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Research Article
Green Tea Protects Against Perinatal Nicotine-induced Histological, Biochemical and Hematological Alterations in Mice Offspring

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Abstract

Objective: Perinatal nicotine exposure induces malformations and imbalances the prooxidant/antioxidant status. The present study aimed to investigate the possible protective effects of green tea extract against perinatal nicotine-induced alterations in mice newborns. **Materials and Methods:** Pregnant mice received 0.25 mg kg^{-1} nicotine on gestational day 12 to postnatal day 15. A control group received an equal volume of saline. Both control and nicotine exposed mice received 50 mg kg^{-1} green tea on gestational day 1 to postnatal day 15. **Results:** Mice born to nicotine-exposed dams showed significantly decreased body weight at days 10, 15 and 20 after birth. Nicotine administration provoked chromatolysis in cerebral neurocytes and oxidative stress, evidenced by elevated lipid peroxidation and declined antioxidants, in newborn mice. Green tea supplementation significantly prevented body weight reduction, histological alterations and oxidative stress. In addition, nicotine significantly increased blood glucose and cholesterol, erythrocytes, leukocytes and platelets, an effect that was significantly reversed following green tea supplementation. **Conclusion:** Green tea protects against perinatal nicotine-induced oxidative stress and hematologic, histologic and metabolic alterations. Therefore, green tea may be considered a potential candidate for attenuating smoking/nicotine-induced alterations in newborns.

Key words: Nicotine, green tea, oxidative stress, cerebrum, lipid peroxidation

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Cigarette smoking related disease risks increased over most of the 20th century[1] and the health consequences are particularly severe during pregnancy[2]. Cigarette smoke consists of more than 4000 compounds including candidates for causing perinatal damage such as nicotine, aldehydes and carbon monoxide[3,4]. It increases the risk of oral, pharyngeal, esophageal, pancreatic, bladder, cervix and lung cancers[5-7]. Maternal smoking has been identified to cause premature birth, miscarriage, fetal weight deficiency, perinatal/neonatal death, congenital anomalies and neural tube defects[8,9].

Nicotine, a major toxic component of cigarette smoke, is a strong alkaloid reported to cross the blood-brain barrier and induces malformations and apoptosis[10]. In addition, fetal exposure to maternal smoking was associated with cardiovascular disease and elevated blood pressure[11,12]. Multiple studies have demonstrated that oxidative stress plays a central role in tobacco smoking associated alterations during pregnancy[13,14]. *In vivo* chronic administration of nicotine has been reported to imbalance the pro-oxidant/antioxidant status in blood and tissues of rats[15]. Moreover, *in vitro* experiments have shown that nicotine induces oxidative stress and DNA damage[16]. Therefore, antioxidant and radical scavenging agents may represent a strategy for preventing alterations in newborns born to nicotine-exposed mothers.

Green tea (*Camellia sinensis*), a commonly used beverage, contains appreciable amounts of phytochemicals especially polyphenols[17]. The dried leaves of green tea have been reported to contain 10-25% polyphenols including flavonols, flavonoids and flavondiols[18]. The main components of the green tea polyphenolic catechins are epigallocatechin-3-gallate (EGCG), epicatechin-3-gallate (ECG), epicatechin (EC) and epigallocatechin (EGC). The EGCG is the main catechin in green tea and is an effective antioxidant with potent radical scavenging abilities[18]. Several studies have demonstrated the beneficial health effects of green tea such as prevention of diabetic nephropathy[19], reduced risk of cancer[20] and anti-obesity[21], nephroprotective[22] and hypocholestrolimic effects[23]. Recently, the protective role of green tea extract against cigarette smoke-induced oxidative stress has been reported[24].

Therefore, the present study was designed to demonstrate the possible protective effects of green tea extract against perinatal nicotine-induced cerebral injury and oxidative stress and hematologic and metabolic alterations in mice newborns.

MATERIALS AND METHODS

Chemicals: Nicotine was purchased from SOMATCO (Riyadh, KSA). The 5,5 -dithiobis-(2-nitrobenzoic acid) (DTNB), reduced glutathione (GSH), pyrogallol, thiobarbituric acid (TBA) and 1,1,3,3 tetramethoxypropane were purchased from Sigma (USA). All other chemicals were obtained from standard commercial supplies.

Preparation of green tea extract: Green tea leaves were obtained from local herbalist and ground to a fine powder. One liter of boiled distilled water was added to 50 g of plant powder and left for 15 min. The infusion was filtered and the filtrate was freshly used.

Experimental animals: Swiss-Webster strain mice (10-12 weeks old) were housed in standard plastic cages (three females to one male in each cage), in the animal facility of the Zoology Department, King Saud University (Riyadh, Saudi Arabia). Animals were kept at normal temperature (22±2°C) and normal 12 h light/dark cycle. After pregnancy (appearance of vaginal plug was considered as day one [PD1] of pregnancy), the males were removed from the cages and the females were subjected to experimental treatments. Standard diet and water were supplemented *ad libitum*. All animal procedures were approved by the ethical committee of King Saud University.

