CENTENARY OF THE OIV
45th WORLD CONGRESS OF VINE AND WINE
14-18 OCTOBER 2024 FRANCE-DIJON

Available on IVES Conference Series vine & wine

DOI : https://doi.org/10.58233/tyP3YpaK

White grape juice consumption reduce muscle damage parameters in combat athletes

Caroline Dani[1,2], Samanta Dias Machado[3] and Ana Lúcia Hoeffel[3]

[1] Programa de Pós-Graduação em Farmacologia e Terapêutica da UFRGS
[2] Associação Brasileira de Sommeliers do Rio Grande do Sul
[3] Centro Universitário da Serra Gaúcha

Abstract. ***Introduction and objective***: The practice of physical exercises in an exhaustive way is related to damage. Muay Thai (MT) is a high-intensity sport that demands agility, strength and power, which can lead to fatigue and muscle damage. Grape juice is rich in carbohydrates and antioxidants, which can delay the onset of fatigue and muscle damage. The objective of the study was to evaluate the impact of white grape juice consumption, during 14 days, on muscle damage parameters in TM athletes. ***Materials and methods*****:** Clinical study with white grape juice for 14 days as an intervention. Food consumption, anthropometry, basal caloric expenditure and activities (MET) and the enzymes Creatine Kinase Fraction MB - CKMB, Lactate Dehydrogenase - LDH, Oxalacetic Transaminase - GOT and Creatine Phosphokinase - CPK were measured in 3 moments after a week of training, after weekly rest before the intervention with grape juice (baseline) and after the intervention (post-juice). ***Results*****:** With regard to enzymes, the consumption of juice had effects on enzymes, with regard to CKMB and LDH, where both enzymes had a plasmatic reduction in the week after ingestion of grape juice (CKMB $p < 0.04$ and LDH $p=0.01$). In GOT and CPK, the white grape juice returned the levels of this enzymes at the same of the basal level levels. ***Conclusion*****:** White grape juice was able to positively affect enzyme levels in Muay Thai athletes.

1. Introduction

Combat sports are characterized by different levels of contact and positions during the fight, and can occur standing as in boxing, karate, taekwondo and Muay Thai [1,3], on the ground (for example, Brazilian jiu-jitsu), or even in mixed positions (judo, jiu-jitsu, mixed martial arts - MMA) [4,5]. The structure of each fighting style requires specific physical preparation [6]. In combat sports, career and sports training depend on comprehensive motor fitness, including muscle strength, endurance, and speed, which results primarily from an above-average level of development of coordination and flexibility skills and from strength-speed and strength-endurance interactions that affect performance, comprehensive physical and mental development of athletes [2,5,7]. In recent years, several authors representing various research centers have focused on investigating motor skills in combat sports such as kickboxing [1,3,7-10], jiu-jitsu [7,11-13], karate [14-17], Olympic taekwondo [18,19], judo [20] and wrestling [21]. Researchers are increasingly trying to identify physiological demands and reactions during the fight [22,23], and the biomechanics of movement [24,25].

The physiological and biochemical demands of this sport are extremely significant, requiring fighters to develop speed and muscle strength, as well as high aerobic capacity [22]. The main physical valences attributed to Muay Thai are agility, strength and flexibility that are necessary for the precision of their blows. [26].

The practice of Muay Thai has been spreading more and more and especially among young people, it has also been shown that the commitment to the fighting modalities has been associated with benefits such as: the increase in aerobic capacity [27].

Grapes (*Vitis vinifera*) are one of the most consumed fruits worldwide, either *in natura* or in processed form, such as juice or wine [28]. Grape juice is the unfermented and undiluted beverage obtained from the edible part of the grape. It is a rich source of polyphenols (such as flavonoids and anthocyanins) and non-flavonoids (phenolic acids and resveratrol) [29].

Currently, most studies have been carried out with dark-colored grapes (purple) and whose results point to health benefits [30]. These cardiometabolic benefits of purple grapes have been expanded to the sports context. In animal models, grape products promoted improved physical performance [31,32], antioxidant protection, anti-inflammatory protection [32] and ergogenic effect [34].

Studies evaluating the effect of white grape juice on health are rare [35-37] and practically non-existent in the context of sports nutrition.

