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Laurus nobilis L. modulates oxidative stress induced by propineb in rats: Impact on hepatic and renal functions

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The increasing use of pesticides has led to significant ecological, environmental, and health concerns, highlighting the need for natural protective agents. This study investigates the potential of *Laurus nobilis L.* as a protective agent against propineb-induced hepatotoxicity and nephrotoxicity in rats. Forty-eight Wistar rats were divided into six groups and treated with propineb and/or *Laurus nobilis L.* either as a powder in feed or as an essential oil for 30 days. Propineb exposure resulted in slow body growth, anemia, and biochemical disturbances accompanied by increases in the relative weight of the liver and kidney. The oxidative stress profile revealed heightened MDA levels and GPx activity, while GSH levels, GST, and CAT activities decreased in the studied organs. Furthermore, propineb induced histological changes in liver and kidney tissues. Otherwise, adding *Laurus nobilis L.* either in powdered or essential oil form, makes it possible to restore most of the parameters measured in this study without any significant differences being detected compared to the controls and the improvement of organ tissue architecture. These results conclusively testify the antioxidant and therapeutic potential of *Laurus nobilis L.* in mitigating propineb-induced oxidative damage.

Keywords: Propineb toxicity, Antioxidant biomarkers, Hepatotoxicity, Nephrotoxicity, Plant extracts, Environmental contaminants

Agricultural production for human consumption requires protection against pests that can cause irreversible damage[1]. Among various phytosanitary products, the fungicide propineb a broad-spectrum dithiocarbamate, provides rapid preventive action against mildew and certain botrytis species that threaten vegetable and fruit crops[2]. The use of pesticides expanded significantly in the late 20th century, which has a harmful environmental impact due to their persistence, mobility, and long-term effects on living organisms[3]. Currently, agriculture is a source of worrying water pollution in many countries, including Mediterranean countries where pesticides used in agricultural production diffuse into groundwater and surface[4]. Numerous epidemiological studies suggest a strong correlation between the professional use of pesticides and the appearance of certain pathologies in the concerned populations. Carcinogenic, neurotoxic, liver and kidney impairment, endocrine disruption, infertility problems, or weakened immune systems have been observed[1]. Pesticides are recognized for their ability to elevate the production of free radicals, leading to oxidative stress in various tissues. These reactive compounds have the potential to harm biomolecules like proteins, lipids, and DNA[5].

In recent years, many scientific studies have been conducted on the therapeutic virtues of aromatic herbs, which include chemical compounds that possess antioxidant activities that protect against diseases associated with oxidative stress. These effects are attributable to phytochemical compounds like phenolic acids, phenols, flavonoids, vitamins, carotenoids, terpenoids, and alkaloids[6]. Among these spices is *Laurus nobilis L*, following the Lauraceae family, which is widespread in the Mediterranean region and Europe. Bay leaves have traditionally served both culinary for seasoning and folk medicine for treating viral infections, cough, impaired digestion, flatulence, diarrhea, nerve pain, and epilepsy. Numerous scientific researches highlight many pharmacological activities including

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antimicrobial and anti-inflammatory activities, treatment of rheumatism, gastrointestinal diseases, and type II diabetes. It has antihypertensive effect, neuroprotective, anticonvulsant and anticholinergic activities, anticancer and antioxidant properties[7-9].

Because of the traditional usage and economic importance of *L. nobilis* leaves, researchers have devoted more extensive attention to their chemical composition compared to other parts of the plant. Al-Abri *et al.*[10] found that laurus leaves contain essential oils representing 1 to 3% of the dry weight. This oil contains 30 to 70% cineol and several terpene compounds: linalol, geraniol, eugenol, pinene, terpinene, and phelandrene. In addition to this essential oil, the leaves also contain isoquinoline alkaloids, lactones, and flavonoids some of which are derivatives of kaempferol, vitamin E, and lauric acid[11].

By referring to the literature, several studies have focused on identifying the main compounds of *Laurus nobilis,* but few experimental data demonstrate its therapeutic proprieties, especially against pesticide-induced toxicity. To our knowledge, this study is the first to investigate the protective effects of *Laurus nobilis* both in dry form and as an essential oil against toxicity induced by propineb, a fungicide frequently applied in Algeria.

Materials and Methods

Preparation of propineb solution

We used propineb 70% WP purchased from Agripropi firm (Algeria). This was dissolved in mineral water at 200 mg/kg and then administered to rats through oral gavage (*per os*) using a gastric tube.