Experimental design: The pregnant mice were divided into 4 groups; each consists of 4-5 mothers as follows (Fig. 1):

- **Group I (Control):** Received distilled water by oral gavage from day 1 of pregnancy (PD1) until day 15 after birth (D15). Mice received subcutaneous injection of physiological saline from day 12 of pregnancy (PD12) and was continued until D15
- **Group II (Green tea):** Received green tea extract (50 mg kg^{-1} b.wt.)[25] by oral gavage from PD1 until D15 after birth
- **Group III (Nicotine):** Received nicotine (0.25 mg kg^{-1} b.wt.)[26] dissolved in saline subcutaneously from PD12 until D15 after birth
- **Group IV (Nicotine+green tea):** Received nicotine (0.25 mg kg^{-1} b.wt.)[26] subcutaneously from PD12 until D15 after birth and green tea extract (50 mg kg^{-1} b.wt.)[25] by oral gavage from PD1 until D15

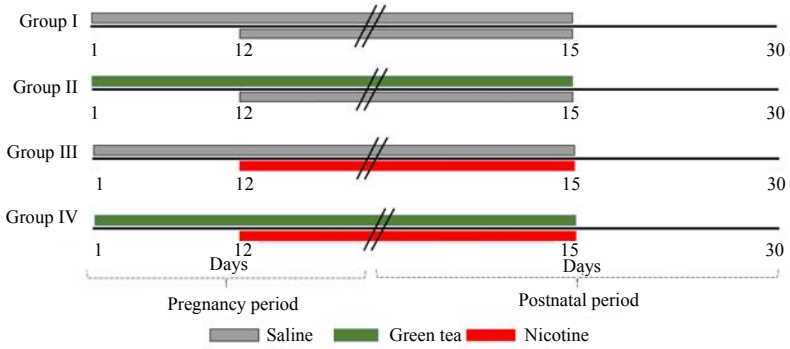

Fig. 1: Schematic diagram showing the experimental design

The pups of each experimental group were culled to eight per dam on D0 and left with their mothers until D22 after birth. During the weaning period, male and female pups of each litter were color marked and were subjected to various tests. In all, 18 pups from each treatment category were considered.

Because body weight is a useful indicator of development, the pups were weighed periodically until the 21st day.

Preparation of samples: Six pups from each experimental group were sacrificed by decapitation at D7, D15 and D30 after birth. Blood samples were collected, left to coagulate and centrifuged for 15 min at 3000 rpm to separate the serum. Other blood samples from the groups decapitated at D15 and D30 were collected on EDTA tubes for hematological assays. Cerebrum was dissected and perfused with ice-cold saline. Samples from the cerebrum were either fixed in 10% buffered formalin for histological processing or homogenized (10% w/v) in cold Phosphate Buffered Saline (PBS). The homogenates were centrifuged at 3000 rpm for 10 min and the clear homogenates were collected and used for subsequent assays.

Hematological study: Red Blood Corpuscles (RBCs), total White Blood Cells (WBCs) and platelets counts and hemoglobin (Hb) content were determined using an automated hematoanalyzer (UniCelDxH 600, Beckman, France).

Biochemical assays: Serum glucose and total cholesterol levels were determined using commercially available assay kits (Spinreact, Spain) according to the methods of Trinder[27] and Allain *et al.*[28] respectively. Lipid peroxidation in the cerebral homogenates was assayed by measuring malondialdehyde (MDA) content following the method of Preuss *et al.*[29] Reduced glutathione (GSH) content and the activity of superoxide dismutase (SOD) were determined according to the methods of Beutler *et al.*[30] and Marklund and Marklund,[31] respectively.

Histopathological study: Fixed samples from the cerebrum of decapitated mice were dehydrated, cleared and embedded in paraffin wax. Five micrometers sections were cut, dewaxed, hydrated and stained with hematoxylin and eosin (H and E) for microscopic examination.

Statistical analysis: The obtained data were analyzed using Graphpad Prism 5 (San Diego, CA, USA) and all statistical comparisons were made by two-way ANOVA followed by Tukey's test *post hoc* analysis. Data were expressed as Mean±Standard Error (M±SEM). A $p<0.05$ was considered significant.

RESULTS

Green tea represses nicotine-induced body weight loss: Body weight, a useful indicator of development was periodically determined at D1, D5, D10, D15 and D21 after birth. Green tea supplementation produced non-significant ($p>0.05$) effect on body weight of newborns throughout the experiment when compared with the corresponding control group (Fig. 2). Body weight of the nicotine-exposed mice newborns showed non-significant ($p>0.05$) differences at D1 and D5 after birth when compared with the control mice. At D10, D15 and D21 after birth, the nicotine-exposed newborns exhibited significant ($p<0.001$) decrease in body weight when compared with the corresponding controls. On the other

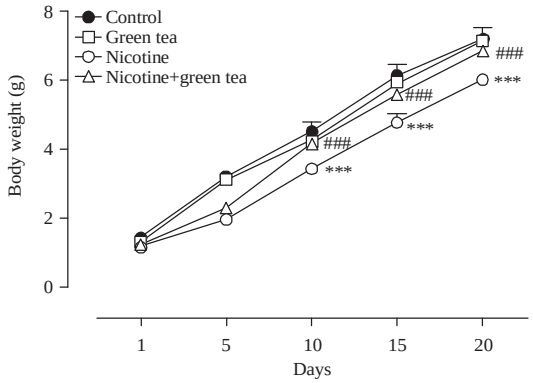

Fig. 2: Green tea represses nicotine-induced body weight loss in mice offspring, data are Mean±SEM, ***p<0.001 vs control and ###p<0.001 vs nicotine

hand, supplementation of green tea extract significantly (p<0.001) prevented weight loss in nicotine-exposed mice newborns at D10, D15 and D21 with non-significant (p>0.05) differences recorded at D1 and D5 after birth.

