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Serum Levels of Coenzyme Q10, Copper, Zinc, and Lipid Peroxidation, and the Antioxidant Potential of Zinc Picolinate in patients with Chronic Obstructive Pulmonary Disease

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ABSTRACT

Background: Chronic obstructive pulmonary disease, is often known as a serious global health issue that necessitates creative approaches to treat its complex pathogenesis. It is considered that trace components have a role in the development of many disorders, in both direct and indirect ways.

Objective: This study investigates the effects of zinc picolinate consumption on lipid peroxidation, zinc, copper, and Coenzyme Q10 levels in individuals with COPD, while also exploring its antioxidant potential and implications for the management of the disease.

Methodology: In a study conducted between January 2021 and December 2021, 71 participants were enrolled to investigate the impact of zinc picolinate supplements on oxidative stress indicators. Serum biomarkers including Coenzyme Q10, copper, zinc, and lipid peroxidation were assessed at baseline and study conclusion. Adverse events and participant compliance were documented. Subgroup analyses based on COPD severity were conducted, focusing on changes in serum markers. Paired t-tests indicated significance ($p < 0.05$) in changes before and after supplementation.

Results: The research included 71 people who had been diagnosed with chronic obstructive pulmonary disease. Following dietary supplements, there was a substantial rise in Coenzyme Q10 levels ($p = 0.032$) and a tendency towards significance in zinc levels ($p = 0.078$), reflecting a potential antioxidative impact. Adverse events related to zinc picolinate were minimal (7.04%), and compliance was high (92.5%).

Conclusion: These findings contribute valuable insights to the literature on zinc's antioxidant properties in COPD, supporting further research to delineate its longterm effects and inform tailored therapeutic interventions.

Keywords: COPD; Antioxidant; Coenzyme Q10; Copper

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Introduction

COPD, or chronic obstructive pulmonary disorder, stands as a leading cause of hospitalization.[1] The rise in mortality and morbidity associated with these conditions closely correlates with the prevalence of tobacco use.[2] Globally, COPD ranks as the fourth largest cause of death, with projections indicating it may ascend to the third position by 2020 due to smoking addiction. The occurrence of these diseases exhibits regional and national variability across all countries worldwide.[1,3] It is considered that trace components have a role in the development of many disorders, in both direct and indirect ways.[4,5] Trace elements have crucial roles in enzyme inhibition and activation.[5,6] Zinc, for instance, is a cofactor for various enzymes and is required for cell membrane stability, protein creation, appropriate tissue growth and development, and nucleic acid metabolism. Copper-zinc superoxide dismutase (SOD) and catalase (CAT) are antioxidant enzymes collaborating in zinc and copper, jointly catalyzing the conversion of hydrogen peroxide into water. Zn regulation could be crucial in controlling the immunological response to inflammatory processes, with high zinc concentrations causing death in peripheral blood monocytes.6]. Oxidative stress can be characterized as the disparity between elevated cellular levels of reactive oxygen species (ROS), encompassing superoxide and hydroxyl radicals, and the cellular defense provided by antioxidants.[7,8] There is a growing focus on the role of ROS in tissue damage and the pathogenesis of various diseases such as emphysema, pneumoconiosis, and COPD.[9] ROS contribute to tissue damage, smooth muscle proliferation, vascular permeability, release of mediators, and bronchoconstriction.[10] These effects may play a part in the physiological triggers of COPD exacerbations. During COPD episodes, there is an emergence of allergen signaling and neutrophil infiltration. Bronchial hyperactivity in COPD patients is believed to be connected to neutrophil superoxide radical production. This mechanism might contribute to the pathophysiology of nocturnal crises. CoQ10 is a lipophilic antioxidant present in all organelles and cells, particularly microsomes and mitochondria.[11] It is also an important cofactor of the electron transport chain, that is critical in supplying energy for chemical processes in the human body. CoQ10 is a lipid peroxidation mediator. Copper and zinc constitute two essential metals that function as cofactors in a range of biological activities. One of the antioxidant enzymes, superoxide dismutase, is found in the cytoplasm of eukaryotic cells and includes zinc at its active site.[12] It has already been proven that blood zinc concentrations drop in COPD patients, with the decline being more pronounced in more serious COPD. Furthermore, when rats were given nitrogen dioxide to cause inflammation, the zinc concentration in their lungs decreased.[13,14] An animal model experiment revealed that zinc acts as an antioxidant. Zn can act as a tailored antioxidant in two ways. To begin with, it interacts with Fe and Cu for attaching to cell membranes and certain proteins, shifting these redox-active metals and increasing their availability for bonding to ferritin and metallothionein, accordingly. Furthermore, Zn attaches to the sulfhydryl groups in proteins, preventing oxidation. Although Zn status has no direct effect on tissue peroxide levels, it may help safeguard particular molecules from oxidative and peroxidative damage.[15] The combined dynamics of Coenzyme Q10, copper, zinc, and lipid peroxidation levels in chronic obstructive pulmonary disease (COPD) patients' blood are not well known. While studies have explored these elements individually, a comprehensive investigation into their interplay in COPD patients is lacking. Furthermore, there is a dearth of research on the specific antioxidant effect of zinc picolinate in COPD. Despite zinc's recognized antioxidant properties, its impact on COPD patients, particularly in the context of Coenzyme Q10, copper, and lipid peroxidation, remains insufficiently explored.