Preparation of bay leaf powder

Fresh aerial parts of the laurel, including stem and leaves, were purchased from the local market in Tebessa (Algeria). The plant material was identified and authenticated by Dr. Attoui Nawel from the Laboratory of Vegetal Resources Valorisation and Food Security in Semi-arid Area South-West of Algeria, University of Tahri Mohamed, Bechar, Algeria. The plant material underwent a thorough washing, followed by air drying and subsequent pulverization into a fine powder using a blender. To preserve the integrity of its molecules as much as possible, bay powder was stored in airtight containers at room temperature (25±2°C). It was then added (w/w) to the feed, ensuring mixing to create a diet containing 2% bay powder.

Essential oil extraction

Essential oil from bay-dried leaves was extracted using the hydrodistillation method through a clevenger-type apparatus. In this process, 100 g of plant material and 1000 mL of distilled water were heated for 3 h. The resulting steam, saturated with essential oil passes through the vertical tube and then into the cooling coil where condensation occurs. The droplets of essential oil produced accumulate in a collector and are recovered by decantation. To preserve its quality, the essential oil was stored in dark glass vials covered with aluminum foil and kept at 4°C. The oil yield was calculated in terms of w/v%[12]. For animal treatment, the essential oil needed to be diluted in distilled water, with a few drops of Tween-80 to obtain a solution at a concentration of 0.1 mL/kg body wt.

Experimental design

A total of forty-eight Wistar rats, weighing 220±10 g, were sourced from the Algiers Pasteur Institute, Algeria. These animals were accommodated in clean polypropylene cages and subjected to standard laboratory conditions, which entailed a light/dark cycle of (12/12 h), maintaining relative humidity levels within the range of 40-60%, and sustaining the room temperature at a stable 25±2 °C. The rats were provided with a nutritionally balanced diet prepared following Upreti *et al.*[13] and had access to water *ad libitum* throughout the experimental period. After two weeks of acclimatization, rats were randomly divided into six groups with eight animals each and received daily different treatment for 30 days. The control group (0-0): rats received a standard diet. The Laurus essential oil group (0-LEO): rats nourished with a normal diet and injected intraperitoneally with Laurus essential oil. The laurus powder group (0-LPW): rats fed on an experimental diet containing 2% laurus leaf powder. The propineb group (Pr-0): rats feed on an ordinary diet, but it treated *per os* with 200 mg/kg body wt. of propineb using a gastric tube. The combined propineb and essential oil group (Pr-LEO): rats treated *per os* with 200 mg/kg body wt. of propineb and injected IP with 0.1 mL/kg of laurus essential oil. The combined propineb and laurus powder group (Pr-LPW): rats treated orally with 200 mg/kg dose of propineb and an experimental diet containing 2% of laurus powder.

Blood and serum samples

Upon completion of the experimental period, the rats were humanely euthanized via decapitation; blood

samples were then collected and divided into two tubes. One of these tubes contained EDTA, facilitating blood enumeration using ERMA INC full automatic blood cell counter model PCE-210N; the other is a dry tube for estimation of various biochemical parameters in serum (glycemia, creatinine, urea, uric acid, triglycerides, cholesterol, alanine aminotransferases, and aspartate aminotransferases). All biochemical parameters were evaluated using an automated analyzer (Mindray BS-240).

Tissue preparation and histopathological examination

The liver and kidneys were promptly removed and weighed. The Organo-somatic index was expressed as g/100 of body weight. The organs were then chopped into two fragments: one was fixed in 10% formalin, and serial paraffin sections were obtained to examine the histological changes using hematoxylin-eosin (HE) stain[14], then slides were photographed by light microscope (B-350 OPTIKA); while the other part was intended for oxidative stress analyses. Tissue specimens were homogenized with buffers, after being centrifuged at 10000 g for 20 min at 4 °C, the resulting supernatants were utilized for various essays. The levels of lipid peroxidation marker malondialdehyde (MDA), reduced glutathione content (GSH), and protein concentration were determined following the methods described by Esterbauer *et al*.[15], Weckbecker & Cory[16] and Bradford[17] respectively. Catalase activity (CAT) was assessed using the Aebi[18] method, while glutathione peroxidase activity (GPx) was measured following Flohé & Günzler[19]. Finally, the glutathione S-transferase (GST) activity was estimated by Habig *et al*.[20] methods.

Statistical analysis

The data from various groups were presented as means ± SEM. Statistical analysis was conducted using one-way analysis of variance (ANOVA) with multiple comparisons. A significance level of $P < 0.05$ was approved as statistically significant.

Results

Yield of essential oil extraction

In this report, the extraction by hydro distillation carried out on bay leaves gave us a clear essential oil with a light yellow colour and liquid at room temperature, very aromatic with a characteristic odor. The average essential oil yield calculated on the basis of dry plant matter, provided a rate of approximately 0.97%.