Green tea prevents nicotine-induced histological alterations in the cerebrum of mice: Histological examination of sections at D7 (Fig. 3) and D15 (Fig. 4) after birth showed that the cerebral cortex was undifferentiated into definite layers except the outer molecular layer. The pyramidal neurons appeared rounded and pyramidal in shape in all studied groups. No histopathological alterations were recorded in green tea-supplemented group at all experimental periods. On the other hand, sections in the

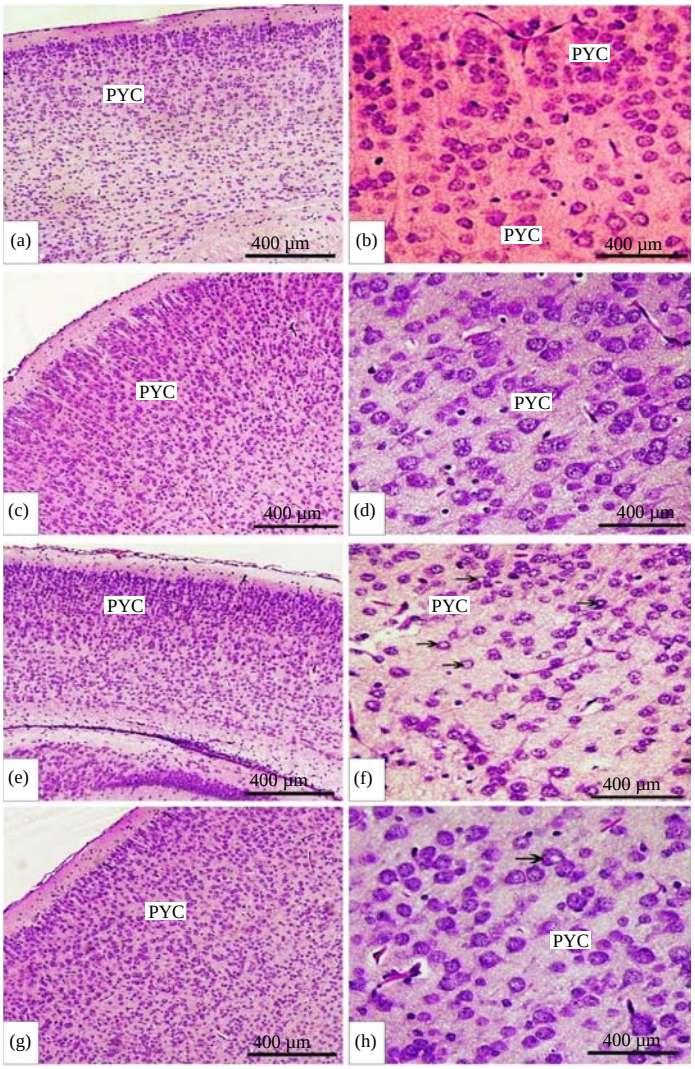

Fig. 3(a-h): Sagittal sections at D7 in the cerebrum of (a, b) Control, (c, d) Green tea, showing normal histological structure and pyramidal neurons (PYC), (e, f) Nicotine-exposed mice with central chromatolysis (arrow) and (g, h) Nicotine+green tea groups showing normal histological architecture

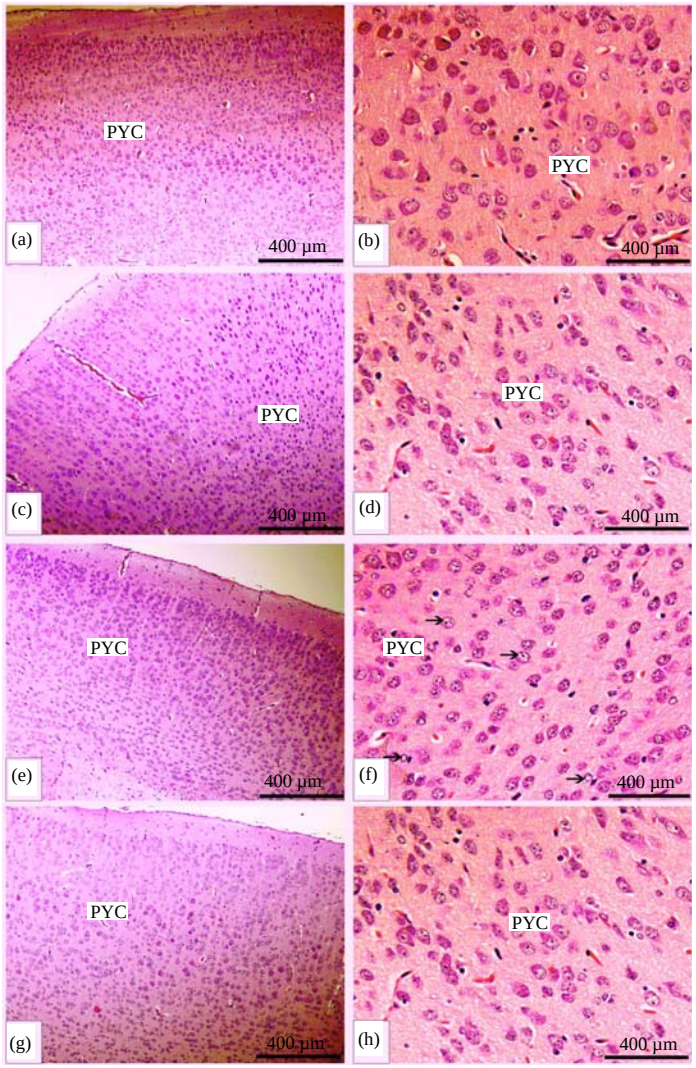

Fig. 4(a-h): Sagittal sections at D15 in the cerebrum of (a, b) Control, (c, d) Green tea, showing normal histological structure and pyramidal neurons (PYC), (e, f) Nicotine-exposed mice with central chromatolysis (arrow) and (g, h) Nicotine+green tea groups showing normal histological architecture

cerebrum of mice born to nicotine-exposed dams showed neuronal loss by central chromatolysis, an effect that was markedly prevented through green tea administration, as depicted in Fig. 3-5.