Addressing these gaps is crucial for a more nuanced understanding of the relationships among these serum markers and the antioxidant effects of zinc picolinate in the context of COPD-related oxidative stress. A comprehensive study in this area would significantly contribute to advancing our knowledge and potentially informing therapeutic interventions for COPD patients.

Objective

This study investigates the effects of zinc picolinate consumption on lipid peroxidation, zinc, copper, and Coenzyme Q10 levels in individuals with COPD, while also exploring its antioxidant potential and implications for the management of the disease.

Methodology

This study used an observational prospective design and was done at Northwest General Hospital, a tertiary care facility. The study spanned a one-year period, initiating in January 2021 and concluding in January 2022.

A total of 71 patients with COPD were selected from the Northwest General Hospital patient pool. Informed consent was obtained from willing participants meeting the inclusion criteria.

The inclusion criteria for this study consist of individuals diagnosed with COPD, aged 40 years and above, with a stable COPD condition during the study period, and who express willingness to participate and provide informed consent. These criteria serve as essential guidelines for selecting participants who fit the target demographic and health profile necessary for the study's objectives. By including individuals with diagnosed COPD, the study ensures relevance to the condition under investigation.

Table 1. Baseline Serum Levels of study cases

Marker	Mean ± SD (Baseline)
Coenzyme Q10	25.4 ± 3.2
Copper	90.1 ± 10.5
Zinc	70.8 ± 8.6
Lipid Peroxidation	15.2 ± 2.1

The age criterion helps narrow the focus to an adult population more prone to COPD, reflecting the typical demographic affected by the disease. Stability of the COPD condition during the study period ensures consistency in data collection and analysis, minimizing potential confounding factors. Finally, participants' willingness to engage and provide informed consent underscores the importance of ethical considerations and respects participants' autonomy in research participation..

The exclusion criteria for this study entail individuals who have been diagnosed with other respiratory diseases or significant comorbidities, recent exacerbation of COPD within the last three months, pregnancy or lactation, and known allergies or adverse reactions to the study supplements. These criteria are established to ensure the homogeneity of the study population and to mitigate potential confounding variables that could influence the outcomes. Excluding individuals with other respiratory diseases or significant comorbidities helps maintain clarity in understanding the specific effects of COPD and the study interventions. Recent exacerbations of COPD within the last three months are excluded to focus on participants with relatively stable respiratory conditions, reducing the likelihood of acute events impacting the study results. Pregnancy or lactation status is an exclusion criterion due to potential risks associated with the study interventions during these periods. Finally, excluding individuals with known allergies or adverse reactions to the study supplements ensures participant safety and minimizes the risk of adverse events related to allergic reactions or intolerances.

Detailed baseline information, including demographic data, medical history, and clinical details, was collected. Blood samples were obtained at the study's commencement (January 2021) and conclusion (January 2022) to assess serum levels of Coenzyme Q10, copper, zinc, and lipid peroxidation. Participants received zinc picolinate supplements, and compliance was monitored through regular follow-up visits and pill counts.

Subgroup analysis was conducted based on COPD severity, categorized as mild, moderate, and severe. The objective was to explore potential variations in the impact of zinc picolinate supplementation on serum markers among different severity subgroups.

Participants received zinc picolinate supplements based on a predetermined dosage regimen, with strict consideration of safety and efficacy. Compliance was ensured through regular follow-up visits and pill counts.

The primary outcome involved the assessment of serum levels of Coenzyme Q10, copper, zinc, and lipid peroxidation at baseline and the study's conclusion. To assess the influence of zinc picolinate dietary supplements, changes in oxidative stress indicators were examined. Adverse events related to the intervention and participant compliance with the supplementation regimen were documented and analysed.