Physiological parameters

Surveillance of body mass during the treatment period reveals a progressive rise in body weight of the control group (28.38%) and animals receiving bay leaf powder (23.3%) or its essential oil (25.44%) treatments. However, rats exposed to propineb (Pr-0) showed delayed growth along with a decrease in weight gain (13.50%). According to the findings, there were no differences between the control group and the rats treated with the combinations (Pr-LEO) and (Pr-LPW) in terms of their physiological growth (Table 1). The animals maintained a regular appetite, which helped to keep their weight, and the food ration remained constant. The study of the absolute and relative weight of the liver and kidneys shows a significant increase in these parameters in Pr-treated rats as compared to the control group. On the other side, *Laurus nobilis* supplementation ameliorated these settings in comparison to the (Pr-0) group.

Hematological profile

Results in Table 2 reveal that exposure of rats to propineb at a dose of 200 mg/kg induced a significant decrease in the rate of white and red blood cells, hemoglobin, platelets, and the percentage of hematocrit compared to the control group. However, the addition of bay leaf extracts either alone or in combination with propineb restored some of the

Table 1 — Effect of *Laurus nobilis* and/or propineb treatment on physiological parameters after 30 days of experience (values represent the mean ± SEM of 8 rats)

Parameters	(0-0)	(0-LEO)	(0-LPW)	(Pr-0)	(Pr-LEO)	(Pr-LPW)
Initial weight (g)	227.25±3.30	225.00±3.74	230.25±6.34	231.50±1.73	232.25±2.99	229.75±7.72
Final weight (g)	291.75±9.32	282.50±5.00	287.00±7.07	262.75±8.18**	279.50±4.65$^{\#}$	278.25±2.99$^{\#}$
Gain (%)	28.38	25.44	23.31	13.50	20.34	21.11
ALW (g)	6.164±0.203	6.297±0.138	6.174±0.424	8.367±0.289***	7.756±0.599*	7.696±0.540*
HSI	2.567±0.074	2.672±0.076	2.590±0.142	3.885±0.183**	2.920±0.188* $^{\#\#}$	2.885±0.159* $^{\#\#\#}$
AKW (g)	1.306±0.035	1.268±0.012	1.386±0.099	2.007±0.104**	1.450±0.032* $^{\#\#}$	1.593±0.060* $^{\#\#}$
RSI	0.542±0.043	0.465±0.042	0.587±0.063	0.847±0.092**	0.535±0.077$^{\#\#}$	0.605±0.075 $^{\#}$

ALW: Absolute liver weight (g); HSI: Hepatosomatic index; AKW: Absolute kidney weight (g); RSI: Renosomatic index [* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$ significant difference from the control group (0-0); $^{\#}$ $P \leq 0.05$; $^{\#\#}$ $P \leq 0.01$; $^{\#\#\#}$ $P \leq 0.001$ significant difference from the propineb-treated group (Pr-0)]

Table 2 — Effect of *Laurus nobilis* and/or propineb treatment on hematological parameters after 30 days of experience (values represent the mean ± SEM of 8 rats)

Parameters	(0-0)	(0-LEO)	(0-LPW)	(Pr-0)	(Pr-LEO)	(Pr-LPW)
WBC (10^3/µL)	8.433±0.493	7.767±0.513	7.933±0.551	7.367±0.379*	8.633±0.416$^{\#}$	8.400±0.300$^{\#}$
Lym 10^3/µL	6.433±0.800	7.200±0.490	6.300±0.624	4.967±0.666	6.800±0.529$^{\#}$	6.100±0.100
Mon (10^3/µL)	1.367±0.153	1.400±0.100	1.400±0.200	1.133±0.057*	1.300±0.100	1.267±0.252
RBC (10^6/µL)	8.830±0.690	7.900±0.968	9.163±0.528	6.867±0.534*	7.300±0.427*	7.333±0.671*
Hb (g/dL)	15.567±0.115	14.900±0.265	15.833±0.416	12.167±0.764*	15.300±0.200$^{\#}$	15.467±0.252$^{\#}$
HTC (%)	47.533±0.709	45.733±0.850	49.500±1.310	40.600±1.470*	44.400±0.693*	43.433±0.577*
MCV (fl)	54.170±1.480	54.970±1.180	51.167±0.635	55.070±1.62	56.93±1.55	55.60±0.529
MCHC (g/dL)	32.330±2.720	35.800±1.370	34.330±1.640	33.170±2.510	27.270±1.100	38.000±0.529
PLT (10^6/µL)	727.33±8.740	724.00±5.570*	713.33±4.730	591.00±22.90*#	703.70±25.10	652.30±11.10**