Green tea attenuates nicotine-induced oxidative stress in cerebrum of mice: The effect of green tea extract on cerebral oxidative stress in control and nicotine-exposed male and female newborns was determined through assessment of MDA, GSH and SOD.

Green tea administration induced non-significant ($p>0.05$) changes in the cerebral MDA levels as depicted in Fig. 6a. Nicotine-expose newborns showed significant ($p<0.001$) increase in cerebral MDA levels at D7, D15 and D30 after birth. On the other hand, treatment of the nicotine-induced mice with green tea produced significant ($p<0.001$) decrease in cerebral MDA levels at D7, D15 and D30.

Cerebral MDA levels of the female newborns exhibited the same pattern where green tea supplementation induced non-significant ($p<0.05$) changes in control group. Nicotine administration produced a significant ($p<0.001$) increase in MDA levels in the cerebrum of female mice, an effect that was significantly ($p<0.001$) reversed by green tea supplementation (Fig. 6a).

The GSH content in the cerebrum of green tea-supplemented male newborn mice showed non-significant ($p>0.05$) changes at all studied periods when compared with the control group (Fig. 6b). Nicotine

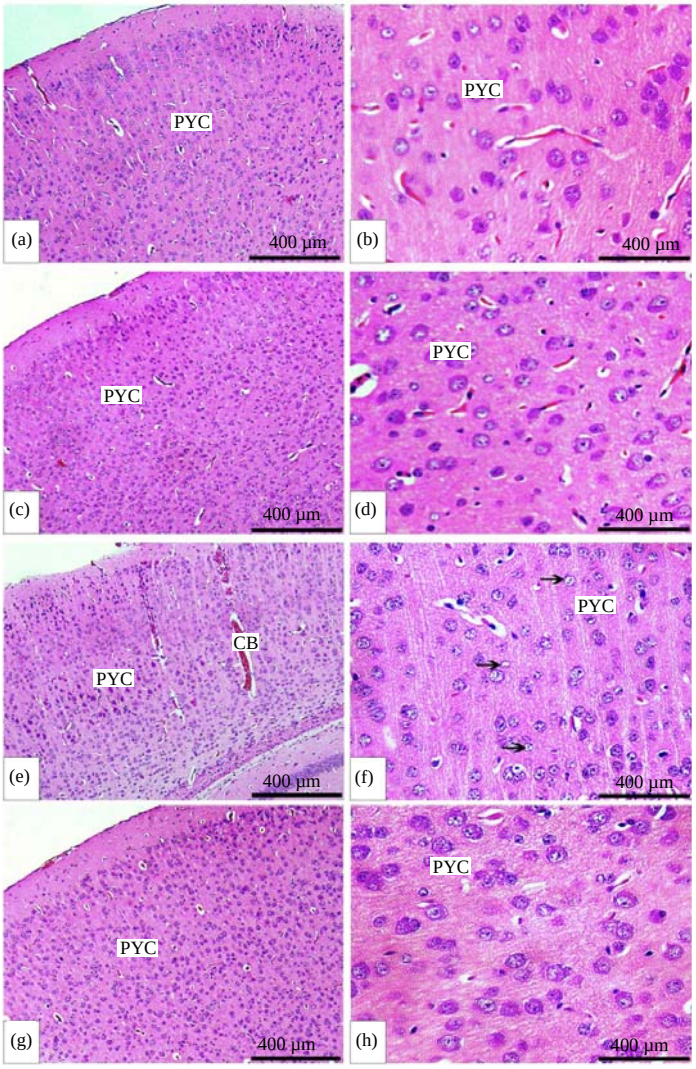

Fig. 5(a-h): Sagittal sections at D30 in the cerebrum of (a, b) Control, (c, d) Green tea, showing normal histological structure and pyramidal neurons (PYC), (e, f) Nicotine-exposed mice with central chromatolysis (arrow) and (g, h) Nicotine+green tea groups showing normal histological architecture

administration significantly decreased cerebral GSH content at D7 ($p<0.01$), D15 ($p<0.01$) and D30 ($p<0.001$). Treatment of the nicotine-exposed mice with green tea produced a significant amelioration of cerebral GSH content at D7 ($p<0.01$), D15 ($p<0.05$) and D30 ($p<0.01$) when compared with the control group.

Female newborns of mice received green tea exhibited non-significant ($p>0.05$) changes in cerebral GSH content when compared with the control group (Fig. 6b). Nicotine induced significant decline in cerebral GSH content at D7 ($p<0.01$), D15 ($p<0.001$) and D30 ($p<0.001$). Green tea supplementation significantly ameliorated cerebral GSH content of nicotine-exposed female newborns at all studied periods.