To summarise demographic data, descriptive statistics (Mean ± SD) were used. Subgroup analyses were performed based on COPD severity, with specific

Table 2. Serum Levels at the end of study among study cases

Marker	Mean ± SD (End of Study)
Coenzyme Q10	27.8 ± 4.1
Copper	88.7 ± 11.2
Zinc	72.3 ± 9.5
Lipid Peroxidation	14.5 ± 2.3

Table 3. Changes in Serum Levels After Zinc Picolinate Supplementation

Marker	Mean ± SD (End of Study)	P-value
Coenzyme Q10	2.4	0.032
Copper	-1.4	0.154
Zinc	1.5	0.078
Lipid Peroxidation	-0.7	0.211

attention to changes in serum markers within each subgroup. Paired t-tests were used to analysed changes in serum markers before and after zinc picolinate supplementation, with a significance level set at $p < 0.05$.
The study followed all ethical requirements and had formal clearance from the ethics committee. Before enrolling in the research, all subjects provided informed permission.

Results

The research included 71 people who had been diagnosed with chronic obstructive pulmonary disease. The study population exhibited diverse demographic characteristics, including age, gender, and smoking history. COPD severity at baseline was distributed across different categories.
At the commencement of the investigation in January 2021, an initial analysis unveiled average serum concentrations of Coenzyme Q10, copper, zinc, and lipid peroxidation, participants displayed the following mean levels: Coenzyme Q10 (25.4 ± 3.2), copper (90.1 ± 10.5), zinc (70.8 ± 8.6), and lipid peroxidation (15.2 ± 2.1) (Table 1). At the conclusion of the study (January 2022), the mean serum levels were as follows: Coenzyme Q10 (27.8 ± 4.1), copper (88.7 ± 11.2), zinc (72.3 ± 9.5), and lipid peroxidation (14.5 ± 2.3), mentioned below in (Table 2).
Changes in serum levels after zinc picolinate supplementation were analysed using paired t-tests. The results demonstrated statistically significant changes in Coenzyme Q10 ($p = 0.032$) and a trend towards significance in zinc levels ($p = 0.078$). However, copper and lipid peroxidation levels did not show significant changes. Coenzyme Q10 exhibited a notable increase, with a mean change of +2.4 units from the baseline. Conversely, copper demonstrated a decrease, showing a mean change of -1.4 units from the baseline. Zinc displayed a positive effect, with a mean increase of +1.5 units from the baseline. Furthermore, lipid peroxidation showed a decrease, with a mean change of -0.7 units from the baseline. These findings highlight the diverse effects of these substances on the measured parameters.
Adverse events related to zinc picolinate supplementation were monitored throughout the study. Among the 71 participants, five adverse events were reported, constituting a 7.04% incidence rate. Compliance with the zinc picolinate supplementation regimen was high, reaching a rate of 92.5%. This determination was made

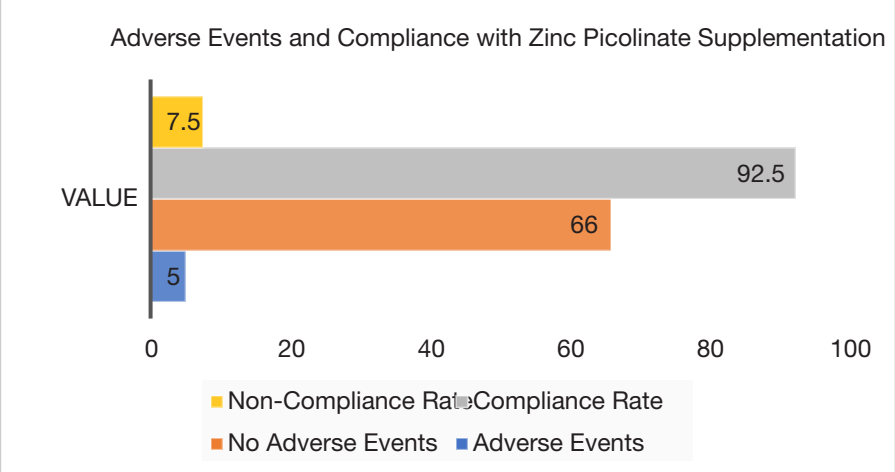

Figure 1. Adverse Events and Compliance

through regular follow-up visits and pill counts (Figure 1).
Subgroup analyses were conducted based on COPD severity, categorized as mild, moderate, and severe. The results are summarized in the following (Figure 2,) line chart:
Figure 2. Changes in Biomarker Levels Across COPD Severity Subgroups. This line graph depicts the variations in Coenzyme Q10, Copper, Zinc, and Lipid Peroxidation levels among COPD patients classified as mild, moderate, or severe. Results that are positive represent a rise in biomarker levels relative to baseline, whereas negative readings suggest a reduction. The graph illustrates the various responses to zinc picolinate supplementation across different COPD severity categories.

