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Effects of Six Weeks of Tart Cherry Juice Consumption Combined with Concurrent Training on AST, ALT, TAC, and MDA in Women with Overweight and Obesity

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Abstract

Introduction: Obesity is associated with increased oxidative stress and chronic inflammation, which may adversely affect liver function. Accordingly, nutritional and exercise interventions have attracted attention as potentially effective strategies for improving this condition. Tart cherry juice, owing to its antioxidant and anti-inflammatory constituents, may exert beneficial effects on hepatic and oxidative stress indices when combined with concurrent exercise training in women with overweight and obesity.

Methods: This quasi-experimental study employed a pretest-posttest design with two groups: concurrent training alone and concurrent training plus tart cherry juice supplementation. Twenty-four women with overweight or obesity, aged 20-35 years, participated in the study. The intervention consisted of six weeks of concurrent resistance and aerobic training performed in three 90-minute sessions per week. The supplementation group consumed 240 mL of tart cherry juice daily. Between-group differences were analyzed using analysis of covariance (ANCOVA), while within-group changes were assessed using paired-samples t tests. Statistical significance was set at $P \leq 0.05$.

Results: ANCOVA indicated that, after six weeks of intervention, there were no statistically significant between-group differences in AST, ALT, TAC, or MDA (all $P > 0.05$).

Conclusions: Six weeks of tart cherry juice supplementation combined with concurrent training did not produce statistically significant changes in the studied hepatic, inflammatory, and oxidative stress indices. Nevertheless, the direction of the observed changes suggests that this combined intervention may have potential synergistic effects that warrant further investigation.

Key Words: Tart cherry juice; concurrent training; inflammatory markers; oxidative stress; women with overweight and obesity.

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1. Introduction

According to global health estimates, more than 650 million people worldwide live with obesity, defined as a body mass index (BMI) of 30 kg/m² or higher (1). Individuals with overweight or obesity are at greater risk of developing hepatic steatosis, which may lead to abnormal liver function (2). In this context, liver enzymes such as alanine aminotransferase (ALT), aspartate aminotransferase (AST), and gamma-glutamyl transferase (GGT) are widely regarded as useful indicators of liver injury (3,4). Previous studies have demonstrated associations between non-alcoholic fatty liver disease (NAFLD), insulin resistance, and components of the metabolic syndrome, including hypertension, type 2 diabetes, and obesity (5-7).

The role of liver enzymes in predicting the development of type 2 diabetes has been investigated previously, although the findings have not been entirely consistent. Several studies have examined the possible association between ALT and type 2 diabetes (7-9), while others have reported that GGT, but not ALT, remains an important predictor of diabetes (10,11). Similarly, the relationship between insulin resistance and abnormal liver enzyme concentrations remains controversial. Some studies have shown that the homeostatic model assessment of insulin resistance (HOMA-IR) increases in parallel with elevations in liver enzymes. ALT and AST, but not GGT, have shown significant associations with HOMA-IR (5,12). In individuals with overweight or obesity, increased body-fat accumulation may be a major contributor to insulin resistance. This condition is accompanied by activation of lipolysis and de novo lipogenesis and may contribute to the development of fatty liver (steatosis) and, in more advanced cases, hepatic inflammation (steatohepatitis) (13).

Inflammation is a normal immune response to injury or infection; however, when it becomes chronic, it may cause tissue damage and contribute to the development of a variety of diseases (14,15). Malondialdehyde (MDA) is recognized as a key marker of oxidative stress (16), because elevated levels indicate excessive free-radical production and oxidative damage to cell membranes. In contrast, total antioxidant capacity (TAC) reflects the body's overall ability to counteract free radicals and reduce their harmful effects (17). The relationship between MDA and TAC may therefore be useful for evaluating inflammatory status and oxidative stress, such that elevated MDA together with reduced TAC may indicate chronic inflammation and related disorders (18,19).

