# Exploring the Synergistic Effects of Aerobic Exercise and Cinnamon Extract on Metabolic Markers in Insulin-Resistant Rats through Advanced Machine Learning and Deep Learning Techniques

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**Abstract :** The present study aims to explore the effect of an 8-week aerobic training regimen combined with cinnamon extract on serum irisin and leptin levels in insulin-resistant rats. Additionally, this research leverages various machine learning (ML) and deep learning (DL) algorithms to model the complex interdependencies between exercise, nutrition, and metabolic markers, offering a groundbreaking approach to obesity and diabetes research. Forty-eight Wistar rats were selected and randomly divided into four groups: control, training, cinnamon, and training cinnamon. The training protocol was conducted over 8 weeks, with sessions 5 days a week at 75-80% VO2 max. The cinnamon and training-cinnamon groups were injected with 200 ml/kg/day of cinnamon extract. Data analysis included serum data, dietary intake, exercise intensity, and metabolic response variables, with blood samples collected 72 hours after the final training session. The dataset was analyzed using one-way ANOVA ($P < 0.05$) and fed into various ML and DL models, including Support Vector Machines (SVM), Random Forest (RF), and Convolutional Neural Networks (CNN). Traditional statistical methods indicated that aerobic training, with and without cinnamon extract, significantly increased serum irisin and decreased leptin levels. Among the algorithms, the CNN model provided superior performance in identifying specific interactions between cinnamon extract concentration and exercise intensity, optimizing the increase in irisin and the decrease in leptin. The CNN model achieved an accuracy of 92%, outperforming the SVM (85%) and RF (88%) models in predicting the optimal conditions for metabolic marker improvements. The study demonstrated that advanced ML and DL techniques could uncover nuanced relationships and potential cellular responses to exercise and dietary supplements, which is not evident through traditional methods. These findings advocate for the integration of advanced analytical techniques in nutritional science and exercise physiology, paving the way for personalized health interventions in managing obesity and diabetes.

**Keywords :** aerobic training, cinnamon extract, insulin resistance, irisin, leptin, convolutional neural networks, exercise physiology, support vector machines, random forest

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