Cerebral SOD activity of both male and female newborns was non-significantly ($p>0.05$) affected in green tea supplemented groups when compared with the corresponding controls (Fig. 6c). On the other hand, nicotine administration produced significant ($p<0.001$) decline in SOD activity in the cerebrum of both male and female newborns at all studied experimental periods. Green tea supplementation significantly ($p<0.001$) improved cerebral SOD activity in nicotine-exposed male and female newborns.

Green tea reverses nicotine-induced hematological alterations: The RBCs number determined at D15 and D30 after birth exhibited non-significant ($p>0.05$) changes in both male and female green tea-supplemented mice

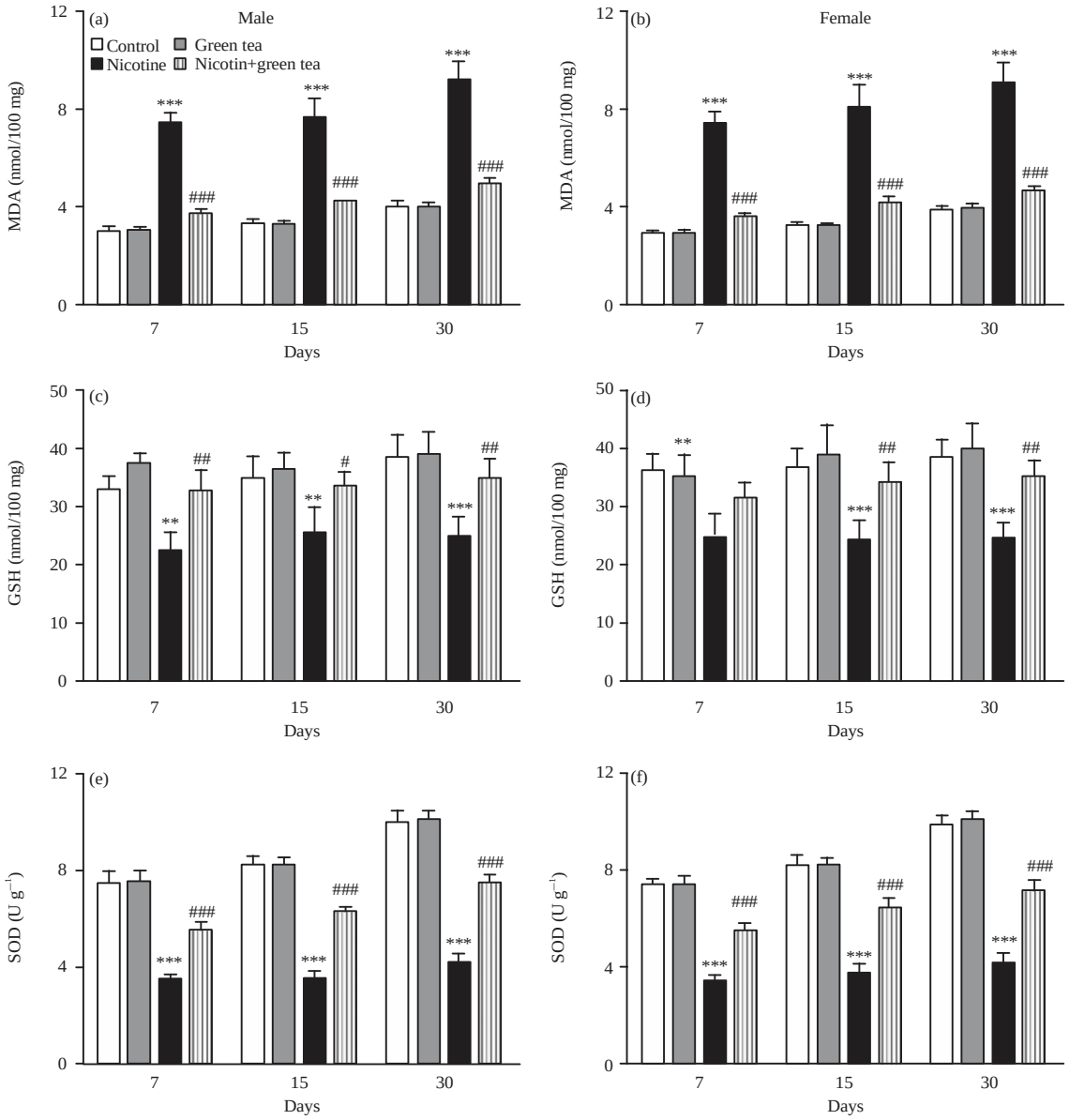

Fig. 6(a-f): Green tea prevents nicotine-induced (a, b) Lipid peroxidation, (c, d) Ameliorates GSH and (e, f) SOD activity in cerebrum of male and female mice newborns. Data are M±SEM, **p<0.01 and ***p<0.001 vs control and $^{\#}$p<0.05, $^{\#\#}$p<0.01 and $^{\#\#\#}$p<0.001 vs nicotine

newborns when compared with the control group (Fig. 7a). Nicotine administration produced a significant (p<0.001) increase in the number of RBCs at D15 and D30 after birth in both male and female newborns. The number of RBCs was significantly (p<0.001) normalized in the male and female nicotine-exposed mice following green tea supplementation.