[* $P \leq 0.05$; ** $P \leq 0.01$ significant difference from the control (0-0) group; $^{\#}$ $P \leq 0.05$ significant difference from the propineb-treated group (Pr-0)]

Table 3 — Effect of *Laurus nobilis* and/or propineb treatment on biochemical parameters after 30 days of experience (values represent the mean ± SEM of 8 rats)

Parameters	(0-0)	(0-LEO)	(0-LPW)	(Pr-0)	(Pr-LEO)	(Pr-LPW)
Glycemia (g/L)	1.114±0.053	1.132±0.099	1.108±0.041	1.418±0.021***	1.214±0.080$^{\#\#}$	1.204±0.067$^{\#\#}$
Triglycerides (g/L)	0.376±0.032	0.352±0.030	0.382±0.042	0.668±0.064***	0.444±0.072$^{\#\#}$	0.462±0.047$^{\#\#}$
Cholesterol (g/L)	0.694±0.079	0.602±0.057	0.634±0.074	1.350±0.072***	0.776±0.076$^{\#\#\#}$	0.814±0.098$^{\#\#\#}$
Creatinine (mg/dL)	7.040±0.394	7.160±0.492	7.182±0.550	9.016±0.601**	8.344±0.700*	8.492±0.392**
Uric acid (mg/dL)	1.066±0.075	1.086±0.023	1.030±0.058	1.714±0.119***	1.142±0.095$^{\#\#\#}$	1.130±0.066$^{\#\#\#}$
Urea (g/L)	0.326±0.086	0.316±0.057	0.330±0.029	0.460±0.031**	0.348±0.054$^{\#\#}$	0.362±0.080$^{\#}$
ALT (UI/L)	49.400±7.54	51.600±6.58	47.600±5.68	66.200±8.79*	59.200±5.85	56.200±5.12
AST (UI/L)	224.60±5.18	215.00±8.46	219.80±6.42	358.60±4.28***	231.20±7.60$^{\#\#\#}$	238.80±6.38** $^{\#\#\#}$

[*$P \leq 0.05$; **$P \leq 0.01$; ***$P \leq 0.001$ significant difference from the control (0-0) group; $^{\#}P \leq 0.05$; $^{\#\#}$ $P \leq 0.01$; $^{\#\#\#}$ $P \leq 0.001$ significant difference from the propineb-treated group (Pr-0)]

mentioned values; no significant difference was observed in comparison with the control.

Biochemical profile

The results summarized in Table 3 affirmed that the daily consumption of propineb solution at a rate of 200 mg/kg for 30 days causes a large metabolic imbalance characterized by hyperlipidemia, a significant increase in the level of uric acid, urea, creatinine and the enzymatic activity of AST and ALT. The addition of *Laurus nobilis* powder or in the form of an essential oil-based injectable solution restored all these biochemical parameters to nearly normal levels.

Oxidative stress parameters

Propineb intake was found to cause impressive oxidative stress which occurs mainly through a significant disturbance in all biomarkers of the antioxidant system in the liver and kidneys, estimated by significantly higher levels of MDA (Fig. 1A), lower levels of GSH (Fig. 1B) and impaired antioxidant enzymes activities, as indicated by elevated GPx activity (Fig. 1C) and decreased GST (Fig. 1D) and CAT (Fig. 1E) activities in comparison with control. However, bay leaf powder or its essential oil exhibits a potent therapeutic impact in combination groups by restoring all antioxidant parameters.

Histopathological examination of liver and kidney

The normal histological view of the liver was observed in the control rats (0-0) and both Laurus-treated rats (0-LEO) and (0-LPW) (Fig. 2A,-2C). Degeneration and periportal necrosis lesions in the hepatocytes were detected in propineb-treated rats (Pr-0) made of lymphoplasmocytes as well as neutrophils (yellow arrows) accompanied by a disruption of hepatic cords and sinusoidal architecture (yellow star) (Fig. 2D). These findings were found to be significantly reduced in the liver of propineb-treated rats and subjected to treatment with laurel essential oil (Pr-LEO) or in the form of powder (Pr-LPW), some light lesions remain observed with the presence of blackish deposits found in combination groups (Fig. 2E & 2F). Microscopically, the kidney of the control rat (0-0) revealed normal histological structure (Fig. 2 G). Moreover, individual intake with *Laurus nobilis* in both (0-LEO) and (0-LPW) rats showed no histopathological changes (Fig.2H & 2I). Nevertheless, severe degeneration and necrosis of