Thus, the objective of the present study was to evaluate the impact of white grape juice consumption for 14 days on muscle damage parameters in TM athletes from a team in the city of Caxias do Sul

2. Methodology

This is an open clinical study, in which white grape juice was used as an intervention. This project was approved by the Research Ethics Committee (CEP) of IPA Centro Universitário de Porto Alegre under opinion number 5.779.341. The sample size calculation was based on the study with grape juice, where the outcome variable was plasma antioxidant capacity in individuals who consumed whole grape juice rich in polyphenols [38]. Considering the results of the study, together with an error of 0.05 and a power of 0.9, the value obtained was 13 subjects. The sample was selected by convenience, and athletes from a TM team in the city of Caxias do Sul, Rio Grande do Sul State, Brazil, were recruited. After approval of the project by the ethics committee, all athletes on the team, whose ages ranged from 20 to 35 years old, were invited to participate in the study. Those who agreed to participate in the study signed the ICF and then the evaluations (anthropometry and feeding) were made in the training den.

The study included fighters of both sexes, aged between 20 and 35 years and who had been practicing fighting for at least 1 year, with daily training routines. The exclusion criteria were: injured athletes who had been absent from training in the last six months, who were using anti-inflammatory or anabolic drugs, and those who had an aversion or allergy to the components of grape juice.

To carry out the research, a standardized questionnaire was used with sociodemographic, lifestyle and injury frequency questions [39]. Weight, height, and perimeter data were evaluated at a specific location, within the training site in a separate room. Anthropometric data were evaluated only before the beginning of juice consumption.

The samples for biochemical evaluation were collected and evaluated in a third-party laboratory (-FSG). The collections took place in 3 moments: Friday, after a week of training; the Monday following the Friday for post-rest evaluation and on a Monday after the consumption of white grape juice for 14 days.

After Monday's collection, the athletes received grape juice and were instructed to consume 400 mL of white grape juice (morning and evening).

Regarding the study variables, age was collected continuously and was later categorized by the value of the quartiles, 18 to 29 years, 30 to 39 years, and ≥ 40 years.

Self-reported skin color was collected by the participants' reports and, due to the small proportions identified of black and brown skin color, the variable was categorized as white and black/brown.

Regarding marital status, due to the small proportion of members in the variable 'divorced' and the absence of members in the variable 'widowed', the variables were classified as "single/divorced" and "married".

The participants' food intake was assessed using three 24-hour recalls, two on weekdays and one on weekends [40,41]. The multiple-pass method was used to collect the food recall. The first step was to list the foods consumed in the last 24 hours, a quick listing without interruption from the interviewer. The second step consisted of reviewing this quick list, allowing the interviewee to remember some more food. In the third step, the interviewee was instructed to remember the time of each meal, and then in the fourth step the information of the complete meal with details was collected. The fifth step was to review the recall aloud with the interviewee [42].

After the recall was applied, consumption data were converted from household measurements to mass or volume (grams or mL) using household measurement and food composition (TACO) tables, which were tabulated in Excel® to obtain the average intake for carbohydrates, proteins, fats, and caloric intake [43].

The Resting Metabolic Rate (RMR) was obtained by means of predictor formulas (Harris and Benedict ; Cunninghan) [44-47]. For expenditure on physical activities, the metabolic equivalent (MET) was used [48,49].

To assess body weight, the individuals were instructed to be barefoot and wear light clothing. A digital scale with a capacity of 200 kg and accuracy of 50 g (G-Tech Glass®) was used. Height was measured with the individuals in an upright, upright position, with the feet parallel and the head positioned in the Frankfurt plane. A pocket stadiometer of up to three meters and a precision of 0.5 cm (Cescorf®) was used [50]

Skinfolds (triceps, bicipal, subscapular, suprailiac, abdominal, thigh, and calf) were measured with a Cescorf® scientific plicometer (capacity of 85 mm and accuracy of 0.1 mm) in accordance with the standardization recommendations made by the International Society for the Advancement of Kineanthropometry (ISAK) [50]. Three measurements from each site were taken and the average of the skinfold measurements at each site was used for analysis. The protocol for accurate localization and measurement of skinfolds was carefully followed, according to the standardized procedures and guidelines described by *Lohman* [51]. Body fat percentage and fat-free mass were determined according to the *Durnin* and *Rahaman* equations for calculating body density (CO= 1.1533– 0.0643 × logarithm of the sum of triceps, biceps, subscapular, and suprailiac skinfolds) [52], with subsequent calculation of body fat percentage (BF = 4.95 / DC - 4.5) × 100 [53]. Fat mass and fat-free mass were then calculated and expressed in kilograms for subsequent calculation of the Fat Mass Index (FMI) (kg m2) and the Fat-Free Mass Index (kg) (kg m2), according to formulas defined in the literature [54,55].

The biochemical variables (Creatine Cinase MB Fraction - CKMB, Lactate dehydrogenase - LDH, Oxaloacetic Transaminase - AST and Creatine Phosphokinase - CPK) were measured at 3 moments: Friday after one week of training, after the weekly rest (Monday) before the intervention with grape juice (basal) and Monday after the intervention (post-juice).