Medicinal plants are rich sources of antioxidant and anti-inflammatory compounds and may help reduce inflammation and improve oxidative stress status (20,21). Many contain flavonoids, polyphenols, and other bioactive compounds that may reduce free-radical production, enhance antioxidant capacity, decrease MDA, and increase TAC. Thus, plant-derived products may represent a natural approach to managing inflammation and promoting general health. In the context of changing dietary patterns and the recognized importance of fruit consumption for health and antioxidant defense, tart cherry juice, as a rich source of phenolic compounds and antioxidants, may be a useful option for improving health status and reducing oxidative stress (22,23).

Polyphenols are secondary metabolites with multiple biological activities. Tart cherry polyphenols may exert health-promoting effects through several mechanisms, including antiproliferative and antioxidant actions (23). The antioxidant activity of tart cherries is largely attributed to their high anthocyanin content; these compounds may inhibit lipid peroxidation more effectively than some commonly used conventional antioxidants (22). Maintaining an adequate antioxidant status is important for protection against oxidative stress, which arises from an imbalance between oxidant production and antioxidant defense and may damage lipids, proteins, and other cellular macromolecules. Evidence also suggests that oxidative stress follows a light-dark (circadian) pattern and may vary in intensity across different times of the day (24).

Regular exercise can improve the body's antioxidant status by increasing the production of antioxidant enzymes and strengthening defense mechanisms against oxidative stress (25,26). Exercise may also reduce oxidant levels and improve the balance between oxidant production and clearance, thereby decreasing oxidative damage and improving overall health (26). These beneficial effects may be particularly relevant when exercise is combined with natural supplements intended to modulate oxidative stress and inflammatory conditions. Short-term supplementation with tart cherry powder has been reported to exert beneficial effects on body composition in resistance-trained individuals (27). In contrast, 30 days of supplementation with Montmorency tart cherry juice or capsules did not improve body composition, including body mass, in healthy participants (28).

Previous research on the benefits of tart cherries has generally included mixed samples of women and men, and sex has not been controlled in many studies (29-31). Moreover, much of the available evidence has been obtained from animal models, particularly mice (32-34). Given the limited human research on tart cherry interventions with control for sex, the scarcity of studies simultaneously examining concurrent training and tart cherry juice, and the inconsistencies in previous findings regarding the effects of supplementation on the outcomes assessed in the present study (29,34,35), further investigation is warranted. Therefore, the aim of this study was to compare the effects of six weeks of concurrent training with and without tart cherry juice supplementation on serum AST, ALT, TAC, and MDA in women with overweight and obesity.

2. Methods

This applied, quasi-experimental study used a two-group pretest-posttest design and was conducted following approval by the Ethics Committee of the University of Tabriz (IR.TABRIZU.REC.1403.37). The study population consisted of young women with overweight or obesity (BMI > 24.9 kg/m²), aged 20-35 years, with regular menstrual cycles. Using G*Power software, with a significance level of 0.05, statistical power of 0.80, and an effect size of 0.60, the sample size was estimated at 24 participants. The source manuscript additionally states that two participants withdrew during the study.

Participants were recruited through public advertisements posted on social media and in high-traffic public locations. After written informed consent was obtained, demographic information, medical history, and exercise history were recorded. A one-week instructional period was provided to familiarize participants with the exercise program and dietary regimen. Baseline assessments included anthropometric measures, aerobic capacity, muscular strength, and blood biomarkers. To control for menstrual-cycle phase, blood sampling was performed during the follicular and luteal phases. Participants were matched according to body-fat percentage and then randomly allocated to either the concurrent-training group or the concurrent-training plus tart cherry juice supplementation group.

The exercise intervention consisted of six weeks of concurrent training, performed three times per week in 90-minute sessions. Participants in the supplementation group additionally consumed 240 mL of tart cherry juice each day, between breakfast and lunch (27) (Table 1). Final assessments were conducted 48 hours after the last exercise session.

2.1. Exercise Training Protocol

Before the main intervention, participants completed one week of familiarization training consisting of resistance exercise at 50-55% of one-repetition maximum (1RM) (Table 2) and 15 minutes of aerobic exercise at a similar relative intensity (Table 3). The six-week concurrent training protocol was then initiated. Resistance training consisted of two circuit routines, each including 10 different exercises, and was performed in the University of Tabriz fitness facility. The program included both upper- and lower-body exercises using free weights and resistance machines. Aerobic exercise was performed after the resistance component at 55-70% of heart-rate reserve and consisted of continuous running on an athletics track. Exercise cadence and distance covered were recorded during each session to monitor training intensity.