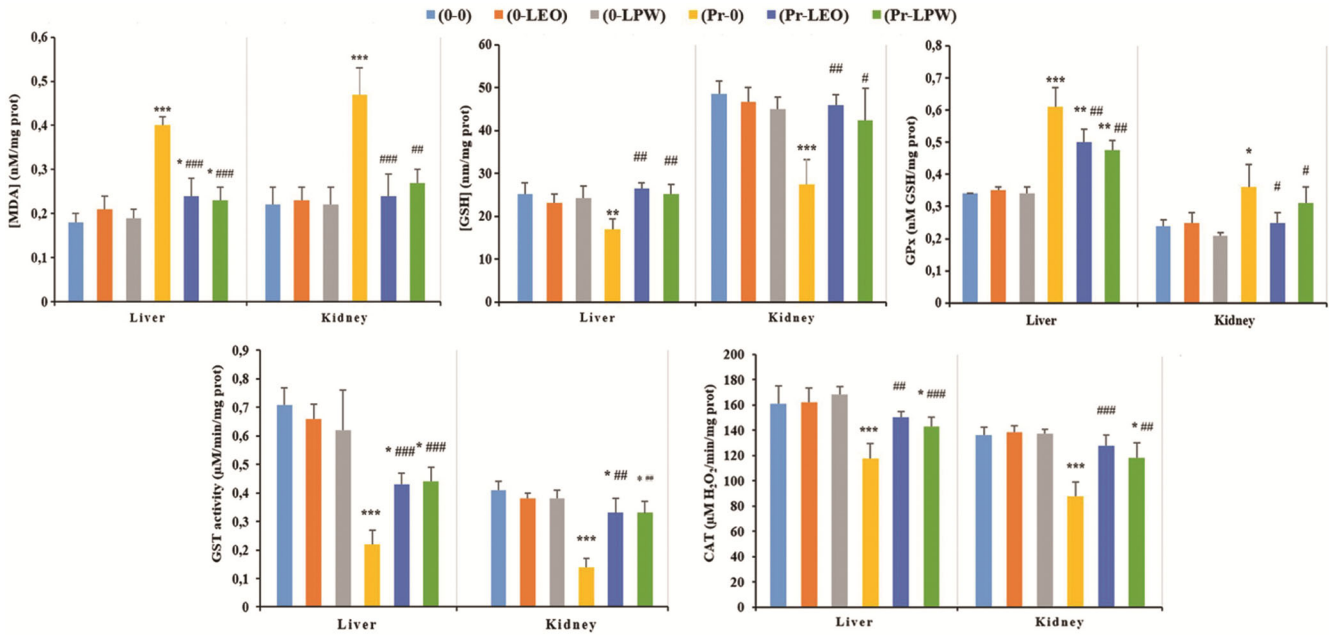

Fig 1 — Effect of *Laurus nobilis* and/or propineb treatment on oxidative stress parameters after 30 days of experience. (A) malondialdehyde (MDA); (B) reduced glutathione (GSH) levels; (C) glutathione peroxidase (GPx); (D) glutathione S-transferase (GST); and (E) catalase (CAT) activities [Values represent means ± SEM (n=8). * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$ significant difference from the control (0-0) group. $^{\#\#}$ $P \leq 0.01$; $^{\#\#}$ $P \leq 0.01$; $^{\#\#\#}$ $P \leq 0.001$ significant difference from the propineb-treated group (Pr-0)]

tubular epithelium accompanied by vascular congestion (yellow arrows) in propineb-treated rats (Fig. 2J). Almost normal appearance with slight degeneration and necrosis were determined in some parts of the tubular epithelial cells in the kidney when the Laurus extract was added to propineb-treated rats (Pr-LEO) and (Pr-LPW) (Fig. 2K & 2L).

Discussion

Bay leaves are commonly used as a condiment, and their medical advantages are widely recognized[21]. These beneficial properties are linked to a variety of highly active secondary metabolites, such as essential oils and phenolics. Laurel extract typically contains key volatile compounds like 1,8-cineole, methyl eugenol, α-terpinyl acetate, α-pinene, sabinene, and linalool[9].

