJ, Woodhead MA, Bell CE, Hardy CC, Hutchison AJ, Gokal R. Side-effects of antituberculosis drug treatment in patients with chronic renal failure. *Eur. Respir. J.*, 20 (2002) 440–443.
- [21] Shih T, Young T, Lee H, Hsieh C, Hu OY Protective effects of kaempferol on isoniazid and rifampicin induced hepatotoxicity. *AAPSJ*, 15(3) (2013) 754-762.
- [22] Silici S, Kutluca S Chemical composition and antibacterial activity of propolis collected by three different races of honey bees in the same region. *J. Ethnopharmacol.*, 99(1) (2005) 69-73.
- [23] Szczesna T Long chain fatty acids composition of honey bee-collected pollen. *J. Apicul. Sci.*, 50(2) (2006) 65–79.
- [24] Zhu W, Li YH, Chen ML, Hu FL Protective effects of Chinese and Brazilian propolis treatment against hepatorenal lesion in diabetic rats. *Hum. Exp. Toxicol.*, 30(9) (2011) 1246-1255.