Similarly, Hb% showed non-significant (p>0.05) changes in both male and female green tea-administered mice newborns as represented in Fig. 7b. Nicotine administration significantly (p<0.001) increased blood Hb% in both male and female newborns at D15 as well as D30 after birth. Nicotine-exposed male newborns treated with green tea showed significant decrease in Hb% at D15 (p<0.001) and D30 (p<0.01) after birth. Nicotine-exposed female mice exhibited nearly the same pattern where green tea supplementation ameliorated Hb% significantly (p<0.001) at both experimental periods.

The WBCs number showed significant (p<0.001) increase in the blood of nicotine-exposed both male and female newborns at D15 and D30 after birth when compared with the

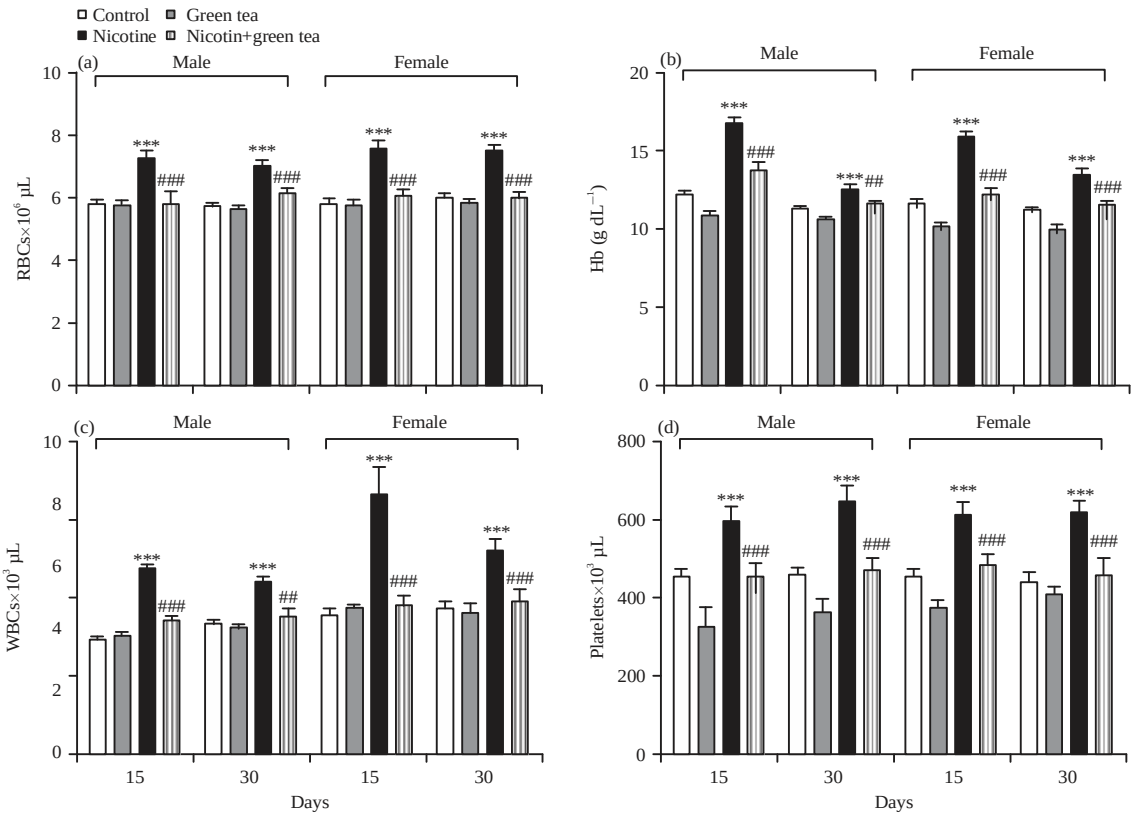

Fig. 7(a-d): Green tea reverses nicotine-induced hematological alterations in nicotine-exposed male and female mice newborns. Data are M±SEM, ***p<0.001 vs control and ##p<0.01 and ###p<0.001 vs nicotine

control group. At D15 after birth, green tea supplementation produced a significant (p<0.001) decrease in WBCs number of nicotine-exposed male and female newborns. At D30 after birth, nicotine-exposed newborns treated with green tea exhibited significant decrease in WBCs (Fig. 7c).

Green tea extract supplementation didn't affect the number of platelets in both male and female control newborn mice either at D15 or D30 after birth as depicted in Fig. 7d. Nicotine administration significantly (p<0.001) increased the number of platelets in mice newborns at both D15 and D30 after birth. Both male and female nicotine-exposed newborns treated with green tea extract showed significant (p<0.001) decrease in platelets number when compared with the nicotine control group.

Green tea ameliorates blood glucose and cholesterol in nicotine-induced mice: Blood glucose levels of male and female newborn mice supplemented with green tea extract showed non-significant (p>0.05) changes when compared with the control group (Fig. 8a). Nicotine administration induced significant (p<0.01) increase in blood glucose levels of both male and female newborn mice; with no effect recorded at D15 in male newborns. At D15 after birth, green tea supplementation significantly (p<0.05) improved blood glucose levels in nicotine-exposed both male and female newborn mice. Similarly, green tea extract supplementation markedly decreased blood glucose levels at D30 after birth in nicotine-exposed male (p<0.01) and female (p<0.05) newborns.

Total cholesterol levels showed non-significant (p>0.05) changes in the serum of green tea supplemented mice newborns when compared with the control group. Nicotine-administered mice newborns exhibited significant (p<0.001) increase in serum cholesterol levels when compared with the control group (Fig. 8b). Supplementation of green tea extract significantly (p<0.001) improved serum cholesterol levels in nicotine-exposed male newborns at D15 and D30 after birth. Nicotine-exposed female newborns supplemented with green tea showed significantly ameliorated serum cholesterol levels at D15 (p<0.05) and D30 (p<0.01) after birth.