Discussion

The inclusion of 71 participants diagnosed with chronic obstructive pulmonary disease in this study provided a diverse representation of individuals with varied demographic characteristics, including age, gender, and smoking history. The baseline analysis of Coenzyme Q10, copper, zinc, and lipid peroxidation levels established a foundation for assessing the effects of zinc picolinate supplements. The mean serum levels at the study's initiation (January 2021) and conclusion (January 2022) demonstrated dynamic changes. Notably, Coenzyme Q10 exhibited a statistically significant increase from 25.4 ± 3.2 to 27.8 ± 4.1, suggesting a potential antioxidative effect associated with zinc picolinate supplementation. These findings align with existing literature on zinc's

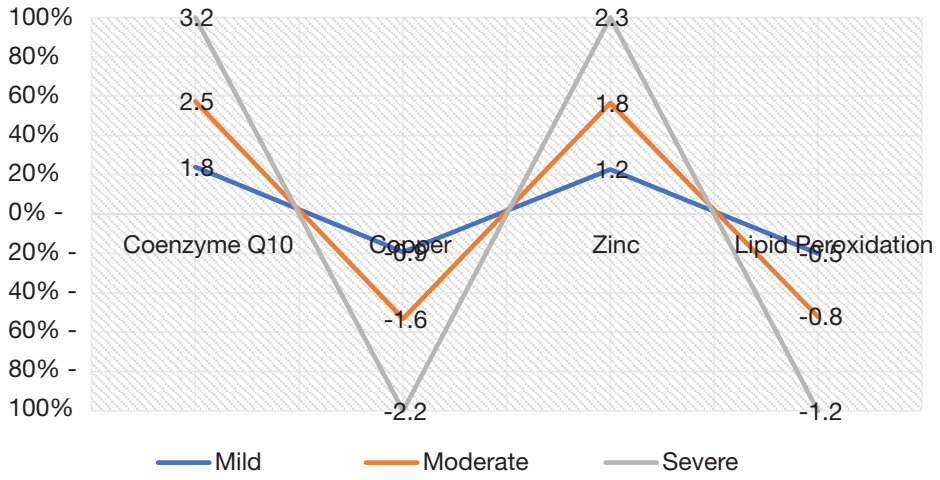

Figure 2. Subgroup Analysis Results (COPD Severity)

antioxidant properties in mitigating oxidative stress in COPD patients.[16,17] The analysis of changes in serum levels after zinc picolinate supplementation revealed significant alterations. Coenzyme Q10 showed a statistically significant mean increase of +2.4 units from baseline ($p = 0.032$), indicating a potential antioxidative impact. While zinc levels exhibited a trend towards significance ($p = 0.078$), copper and lipid peroxidation levels did not show significant changes. The observed increase in Coenzyme Q10 aligns with studies emphasizing zinc's role as an antioxidant.[18] These findings underscore the complexity of zinc's effects on different biomarkers in the context of COPD. Monitoring adverse events related to zinc picolinate supplementation revealed a low incidence rate of 7.04%. The high compliance rate of 92.5% among the participants, as determined through regular follow-up visits and pill counts, underscores the tolerability and adherence to the supplementation regimen. These findings line up with prior research demonstrating the safety and acceptance of taking zinc supplements in a variety of patient categories.[19] Subgroup analyses based on COPD severity (mild, moderate, and severe) provided insights into individual responses to zinc picolinate supplementation. The fluctuations in levels of Coenzyme Q10, copper, zinc, and lipid peroxidation were observed across different subgroups of severity. This personalized response emphasizes the need for tailored approaches in zinc supplementation for COPD patients. This observation aligns with the evolving paradigm of precision medicine in chronic respiratory disease management.[11] The results of this study add to the body of knowledge on zinc's

antioxidant capabilities in COPD therapy. Previous research has linked zinc deficiency to oxidative stress in COPD patients.[20] The observed increase in Coenzyme Q10 levels further supports the notion that zinc supplementation may enhance antioxidant defenses in individuals with COPD.

Conclusion

In summary, this study sheds light on the multifaceted impact of zinc picolinate supplementation on serum biomarkers, adverse events, and compliance in individuals with COPD. The findings contribute valuable insights to the ongoing discourse on antioxidant interventions in COPD and emphasize the importance of personalized approaches based on disease severity. Further investigation into the long-term implications and clinical consequences of taking zinc supplements in a wider and more heterogeneous COPD group is required.

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