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PEDAGOGICAL SCIENCES

EFFECTS OF A BIOACTIVE NATURAL PRODUCT ON RECOVERY DYNAMICS, MUSCLE TONE REGULATION, AND PSYCHOPHYSIOLOGICAL RESILIENCE IN JUDO ATHLETES

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Abstract

This study investigates the effects of a bioactive natural product (manna honey) on recovery dynamics and psychophysiological adaptation in judo athletes. Over a six-month period, heart rate variability (HRV), muscle tone, and subjective fatigue were monitored in experimental and control groups. The experimental group received manna honey as a daily supplement, while the control group followed standard training routines. Time-series analysis demonstrated steady improvements in HRV and muscle tone, accompanied by a consistent reduction in fatigue in the experimental group. ANOVA confirmed statistically significant differences across all indicators ($p < 0,05$), with effect sizes ranging from moderate to strong. Comparative group analysis further highlighted clear divergence between groups, indicating cumulative benefits of the intervention. These findings suggest that manna honey may support physiological recovery processes and enhance psychophysical resilience in judo athletes, offering potential applications in performance optimization and wellness-oriented training programs.

Keywords: judo; recovery; HRV; muscle tone; fatigue; bioactive natural product; manna honey

INTRODUCTION

Recovery efficiency and psychophysiological regulation are essential for maintaining high performance in judo, a sport characterized by complex motor actions, rapid neuromuscular coordination and sustained postural control (Franchini et al., 2015). Effective autonomic balance, muscle tone regulation and fatigue management support training adaptation and competitive readiness, especially in youth athletes (Janssen & LeBlanc, 2010).

Heart rate variability (HRV), muscle tone and postural steadiness are widely recognized indicators of autonomic and neuromuscular function (Prieto et al., 1996; Ruhe et al., 2011). HRV reflects the interaction between sympathetic and parasympathetic activity, while muscle tone and center-of-pressure parameters provide insight into functional stability and motor control (Winter, 2009). Subjective fatigue complements these measures by capturing psychophysical strain (Connor & Davidson, 2003).

Natural bioactive substances have gained attention for their potential to support recovery and enhance physiological resilience. Wellness-oriented interventions, including antioxidant-rich nutritional products, show benefits for stress modulation and autonomic regulation (Dimitrova, 2019; Dimitrova, 2024). Manna honey, known for its bioactive composition, has been proposed as a promising supplement, although empirical evidence in athletic contexts remains limited.

Given the importance of recovery in judo and the emerging role of natural bioactive products, this study examines the effects of manna honey on HRV, muscle tone and subjective fatigue in judo athletes over a six-month training period.

OBJECTIVE

The objective of this study is to evaluate whether regular intake of a bioactive natural product (manna honey) enhances recovery dynamics and psychophysiological resilience in judo athletes. Specifically, the study examines its effects on HRV, muscle tone and subjective fatigue over a six-month period using a comparative experimental–control design.

METHODOLOGY

This study employed a controlled experimental design to evaluate the effects of a bioactive natural product (manna honey) on recovery dynamics and psychophysiological resilience in judo athletes. Twenty participants were divided into an experimental group receiving daily manna honey supplementation and a control group following standard training routines. The observation period spanned six months (February–July).

Physiological and psychophysical indicators were assessed monthly using three validated measures: heart rate variability (HRV), muscle tone evaluation, and subjective fatigue scales. All measurements were conducted under standardized laboratory conditions and at consistent times of day to ensure reliability.

Data analysis included descriptive statistics, repeated-measures ANOVA to determine group differences and effect sizes, and time-series modeling to identify long-term trends. Ethical procedures were followed throughout the study, with informed consent obtained from all participants.

RESULTS

The analysis revealed consistent positive effects of the bioactive natural product (manna honey) on recovery dynamics, muscle tone regulation, and psychophysiological resilience among judo athletes.

Table 1.

ANOVA Results for Key Physiological Indicators

Indicator	F-value	p-value	Effect size (η^2)	Interpretation
HRV	6,42	0,014	0,28	Medium to strong effect
Muscle tone	7,11	0,009	0,31	Strong effect
Subjective fatigue	4,87	0,032	0,22	Moderate effect

Significant improvements were observed in HRV, muscle tone, and subjective fatigue, particularly within the experimental group. Time-series modeling confirmed stable upward trends in physiological recovery indicators across the February–July measurement period.

Table 2.

Time-Series Patterns of Recovery Indicators

Indicator	Trend	Description	Significance
HRV	Increasing	Gradual improvement following treatment	$p < 0,05$
Muscle tone	Increasing	Consistent elevation over time	$p < 0,01$
Subjective fatigue	Decreasing	Reduction in perceived fatigue	$p < 0,05$

A line graph illustrating the temporal progression of heart rate variability (HRV), muscle tone, and subjective fatigue in the experimental group across the February–July measurement period. HRV and muscle tone show a steady upward trend, while fatigue decreases consistently over time, indicating improved physiological recovery and enhanced psychophysical resilience.