2.2. Measurement of Study Variables

At the beginning and end of the study, 5 mL of venous blood was collected from all participants after an overnight fast, within a standardized time window from 8:00 to 10:00 a.m. After centrifugation, serum was separated and stored at -80°C. Total antioxidant capacity (TAC) and malondialdehyde (MDA) were measured using dedicated assay kits in accordance with the manufacturers' instructions and by enzyme-linked immunosorbent assay (ELISA). Blood ALT and AST concentrations were measured using standard laboratory chemistry methods.

2.3. Statistical Analysis

Data normality was first assessed and confirmed using the Shapiro-Wilk test. The assumptions of analysis of covariance, including linearity, homogeneity of

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variances, and homogeneity of regression slopes, were then examined and confirmed. ANCOVA was used to assess between-group differences, and paired-samples t tests were used to evaluate within-group changes. All statistical analyses were performed using SPSS version 26, with statistical significance set at $p \leq 0.05$.

3. Results

Participant characteristics are presented in Table 4. ANCOVA showed no statistically significant differences between the two groups for AST [F(1,21) = 0.188, P = 0.669], ALT [F(1,21) = 0.363, P = 0.553], TAC [F(1,21) = 2.436, P = 0.134], or MDA [F(1,21) = 0.004, P = 0.950].

Table 1. Nutrient and phenolic composition of tart cherry juice (per 240 mL).

Component	Amount per 240 mL
Energy	140 kcal
Total carbohydrate	34 g
Protein	1 g
Sodium	25 mg
Potassium	360 mg
Total phenolics	1,070 mg
Total anthocyanins	88 mg

Table 2. Resistance-training protocol.

Week	Circuit*	Intensity (%1RM)	Repetitions	Circuits / sets	Rest between exercises (min)	Rest between circuits (min)	Sessions / week
1	1	50-55	12	1	1.5	2	3
2	1	55-60	12	2	1.5	2	3
3	1	55-60	12	2	1.5	2	3
4	1	60-65	12	2	1.5	2	3
5	2	60-65	12	2	1.5	2	3
6	2	65-70	12	2	1.5	2	3
7	2	65-70	12	2	1.5	2	3

* One circuit denotes one complete round of the circuit-training sequence.

Table 3. Aerobic-training program.

Week	Exercise duration (min)	Heart-rate reserve (%)
1	15	50-55
2	20	55-60
3	25	55-60
4	25	60-65
5	30	60-65
6	30	65-70
7	35	65-70

Table 4. Demographic characteristics of the participants.

Variable	Concurrent training (n=12)	Training + supplement (n=12)
Age (years)	25.08 ± 5.70	24.25 ± 3.84
Height (cm)	166.67 ± 4.91	165.42 ± 5.95
Weight (kg)	85.97 ± 13.02	84.10 ± 12.95
BMI (kg/m²)	30.57 ± 3.20	30.58 ± 3.72

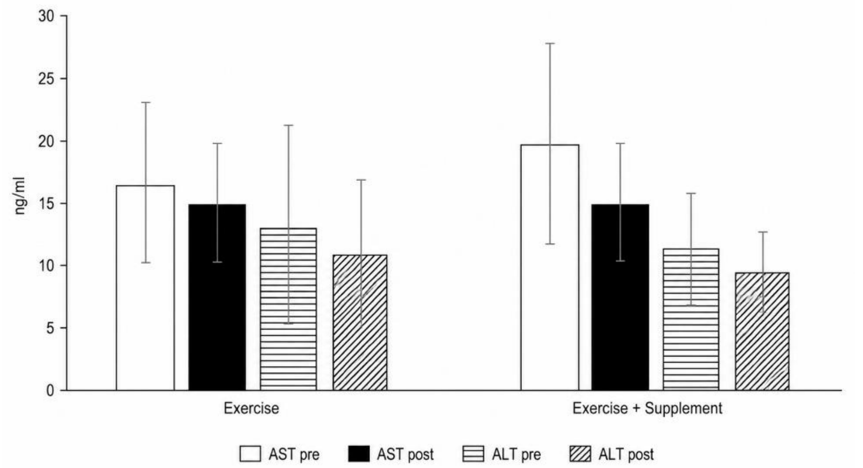

Figure 1. Changes in AST and ALT values in the study groups. No statistically significant difference was observed between the two groups (P > 0.05).

