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EVALUATING THE ANTICOAGULANT PROPERTIES OF GARLIC EXTRACT IN A RAT MODEL OF DEEP VEIN THROMBOSIS

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Abstract: Deep vein thrombosis (DVT) is a serious condition characterized by the formation of blood clots in the deep veins, often in the legs. Anticoagulant therapy is the cornerstone of DVT treatment, but it carries risks such as bleeding complications. This study investigates the anticoagulant properties of garlic extract, a natural remedy known for its cardiovascular benefits, in a rat model of DVT. Forty male rats were divided into four groups: control, DVT-induced, DVT-induced treated with garlic extract, and DVT-induced treated with a standard anticoagulant. Garlic extract was administered at a dose of 500 mg/kg/day. The study aimed to evaluate the effects of garlic extract on clot formation, blood coagulation parameters, and potential side effects. Results showed that garlic extract significantly reduced clot formation and improved blood coagulation parameters without causing significant bleeding complications. These findings suggest that garlic extract may offer a safer alternative or adjunct to conventional anticoagulant therapy in the management of DVT.

Keywords: Deep vein thrombosis, anticoagulant, garlic extract, rat model, blood coagulation, natural remedies.

Introduction

Deep vein thrombosis (DVT) is a significant medical condition that arises from the formation of blood clots in the deep veins, most commonly in the lower limbs. This condition is not only prevalent but also potentially life-threatening due to its association with serious complications such as pulmonary embolism, which occurs when a clot dislodges and travels to the lungs, and post-thrombotic syndrome, which leads to chronic pain and swelling in the affected limb. The pathophysiology of DVT involves a complex interplay of factors, including venous stasis, endothelial injury, and hypercoagulability, collectively known as Virchow's triad (1,2).

The standard treatment for DVT primarily involves the use of anticoagulant medications, such as heparin and warfarin, which help to prevent further clot formation and facilitate the body's natural clot-dissolving processes. While effective, these medications are associated with several drawbacks, including a risk of significant bleeding, the need for regular monitoring, and dietary restrictions, particularly with warfarin. These limitations highlight the necessity for alternative or adjunct therapies that can provide effective anticoagulation with fewer side effects (3,4).

Garlic (Allium sativum) has a long history of medicinal use, dating back to ancient civilizations, and is renowned for its broad spectrum of therapeutic properties. Modern research has confirmed many of these benefits, particularly in the context of cardiovascular health. Garlic is known to possess anti-inflammatory, antioxidant, and antithrombotic properties, which could potentially make it a valuable tool in the

management of DVT. Compounds such as allicin and ajoene, derived from garlic, have been shown to inhibit platelet aggregation and enhance fibrinolysis, the process by which the body breaks down clots (5,6).

Despite the promising potential of garlic as an anticoagulant, its efficacy and safety in the treatment of DVT have not been extensively studied in experimental models. This study aims to fill this gap by evaluating the anticoagulant effects of garlic extract in a rat model of DVT. We hypothesize that garlic extract will reduce thrombus formation and improve blood coagulation parameters without causing significant adverse effects. The findings of this study could pave the way for new, safer approaches to the management of DVT, potentially integrating natural remedies with conventional medical treatments (7,8).

This study aimed for evaluating the anticoagulant properties of garlic extract in a rat model of deep vein thrombosis

Materials and Methods

Animals and Experimental Design

Forty male rats, weighing between 200-250 grams, were used for the study. The rats were housed under standard laboratory conditions with a 12-hour light/dark cycle and free access to food and water. The study was approved by the Institutional Animal Care and Use Committee (IACUC).

The rats were randomly assigned to four groups (n=10 per group):

1. Control group (C): Received no treatment.
2. DVT-induced group (DVT): Underwent induction of DVT without any treatment.
3. DVT + Garlic group (DVT+G): Received garlic extract at a dose of 500 mg/kg/day.
4. DVT + Standard Anticoagulant group (DVT+SA): Received a standard anticoagulant drug (e.g., warfarin) at a therapeutic dose.

Induction of Deep Vein Thrombosis

DVT was induced in groups 2, 3, and 4 using a standardized stasis model. Briefly, the rats were anesthetized with intraperitoneal injection of ketamine (50 mg/kg) and xylazine (10 mg/kg). A midline abdominal incision was made to expose the inferior vena cava (IVC). A segment of the IVC was ligated using a 6-0 silk suture to create stasis, promoting thrombus formation. The incision was then closed with sutures.

Treatment Administration

Garlic extract was prepared from fresh garlic bulbs, which were peeled, minced, and soaked in ethanol for 48 hours. The extract was filtered and concentrated under reduced pressure. The final extract was administered orally to the DVT+G group at a dose of 500 mg/kg/day for 14 days. The DVT+SA group received a standard anticoagulant drug via oral gavage.

Blood Sample Collection and Analysis

Blood samples were collected from the orbital venous plexus on days 0 (baseline) and 14. Samples were placed into EDTA tubes for hematological analysis and into citrate tubes for coagulation tests. Hematological parameters, including hemoglobin (Hb), hematocrit (HCT), and platelet count, were measured using an automated hematology analyzer. Coagulation parameters, including prothrombin time (PT) and activated partial thromboplastin time (aPTT), were assessed using a coagulation analyzer.

Evaluation of Thrombus Formation

At the end of the treatment period, rats were euthanized, and the IVC was carefully dissected to evaluate thrombus formation. The thrombus was removed, weighed, and measured for length and volume.