In the current research, the possible therapeutic effect of bay leaf powder and its essential oil against oxidative stress, biochemical disturbance, and tissue injuries induced by propineb on the liver and kidney was evaluated in experimental rats. To the best of our knowledge, the effectiveness of *Laurus noblis* as a natural remedy to mitigate tissue damage brought on by propined has not been investigated before. Furthermore, limited studies have been conducted on the toxicity of dithiocarbamates containing heavy metals. According to our results, propineb Zinc (Zn)-containing dithiocarbamate a commonly used fungicide in Algeria, can induce slow body growth with a decrease in weight gain compared to the control group (13.50% and 28.38%) respectively. Previous research on adult rats treated with herbicides from the carbamate family revealed a considerable decrease in their body weight[22]. Additionally, Guven *et al.*[23] found that the body weight of pregnant females subjected to 200 and 400 ppm of propineb and 250 ppm of maneb is lower than control animals. However, supplementation of bay leaf powder or its essential oil to propineb-treated rats improved weight gain. This could be attributed to the nutritional composition and elevated caloric content of Laurus and its ability to stimulate appetite and the secretion of gastric juices, thus facilitating the digestion and assimilation of food[24]. Changes in the absolute and relative weight (organosomatic index) of organs are used to indicate the detrimental effects of phytosanitary products. The current research found that rats exposed to 200 mg/kg/day of propined had enlarged livers and kidneys, significantly higher than in the control group. Our findings are consistent with those of Groswald *et al.*[25], who discovered an increase in hepatosomatic indexes following 18 days of exposure to various dosages of methomyl.

