# Impact of Green Tea and Exercise on Hyperthyroidism-Induced Haemostatic Alterations in Rats

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## Abstract

**Introduction:** The strong relationship between thyroid hormones and the coagulation system has been appreciated since the beginning of the past century. Various coagulation abnormalities have been seen during the course of thyroid disorders and hyperthyroidism was found to be associated with potential procoagulant changes in the hemostatic system. Although hyperthyroid patients are prone to develop thromboembolism, bleeding due to various coagulation defects was, also, reported.

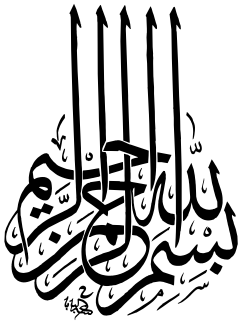
**Aim of the Work:** The purpose of the present study is to investigate the changes in the hemostatic system mediated by hyperthyroidism in an experimental rat model with special emphasis on the possible role of oxidative stress in this aspect. Also, the study will explore whether green tea or exercise training will have any beneficial effect on these hemostatic changes which will help to consider them as adjuvant therapy in the hyperthyroid state.

**Materials and Methods:** This study was carried on (46) adult Wistar male rats weighing 260-330 grams purchased from the experimental animal farm in ElGiza. Rats were maintained in the animal house of Physiology Department, Faculty of Medicine, Ain Shams University under standard conditions of boarding with access to food and tap water ad libitum. The diet consisted of bread, milk and green vegetables. Rats were exposed to the new environment for 7 days prior to experimental protocol to decrease the possible discomfort of animals.

**Results:** The results encountered in the present study, reflecting the effects of hyperthyroidism and of green tea supplementation and exercise training in rats subjected to hyperthyroidism are displayed in tables

**Conclusion:** The purpose of the present work was to determine alterations in the hemostatic mechanism in an experimental model of hyperthyroidism. Also, to throw light on the possible beneficial effects of green tea supplementation and exercise training in alleviating the hyperthyroidism-mediated hemostatic derangements in a trial to introduce useful adjuvant non drug tools in hyperthyroid conditions.

**Keywords:** Green Tea, Hyperthyroidism-Induced, Haemostatic, Rats



" قالوا سبحانك لا علم لنا

إلا ما علمتنا

إنك أنت العليم الحكيم "

سورة البقرة (آية ٣٢)

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# Contents

# List of Tables

## List of Tables

## List of Tables

## List of Tables

# List of Figures

## List of Figures

# List of Abbreviations

| Abbreviation | Full name |
|---|---|
| **ADP** | Adenosine diphosphate |
| **APTT** | Activated partial thromboplastin time |
| **BMI** | Body mass index |
| **BW** | Body weight |
| **C** | Celsius |
| **C** | Catechins |
| **CRP** | C-Reactive protein |
| **EC** | Epicatechin |
| **ECG** | Epicatechin gallate |
| **EGC** | Epigallocatechin |
| **EGCG** | Epigallocatechin gallate |
| **$FT_4$** | Free thyroxine |
| **$FT_3$** | Free triiodothyronine |
| **FDPs** | Fibrin degradation products |
| **GC** | Gallocatechin |
| **GCG** | Gallocatechin gallate |
| **GT** | Green tea |
| **GPx** | Glutathione peroxidase |
| **HTN** | Hypertension |
| **IL** | Interleukin |
| **i.p** | Intraperitoneal |
| **kDa** | Kilo Dalton |
| **MDA** | Malondialdehyde |
| **MPV** | Mean platelet volume |
| **MAPK** | Mitogen activatable protein kinase |
| **Nrf2** | Nuclear erythroid like factor |
| **NF-κB** | Nuclear factor kappa light chain enhancer |
| **PAI** | Plasminogen activator inhibitor |

## List of Abbreviations

| Abbreviation | Full name |
|---|---|
| **PT** | Prothrombin time |
| **PDW** | Platelet distribution width |
| **ROS** | Reactive oxygen species |
| **rT3** | Reversed triiodothyronine |
| **rpm** | Round per minute |
| **Shyper** | Subclinical hyperthyroidism |
| **SEM** | Standard error of mean |
| **SOD** | Superoxide dismutase |
| **$T_4$** | Thyroxine |
| **$T_3$** | Triiodothyronine |
| **Tg** | Thyroglobin |
| **TSH** | Thyroid stimulating hormone |
| **TRH** | Thyrotropin releasing hormone |
| **TBG** | Thyroxine binding globulin |
| **TRs** | Thyroid receptors |
| **t-PA** | Tissue plasminogen activator |
| **TMB** | Tetramethylbenzidine |
| **Vwf** | Von willibrand factor |
| **$VO_2$** | Maximal oxygen uptake |

# Introduction

The strong relationship between thyroid hormones and the coagulation system has been appreciated since the beginning of the past century **(Squizzato et al., 2007).** Various coagulation abnormalities have been seen during the course of thyroid disorders **(Akinci et al., 2011)** and hyperthyroidism was found to be associated with potential procoagulant changes in the hemostatic system **(Homoncik et al., 2007; Stuijver et al., 2012)**. Although hyperthyroid patients are prone to develop thromboembolism, bleeding due to various coagulation defects was, also, reported **(Panzer et al., 1990; Marongiu et al., 1991).**

In addition, hyperthyroidism is associated with high metabolic state, oxygen consumption and reactive oxygen species (ROS) production, resulting in oxidative stress. Oxidative stress reduces the global efficacy of the antioxidant defense system **(Messarah et al., 2011; Ourique et al., 2013)** resulting in tissue injury by oxidative damage of biological macromolecules including lipids, proteins and DNA causing cellular dysfunction and various health issues **(Messarah et al., 2010)**. However, the role of oxidative stress in the development of hyperthyroidism-

induced hemostatic abnormalities remains to be questionable and attracted our attention.

Tea is one of the most consumed beverages worldwide. Green tea accounts for about 20% of the total tea consumption **(Arts and Hollman, 2005).** In recent years, many health benefits of consuming green tea have been reported, including the prevention of diseases associated with free radicals and reactive oxygen species, such as cancer, cardiovascular and neurodegenerative diseases **(Jówko et al., 2015).** Many of these beneficial effects have been attributed to the presence of catechins, the biologically active polyphenolic flavonoids, which have potent antioxidant and radical-scavenging properties **(Kashima., 1999; Thomson et al., 2012).** Thus, being a natural antioxidant source, could green tea improve the hemostatic changes in hyperthyroidism to our knowledge is novel and needs to be clarified.

Adopting a physically active lifestyle through regular exercise has been proposed to lower the risk of developing thrombosis **(Adams et al., 2009).** Indeed, it has been demonstrated that exercise is beneficial for health, although there is inconsistent data from studies investigating the effect of exercise on the risk of