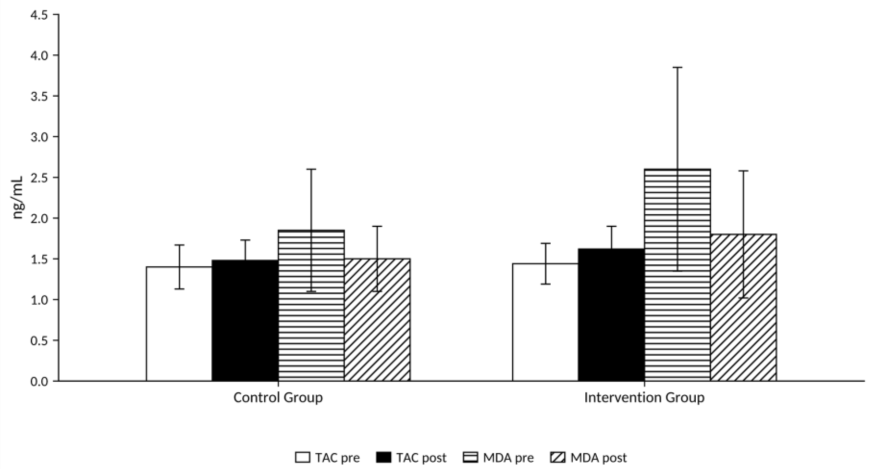

Figure 2. Changes in MDA and TAC values in the study groups. No statistically significant difference was observed between the two groups (P > 0.05).

4. Discussion

The findings of the present study showed that, after six weeks of tart cherry juice consumption combined with concurrent training, no statistically significant differences were observed in AST, ALT, TAC, or MDA. Nevertheless, combined nutritional and exercise interventions have produced promising improvements in health-related biomarkers among populations with overweight and obesity.

Although research specifically examining the combined effects of tart cherry juice and exercise on AST concentrations in women with overweight is limited, available studies of related interventions indicate potential benefits. Tart cherry juice contains several bioactive compounds, including anthocyanins, flavonoids, and other polyphenols, all of which possess antioxidant and anti-inflammatory properties. These compounds may help reduce oxidative stress and inflammation, both of which are commonly elevated in individuals with overweight and obesity. The anti-inflammatory effects of tart cherry juice have also been demonstrated in studies of exercise-induced muscle damage (EIMD), with reports of improved muscle function and reductions in inflammatory markers (36).

Dehghani et al. (2025) reported that tart cherry juice supplementation significantly reduced inflammatory biomarkers such as interleukin-6 (IL-6) and interleukin-8 (IL-8). Their review reported weighted mean differences of -0.4 pg/mL for IL-6 and -0.3 pg/mL for IL-8 compared with placebo conditions (36). These anti-inflammatory effects may potentially extend to hepatic tissue and thereby influence liver enzymes such as AST, although direct evidence for this specific relationship remains limited. In the present study, AST and ALT declined relative to pretest values, but these changes were not statistically significant.

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One possible explanation for the lack of statistical significance may be that the supplement dose was insufficient. The appropriate dose of tart cherry products may vary according to the method of preparation. Previous studies have used tart cherry concentrate, fresh-frozen tart cherry juice, tart cherry concentrate gel, and tart cherry powder, with differing results (37). Dose-response studies are currently lacking, which makes it difficult to determine the optimal amount for each specific preparation. This issue is particularly important when designing interventions that combine tart cherry juice with structured exercise protocols.