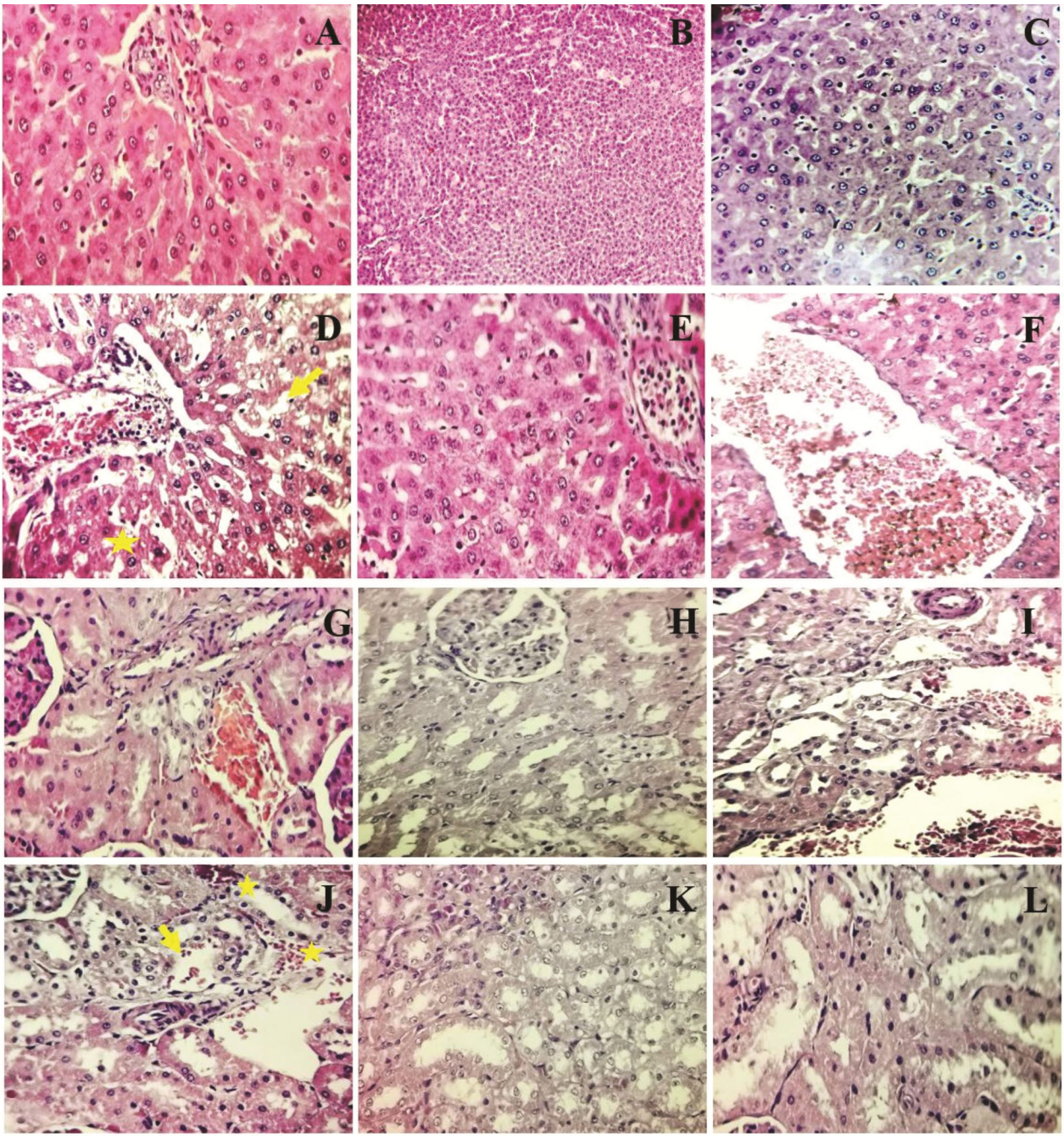

Fig 2 — Histological cross-sections of rat liver and kidney from various experimental groups, stained using Hematoxylin and Eosin (HE × 400). A-F : liver sections A(0-0) ; B(0-LEO) ; C(0-LPW) ; D(Pr-0) ; E(Pr-LEO) ; F(Pr-LPW). G-L: kidney sections G(0-0) ; H(0-LEO) ; I(0-LPW) ; J(Pr-0) ; K(Pr-LEO) ; L(Pr-LPW)

Additionally, we have observed a severe deterioration and necrosis of the kidney and liver tissues. Limited research has explored the mechanisms of organometallic fungicide action and the fate of these fungicides in target organs. In contrast, extensive studies have been conducted on the impact of heavy metals on various organisms. Upon exposure, most metals tend to accumulate in specific tissues and organs. Propineb, which contains zinc, is known to accumulate in the liver and kidneys, potentially leading to biochemical and histopathological changes[26]. Our findings align with the observations of Guven *et al.*[23], who documented edema, cell degeneration, and severe hemorrhage in the kidneys

of propineb-treated mothers and their one-day-old offspring. The detrimental alterations observed in the hepatic and renal tissues in this study might be linked to the depletion of antioxidant reserves and the generation of reactive oxygen species. Oxidative stress significantly contributes to tissue damage in living organisms[27]. The administration of Laurus appears to restore cellular function, alleviate inflammation and oxidative stress, and mitigate cellular damage. This restorative effect could be attributed to the presence of compounds with antioxidant properties, which prevent the formation of free radicals and reduce the associated damage[27].

Usually, the biochemical parameters are used as an important sign of the general state of animal health. Our study revealed that exposure to propineb at a rate of 200 mg/kg causes a considerable biochemical disorder, essentially marked by hyperglycemia, hyperlipidemia, and an increase in creatinine, urea, uric acid, and activity of transaminases (ALT, AST). Pesticide toxicity studies have shown that fungicides, even at very low concentrations, interfere with basal metabolism and can alter biochemical parameters in experimental animals[28]. Hyperglycemia caused by propineb toxicity may be explained by the inhibition of insulin production at the islets of Langerhans or a defect in glucose utilization by target cells[28]. While the precise connections between diabetes and pesticide exposure remain incompletely understood, research indicates that organochlorine pesticides, even at low levels, act as endocrine disruptors over time. These pesticides and their metabolites accumulate in fatty tissues and are slowly released into the bloodstream, where they decrease insulin sensitivity by imitating estrogen receptors present in insulin-sensitive tissues. They alter the differentiation of adipocytes and the mitochondrial functioning of the β cells of Langerhans, thus reinforcing insulin resistance[29]. On the other hand, the intake of *Laurus nobilis* alone or in combination with propineb led to an improvement in blood glucose levels. This amelioration is probably due to its intracellular antioxidant property, according to AL-Ishaq *et al*.[30], flavonoids play a significant role in modulating pancreatic cell function by stimulating insulin secretion. Additionally, they exert hypoglycemic effects on liver by promoting glycogenogenesis.

In an *in vitro* investigation Al-Mijalli *et al.*[31] demonstrated that 1,8-cineole, α-pinene and R-(+)-limonene main components of bay leaves essential oil can inhibit α-glucosidase activity, thereby slowing down the rate of glucose uptake. Our findings align with the results reported by Rebin-Rafaat *et al*.[21], who found that extracts from *L. nobilis* leaves can inhibit diabetes induced by STZ and lower serum glucose levels. Moreover, these leaves improve glucose metabolism and enhance the overall condition of individuals with diabetes by affecting total cholesterol, LDL cholesterol, and triglyceride levels while increasing HDL-cholesterol levels[24].