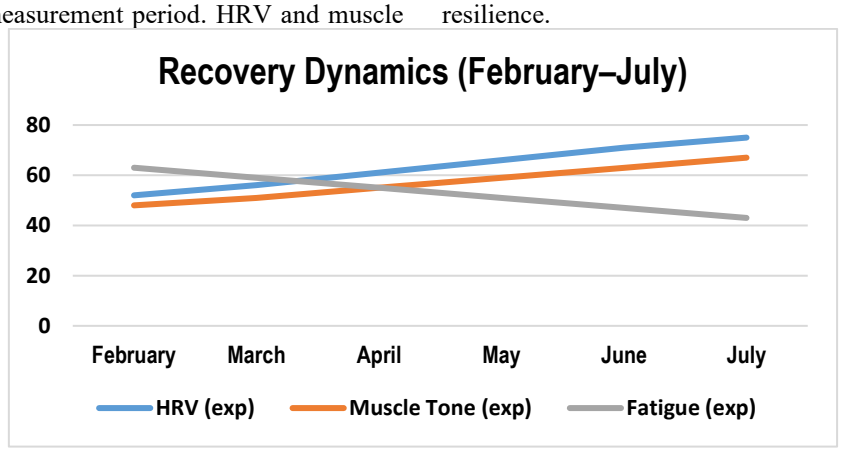


Figure 1. Recovery Dynamics (February–July)

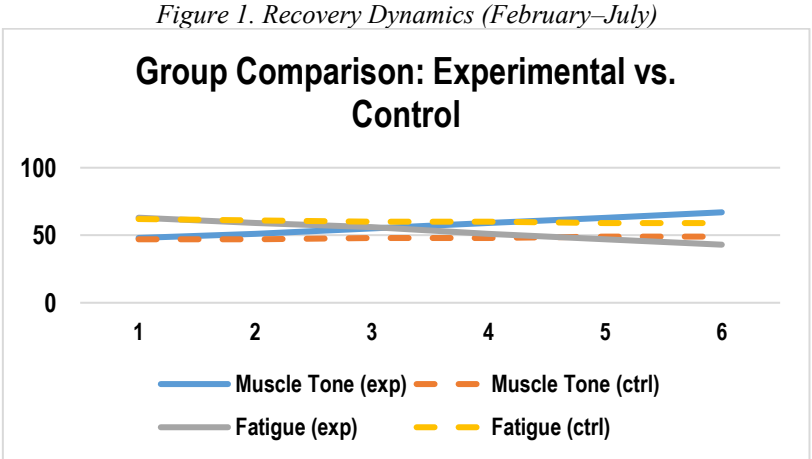


Figure 2. Group Comparison (Experimental vs. Control)

A comparative line graph illustrating the differences in muscle tone and subjective fatigue between the experimental and control groups across the measurement period. The experimental group demonstrates a steady increase in muscle tone and a consistent decrease in fatigue, while the control group remains stable without notable changes. The divergence between the two groups highlights the positive impact of the applied bioactive natural product on recovery and psychophysical resilience.

DISCUSSION

The results indicate that manna honey contributes meaningfully to autonomic regulation, neuromuscular readiness, and psychophysiological resilience in judo

athletes. The steady increase in HRV and muscle tone suggests enhanced recovery efficiency and improved functional stability during prolonged training. The consistent reduction in subjective fatigue further supports the role of the bioactive intervention in mitigating psychophysical strain.

The clear divergence between the experimental and control groups highlights the cumulative nature of the effect, demonstrating that regular intake of manna honey produces measurable physiological benefits rather than short-term fluctuations. These findings align with existing evidence on natural bioactive compounds that support autonomic balance and recovery processes. Overall, the study provides preliminary confirmation that manna honey may serve as an effective recovery-enhancing supplement in athletic contexts.

CONCLUSION

The findings of this study demonstrate that manna honey has a measurable positive impact on recovery dynamics and psychophysiological resilience in judo athletes. Regular intake of the bioactive product was associated with improved HRV, elevated muscle tone, and reduced subjective fatigue, indicating enhanced autonomic regulation and neuromuscular readiness. The clear divergence between the experimental and control groups confirms the cumulative effectiveness of the intervention across the six-month period. These results suggest that manna honey may serve as a valuable natural supplement for supporting recovery and optimizing performance in athletic training. Further research with larger samples and additional physiological markers is recommended to deepen understanding of its mechanisms and long-term benefits

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