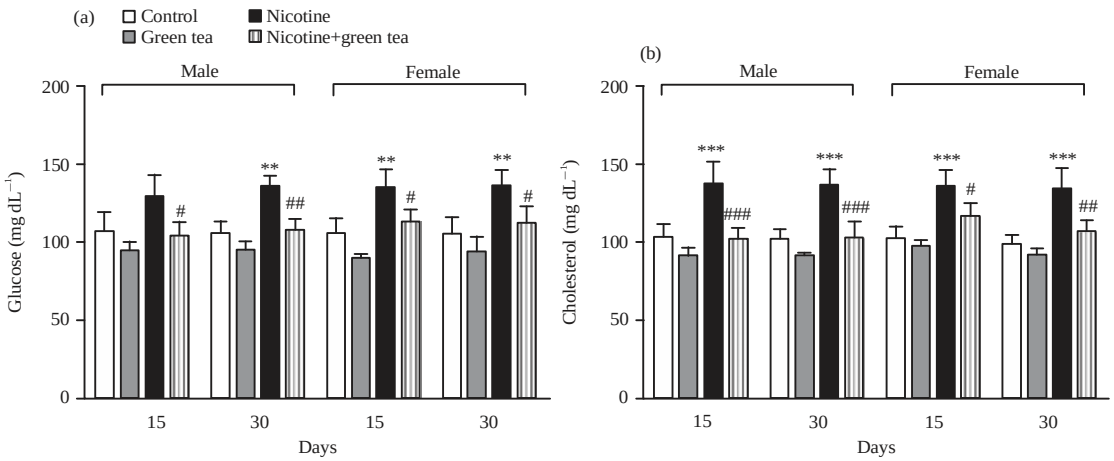

Fig. 8(a-b): Green tea ameliorates blood glucose and cholesterol in nicotine-exposed male and female mice newborns, data are M±SEM, **p<0.01 and ***p<0.001 vs control and #p<0.05, ##p<0.01 and ###p<0.001 vs nicotine

DISCUSSION

The present study was undertaken to demonstrate the possible protective effects of green tea extract against perinatal nicotine-induced deleterious effects in mice newborns. Our results showed a significant decrease in body weight of mice newborns exposed to nicotine at D10, D15 and D21 after birth when compared with the control group. Body weight reduction has been previously reported in newborn rats from nicotine-exposed mothers[32]. In neonate monkeys whose mothers were exposed to nicotine during pregnancy, reduced fat index has been reported[33]. Indeed, the energy expenditure provoked by cigarette smoking in humans and the consequent increase in the lipolysis may be responsible for body weight loss[34]. Also, nicotine can increase energy expenditure and metabolic rate via sympatho-adrenal activation[35]. The study of Mao *et al.*[36] showed that nicotine exposure decreased fetal body weight. In addition, nicotine impaired utero-placental circulation leading to retarded fetal growth in heavy smokers[37]. Green tea supplementation significantly prevented nicotine-induced body weight loss in mice offspring which could be explained in terms of improved energy homeostasis and fluid balance. Accordingly, green tea extract has been reported to ameliorate insulin sensitivity and glucose and lipid metabolism in offspring born to rat fed high fat diet during pregnancy[38].

Oxidative stress has been proposed to be one of the mechanisms mediating nicotine associated alterations during pregnancy[13,14]. In this context, multiple *in vivo* studies have demonstrated that nicotine administration induces oxidative stress in blood corpuscles and tissues of rats,[14,15] and significantly decreased the endogenous antioxidants[39,40]. *In vitro* studies also showed imbalanced prooxidant/antioxidant status and severely damaged DNA in lymphocytes subjected to nicotine[16]. Here, maternal exposure to nicotine induced oxidative stress status in the cerebrum of mice newborns evidenced by the significantly increased lipid peroxidation marker, MDA, along with declined GSH content and SOD activity. Regarding it neurotoxic effects, nicotine has been reported to induce neuronal apoptosis, oxidative stress and DNA fragmentation[41]. In addition, the study of Bruin *et al.*[42] reported that maternal nicotine exposure for 2 weeks prior to pregnancy until weaning induced oxidative stress and apoptosis in the pancreas of rat offspring. Recently, the studies of Chan *et al.*[14,43] have reported increased oxidative stress, inflammation and mitochondrial dysfunction in the brain of mice offspring exposed to maternal cigarette smoking. These data suggest the pro-oxidant activity of nicotine.

We have observed similarities in the effects of perinatal nicotine exposure on the brain in both male and female offspring. However, previous as well as recent studies reported that females are more resistant to oxidative stress[43-45]. These different outcomes could be due to different dose, duration and route of administration. In addition, these studies were mostly conducted on rat offspring. The oxidative stress resistance property of females could be connected directly to the fact that oestrogen inhibits oxidative stress and inflammation[46] and protected female offspring against perinatal nicotine exposure related hypertension[47].

Green tea supplementation potentially decreased nicotine-induced lipid peroxidation and enhanced the antioxidant defenses in the brain of both genders. The beneficial effects of green tea could be explained by its

rich content of phenolic compounds such as catechins and epicatechins. These compounds can protect neurons against oxidative stress and other metabolic insults[48]. Green tea polyphenols protected the dopaminergic neurons against 6-hydroxydopamine-induced damage in a rat model of Parkinson's disease[49] and retinal neurons against ischemia/reperfusion injury[50]. The neuroprotective efficacy of catechins has been reported to be mediated, at least in part, through activation of protein kinase C (PKC) and transcription factors inducing up-regulation of cell-survival genes[51] and potentiation of antioxidant defenses[52].