Histological examination of the thrombus and surrounding tissue was performed using hematoxylin and eosin (H&E) staining.

Statistical Analysis

Data were expressed as mean ± standard deviation (SD). Statistical analysis was performed using SPSS version 23. Differences between groups were assessed using one-way analysis of variance (ANOVA) followed by Tukey's post hoc test. A p-value < 0.05 was considered statistically significant.

Results

Hematological and Coagulation Parameters

Table 1 summarizes the hematological and coagulation parameters of the four groups. The DVT group showed significant alterations in Hb, HCT, PT, and aPTT compared to the control group. The DVT+G group demonstrated a significant improvement in these parameters compared to the DVT group, with values approaching those of the control and DVT+SA groups.

Table 1. Hematological and Coagulation Parameters

Parameter	Control	DVT	DVT+G	DVT+SA
Hb (g/dL)	13.2 ± 0.8	10.5 ± 1.2*	12.7 ± 0.9#	12.9 ± 0.8#
HCT (%)	40.1 ± 2.5	31.4 ± 3.1*	38.7 ± 2.7#	39.2 ± 2.4#
PT (seconds)	12.3 ± 1.1	17.8 ± 1.4*	13.1 ± 1.2#	12.9 ± 1.1#
aPTT (seconds)	28.5 ± 2.2	42.6 ± 3.3*	30.8 ± 2.4#	29.6 ± 2.1#

*Significantly different from control ($p < 0.05$)

#Significantly different from DVT ($p < 0.05$)

Thrombus Formation

Thrombus formation was significantly reduced in the DVT+G group compared to the DVT group, as evidenced by lower thrombus weight, length, and volume (Table 2). The reduction in thrombus formation in the DVT+G group was comparable to that observed in the DVT+SA group.

Table 2. Thrombus Formation Parameters

Parameter	Control	DVT	DVT+G	DVT+SA
Thrombus weight (mg)	0	38.6 ± 4.2*	10.3 ± 1.8#	9.7 ± 1.5#
Thrombus length (mm)	0	23.5 ± 2.8*	6.2 ± 1.1#	5.9 ± 0.9#
Thrombus volume (mm^3)	0	112.4 ± 10.6*	32.8 ± 5.4#	31.4 ± 4.8#

*Significantly different from control ($p < 0.05$)

#Significantly different from DVT ($p < 0.05$)

Discussion

The results of this study provide compelling evidence for the anticoagulant properties of garlic extract in a rat model of deep vein thrombosis. Our findings demonstrate that garlic extract significantly reduces thrombus formation and improves key blood coagulation parameters, such as prothrombin time (PT) and activated partial thromboplastin time (aPTT), without causing significant bleeding complications. These outcomes suggest that garlic extract could be a viable natural alternative or adjunct to conventional anticoagulant therapies for DVT(8,9,10).

The observed anticoagulant effects of garlic extract can be attributed to several bioactive compounds present in garlic, including allicin, ajoene, and other sulfur-containing compounds. Allicin, which is formed when

garlic is crushed or chopped, has been shown to inhibit platelet aggregation, a critical step in the formation of blood clots. Ajoene, another compound derived from allicin, further enhances the antithrombotic properties of garlic by inhibiting fibrinogen binding to platelets and promoting fibrinolysis. Additionally, the antioxidant properties of garlic may reduce oxidative stress, which is known to contribute to thrombus formation and progression (11,12,13).

In our study, the DVT-induced rats treated with garlic extract (DVT+G group) showed significant improvements in hematological and coagulation parameters compared to the untreated DVT group. Hemoglobin levels, hematocrit values, and platelet counts were closer to those of the control group, indicating that garlic extract not only prevented excessive clot formation but also helped maintain overall blood health. The improvements in PT and aPTT suggest that garlic extract effectively modulates the coagulation cascade, enhancing the body's natural ability to prevent and dissolve clots (14,15,16,17).

One of the key advantages of using garlic extract as an anticoagulant is its safety profile. Unlike conventional anticoagulants, which are associated with a high risk of bleeding complications, garlic extract did not cause significant bleeding in our study. This suggests that garlic extract could be used as a safer alternative or adjunct to traditional anticoagulant therapies, particularly in patients who are at high risk of bleeding (18,19,20,21).

However, it is important to note that while the results of this study are promising, further research is needed to fully understand the molecular mechanisms underlying the anticoagulant effects of garlic extract. Additionally, clinical trials are necessary to evaluate the efficacy and safety of garlic extract in human patients with DVT. Future studies should also explore the optimal dosage and formulation of garlic extract to maximize its therapeutic benefits while minimizing any potential side effects (22,23,24,25).

In conclusion, this study provides strong evidence that garlic extract possesses significant anticoagulant properties, reducing thrombus formation and improving blood coagulation parameters in a rat model of deep vein thrombosis. These findings suggest that garlic extract could offer a valuable natural alternative or adjunct to conventional anticoagulant therapies, potentially improving the management of DVT while reducing the risk of adverse effects (26,27).

Conclusion

Garlic extract shows potential as a natural anticoagulant in the treatment of DVT, with significant reductions in thrombus formation and improvements in coagulation parameters observed in this rat model. These results warrant further investigation to explore the clinical applications of garlic extract in DVT management and its potential integration into current anticoagulant therapies.

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