Concurrent exercise programs that include both aerobic and resistance components have demonstrated beneficial effects on a range of health outcomes in populations with overweight and obesity. One study examining hypoxic and normoxic exercise in women with overweight employed a six-week intervention consisting of 30 minutes of strength training and 30 minutes of endurance training performed three times per week (38). Such a combined approach simultaneously targets multiple physiological systems and may provide broader health benefits than a single exercise modality. Liver enzymes, including ALT and AST, are important biomarkers of hepatic health and function. In individuals with NAFLD, which is common among populations with overweight and obesity, these enzymes are frequently elevated. Exercise interventions may normalize liver enzyme levels through several mechanisms, including reductions in hepatic fat, improved insulin sensitivity, and decreased inflammation.

Another finding of the present study was that tart cherry juice combined with concurrent training did not significantly affect TAC or MDA. Recent research has emphasized the importance of reducing oxidative stress and enhancing antioxidant capacity in individuals with overweight and obesity. Although many studies have examined separate interventions for improving these biomarkers, the combined use of tart cherry juice and exercise represents a promising but comparatively underexplored strategy. The present study specifically examined the potential effects of a six-week intervention combining tart cherry juice consumption with concurrent training on MDA and TAC in women with overweight and obesity.

Obesity is associated with chronic low-grade inflammation and increased oxidative stress. Women with overweight often exhibit higher concentrations of oxidative stress markers, including MDA, and lower antioxidant defenses than individuals with normal body weight. This imbalance contributes to the development and progression of obesity-related complications such as insulin resistance, cardiovascular disease, and other inflammatory conditions. Research indicates that cherry consumption may significantly reduce oxidative stress markers. A comprehensive review reported reductions in oxidative stress markers in eight of ten studies examined (23). Proposed mechanisms include direct antioxidant activity and modulation of inflammatory pathways involved in oxidative injury.

Tart cherry juice has also been shown to reduce inflammatory biomarkers such as C-reactive protein (CRP), an observation of particular relevance because inflammation and oxidative stress are closely interrelated processes (39,40). In a study of older adults, 12 weeks of tart cherry juice consumption reduced plasma CRP by approximately 25% and decreased markers of oxidative damage, including oxidized low-density lipoprotein (OxLDL) by 11% and MDA by 3% relative to baseline values (40).

Exercise exerts complex effects on oxidative stress markers. A single bout of intense exercise may transiently increase oxidative stress, whereas regular moderate-intensity exercise generally improves antioxidant defenses over time. Exercise type, intensity, and duration all influence these responses. In a study of women with diabetic dyslipidemia, eight weeks of concurrent aerobic and resistance training produced significant improvements in MDA and TAC (41). This suggests that similar exercise protocols may be beneficial for women with overweight and obesity without diabetes, although the magnitude of the response may differ.

5. Conclusion

Overall, the findings of the present study indicate that six weeks of tart cherry juice supplementation combined with concurrent training produced changes in inflammatory and oxidative stress indices (AST, ALT, TAC, and MDA), but these changes were not statistically significant. This may indicate that the potential synergistic effects of the combined intervention on inflammatory responses and oxidative stress depend on factors such as supplement dose, intervention duration, and participants' baseline characteristics. Given the recognized anti-inflammatory and antioxidant properties of tart cherry juice, more pronounced effects might be observed under different conditions or with higher doses.

The main limitations of the study include the relatively small sample size, the short duration of the intervention, and the use of a single supplement dose. Future studies should therefore specifically investigate the combined effects of tart cherry juice consumption and exercise training on liver enzymes in women with overweight and obesity. Dose-response relationships across different tart cherry preparations should also be evaluated, together with comparisons of the most effective exercise modality (aerobic, resistance, or concurrent training) and the optimal intervention duration. Such studies may help address the current limitations and provide a more precise understanding of the effectiveness of these interventions.

6. Highlights

The present study showed that six weeks of tart cherry juice consumption combined with concurrent training induced changes in inflammatory and oxidative stress indices, although these changes were not statistically significant. The effectiveness of this combined strategy appears to depend on factors such as dose, intervention duration, and baseline participant characteristics. Future studies should examine different doses, longer intervention periods, and specific populations such as women with obesity to provide more definitive evidence regarding the effects of this intervention.

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Conflicts of Interest

The authors declare no conflict of interest related to the publication of this article.

Authors' Contributions

All authors had equal contributions to the present study.

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