Concerning the biochemical profile, we noted that propineb administration caused a hepatic disturbance in rats, demonstrated by the significant increase in plasma levels of transaminases, cholesterol, and triglycerides. Thus, findings corroborate previous research on carbamate exposure[32]. This could be due to hepatotoxicity which leads to the alteration of the permeability of the plasma membrane and therefore the escape of hepatocyte compounds from the tissue to the plasma[32]. However, the supplementation of *L. nobilis* considerably improves the hepatic and lipid profiles. These findings are in agreement with previous research, indicating that the consumption of *L. nobilis* tea among healthy volunteers can enhance their blood lipid profile, suggesting a potentially positive impact on reducing the risk of coronary heart disease[33]**.** Similar outcomes were observed by Casamassima *et al*.[34], who noted a significant improvement in lipidic profile, glycemia, and hepatic biomarker enzymes, due to the incorporation of dried bay leaves meal into the diet. Creatinine, urea, and uric acid are waste products from protein and nucleic acid metabolism, eliminated by the kidneys and commonly used as markers of renal function. Elevated levels indicate the onset of nephrotoxicity[35], this is what we observed in the rats exposed to 200 mg/kg/day of propineb in comparison with the control group. Hyperuricemia is recognized as an independent predictor of kidney injury. Consequently, the accumulation of pesticides may contribute to the development of chronic kidney disease by inducing oxidative stress[36]. This study ″s disturbance in renal functions was confirmed by the degeneration of some tubular epithelial cells and glomerulus. The decrease in the concentration of the parameters mentioned above after *L. nobilis* addition can be justified by the clinical improvement in renal function. According to Mohammed *et al.*[21], diabetic rats treated with bay leaf extract exhibited a noteworthy decrease in urea level compared to untreated diabetic rats.

In the present study, exposed Wistar rats to propineb induces disturbance in complete blood count (CBC) characterized by anemia, leucopenia, decreased rates of hemoglobin, platelets, and the percentage of hematocrit. These harmful changes concur with Bunsri *et al*.[37]. Anemia can be attributed to the influence of propineb, which has increased the fragility of erythrocyte membranes, hastening and accelerating their destruction. Significant alleviating effects were observed when Laurus extract, either in powder or essential oil form, was added to rats. This improvement may be linked to laurus's immunomodulatory properties, as it is recognized as an immune stimulant with antioxidants and anti-inflammatory characteristics due to its abundance of flavonoids and phenols[27]. According to Sandner *et al.*[38], 1,8-cineol also called eucalyptol, monoterpenes such as linalool, α-terpineol, and terpinene1-4-ol stimulate the immune system allowing an increase in γ-globulins. Eugenol and methyl eugenol are low-dose platelet aggregation inhibitors by blocking cyclo-oxygenase mechanisms.

Our results demonstrate that the propineb-treated group had significantly lower GSH levels, GST, and CAT activities as well as higher MDA content and GPx activity in the studied organs compared to the control group. Elevation of lipid peroxidation in the liver and kidney, as evidenced by the increased level of MDA in the present study, suggests the participation of free radicals in cell injury. These findings are in accordance with previous research[5]. Exposure to pesticides leads to oxidative stress by promoting the generation of free radicals or depleting the antioxidant system. Previous studies have indicated that dithiocarbamates, metabolites known as isothiocyanates, can disrupt protein synthesis and metabolism by inactivating -SH groups in amino acids, proteins, and enzymes, thereby reducing their activities and increasing lipid peroxide levels and DNA damage[23,27]. The combination of Laurus with propineb significantly enhanced antioxidant markers in the liver and kidneys compared to the group treated with propineb alone. These results indicate Laurus's positive influence on the antioxidant defenses of these organs, consistent with findings by Gazwi *et al*.[27] Consequently, it can be inferred that Laurus has beneficially modulated the antioxidant status by suppressing and eliminating free radicals, restoring them to nearly normal levels. Laurus's antioxidant properties may be attributed to its high polyphenol content.

Conclusion

Our findings demonstrated that daily exposure to propineb at a dose of 200 mg/kg body weight resulted in impaired body growth, anemia, and significant biochemical alterations, including hyperglycemia, hyperlipidemia, and elevated hepatic and renal function markers, accompanied by an increase in the relative weights of the liver and kidneys. Oxidative stress analysis revealed elevated levels of malondialdehyde (MDA) and glutathione peroxidase (GPx) activity, alongside reductions in glutathione (GSH) levels, glutathione S-transferase (GST), and catalase (CAT) activities in the affected organs. Histological examinations further confirmed the presence of structural changes in liver and kidney tissues.In contrast, the administration of Laurus *nobilis L.* at safe dose levels effectively ameliorated the adverse effects of propineb by restoring biochemical parameters, mitigating oxidative damage, and improving tissue architecture. Given its potent antioxidant, hepatoprotective, and nephroprotective properties, *L. nobilis* in both dry or essential oil forms holds promise as a natural therapeutic candidate for pharmaceutical applications.

Ethical statement

All the animal experiment protocols were done under the guidelines and rules of the international animal experimentation chart, and the Helsinki Declaration of 2008.

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Conflict of interest

The authors have no conflicts of interest to declare.

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