Heavy smoking during pregnancy affected the fetus in utero and may cause brain problems[53]. Here, maternal nicotine administration during pregnancy induced some histological alterations including chromatolysis and congested blood vessels in the cerebrum of mice offspring at D7, D15 and D30 after birth. In addition, both male and female offspring born to mice administered nicotine showed significant increase in Hb% and RBCs, WBCs and platelets count, an effect that was reversed by green tea treatment. The increased RBCs number and Hb% could be a consequence of nicotine-induced fetal hypoxia in utero. Maternal exposure to high nicotine doses resulted in fetal hypoxia in rats as evidenced by decreased blood pO_2 and O_2 saturation and increased[36] pCO_2. Several studies have confirmed that nicotine induces in utero hypoxia, growth restriction and reduced blood flow and intrauterine oxygen tension[36,54]. In line with these findings, in the hypoxic fetal sheep the hemoglobin level is increased to keep sufficient oxygen delivery to the myocardium[55]. Green tea extract normalized the hematological parameters in both male and female offspring born to mice exposed to nicotine. These findings could be related to the ability of green tea to mitigate the intrauterine effects of nicotine. Green tea may have a role in improving the utero-placental circulation; however, further research is required to test this hypothesis.

Next, the effects of perinatal nicotine exposure and green tea was investigated on blood glucose and cholesterol levels in mice offspring at D15 and D30 after birth. Nicotine administration induced significant elevation in blood glucose levels of both male and female offspring which could be attributed to loss of β-cell mass and function in the offspring as reported in the studies of Holloway *et al.*[56] and Bruin *et al.*[57]. As outlined by Bruin *et al.*[42] these findings may explain, at least in part, the increased risk of type 2 diabetes mellitus in children born to mothers who smoked during pregnancy[58]. In addition, oxidative stress and β-cell apoptosis have been reported in the fetal and neonatal pancreas as a direct effect of nicotine[42]. Pancreatic β-cells have low expression of the antioxidant enzymes[59] and therefore are particularly susceptible to oxidative stress and death[60]. Animal models of fetal and neonatal exposure to nicotine have previously been shown to induce β-cell apoptosis at birth and weaning[56,57]. Regarding its deleterious mechanism, maternally administered nicotine has been hypothesized to activate nicotinic acetylcholine receptors in the fetal and neonatal pancreas resulting in oxidative stress and signaling for β-cell apoptosis[42]. Nicotine exposure increased the circulating cholesterol levels in mice newborns at D15 and D30 after birth. Epidemiological studies have shown a relation between maternal smoking during pregnancy and childhood obesity and hypertension[61,62]. *In vivo* experimental studies have demonstrated increased blood cholesterol and free fatty acids in nicotine-induced rats[63]. De Oliveira *et al.*[64] stated that the future development of some metabolic syndrome components in the offspring may be strongly related to perinatal maternal cigarette smoking. Another study conducted by De Oliveira *et al.*[65] demonstrated that maternal nicotine exposure during lactation deteriorates nutritional, hormonal and biochemical parameters in rat dams and offspring.

Interestingly, green tea extract supplementation markedly improved blood glucose and cholesterol levels in nicotine-exposed male and female offspring at both D15 and D30 after birth. Green tea has been reported to induce glucose and cholesterol lowering effects[66,67]. Regarding its maternal supplementation, green tea significantly improved all aspects of metabolic profiles in offspring born to rats fed a high fat diet as reported by Li *et al.*[38]. This study demonstrated also that body weight of offspring at birth wasn't affected by maternal green tea supplementation which coincides with our findings. Thus, the metabolic improvements observed in Li *et al.*[38] study weren't related to body weight. Green tea has suppressed hepatic glucose production, decreased serum lipids and enhanced muscle glucose utilization in offspring when maternally supplemented to high fat-fed pregnant rats[38]. These beneficial effects of green tea could be attributed to the presence of catechins. Among them, EGCG has been reported to prevent intestinal glucose absorption and suppress hepatic glucose production via modulating expression of gluconeogenesis controlling enzymes[68] and glucose-6-phosphatase and phosphoenolpyruvate carboxykinase[69]. In addition, green tea catechins were proposed to decrease blood lipids through inhibition of dietary cholesterol absorption and cholesterol synthesis[70], up-regulation LDL receptor[71] and reduced expression of 3-hydroxy-3-methylglutaryl coenzyme A reductase[72]. Furthermore, green tea extract decreased mRNA and protein expression of sterol regulatory element binding protein

(SREBP-1c) in the liver of offspring born to rat fed high fat diet[38] and thus improved lipid profile.

CONCLUSION

The present study confers new information on the protective effects of green tea extract against nicotine-induced oxidative stress and hematologic alterations in offspring born to mice-exposed to nicotine. Green tea repressed weight loss, decreased lipid peroxidation and enhanced cerebral antioxidant defenses. In addition, green tea supplementation significantly improved hematologic parameters and blood glucose and cholesterol in nicotine-exposed mice newborns. Therefore, green tea may be considered a potential candidate for attenuating smoking/nicotine-induced alterations in newborns.

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