Data entry was performed using Microsoft Excel® and, subsequently, the data were transferred and analyses were performed using the *Statistical Package for the Social Sciences®* (SPSS), version 25.0. For all analyses, a 95% confidence interval was considered (p≤0.05).

The normality of the data was evaluated using the *Kolmogorov-Smirnov* and *Shapiro-Wilk tests* [56]

The data were described as categorical or numerical variables, described as absolute (n) and relative (n%) frequency (categorical) or as mean (M) and standard deviation (SD) (numerical variables).

The crude analysis of the biochemical data was performed using the one-way ANOVA test. The analysis sought to verify whether there was a difference in plasma levels of enzymes between the times (baseline, after week of training and after ingestion of white grape juice for 14 days). The Repeated Measures Analysis of Variance (ANOVA-MR) was performed with the objective of evaluating the levels of enzymes at the 3 moments, baseline, post-week of training and post-intervention with white grape juice in the blood of Muay Thai athletes.

3. Results

The mean age was 27.1 (± 5.95) years. Most of the sample (80%) was made up of men who self-declared themselves white and single (60%). Half of the athletes have completed high school, 100% of the sample works, and 50% work 7 to 8 hours a day. Regarding sleep, 80% of the sample reported sleeping between 6 and 8 hours per night. The average income of the athletes was 3150 (±3887.0). Regarding training time, 60% of the fighters have been practicing for less than 10 years, as well as the same percentage (60%) train five days or more a week, with a weekly workload of between 7 and 13 hours (80%), the same percentage that reported being professional. Regarding injuries, 70% of the sample reported having suffered some injury in the last few months. Finally, 60% of the athletes reported using supplements at some point.

The mean caloric intake of the group was 2050.00 kcal (±580.00). While the average GEBs estimated by the formulas were: Cunninghan 1940.8 (±158.3) kcal and Harris and Benedict 1697.2 (±152.2) kcal. The average expenditure on activities, calculated from the METs, was 1098 (±461.4) kcal, thus obtaining the following GETs: Cunninghan 3038.8 kcal, Harris and Benedict 2795.2 (Table 2). The mean fat percentage was 10.62 (±3.52), with 7.68 (± 2.42) kg of fat mass, 65.1 (± 6.56) kg of fat-free mass. The Fat Mass Index was 2.61 (± 0.89) kg/m2. and the Fat-Free Mass Index 21.91 (± 1.41) kg/m2. (Table 1).

Table 1. Description of Basal Metabolic Rate, Resting Metabolic Rate, Expenditure on Planned Physical Activities and Caloric Intake values by Muay Thai Athletes.

Variable	Mean ± Standard Deviation
Energy (Kcal)	2050.0 ±580
Carbohydrates (g)	267.33 ±85.13
Protein (g)	142.95 ±49.62
Lipid (g)	48.42 ±15.94
% GC	10.62 ±3.52
MG (kg)	7.68 ±2.42
Cunninghan (kcal)	1940.8±158.30
Harris e Benedict (kcal)	1697.2 ±152.2
Average week scheduled PA expenditure (kcal)	1098.0±461.40

The average number of training days was 5.3 days (±1.1) and the average number of training hours was 1h40minutes (±30min) (data not shown)

In the ANOVA-MR analysis, the results are shown in figures 1, 2, 3 and 4. Regarding CKMB levels, Mauchly's sphericity test accepted the assumption of sphericity (Mauchly's W = 0.858; c2 (2) = 1.223, p = 0.543). The overall ANOVA-MDR result showed that there were significant differences in CKMB levels over time (F(2, 18) = 4.517, p < 0.026; $h2$ = 0.334). A posteriori analyses (Bonferroni's *post-hoc*) showed that there was no significant increase in the levels of the enzyme after the week of training (M = 2.46; SD = 1.24), compared with baseline (M = 1.93; SD = 1.24; p = 0.707). In addition, the results showed that the scores of the 3rd collection, after ingestion of white grape juice for 14 days (M = 1.37; SD = 0.63) were lower than the results of the post-training week measurement (p < 0.042), and slightly lower than the baseline results, although not significant (p = 0.288). Figure 1 presents the results mentioned.

Regarding LDH levels, Mauchly's sphericity test accepted the assumption of sphericity (Mauchly's W = 0.627; c2 (2) = 3.730, p = 0.155). The overall ANOVA-MDR result showed that there were significant differences in LDH levels over time (F (2, 18) = 9.677, p < 0.001; $h2$ = 0.518).

A posteriori analyses (Bonferroni's *post-hoc*) showed that there was no significant increase in the levels of the enzyme after the week of training (M = 466.4; SD = 86.12; p = 0.093), compared with baseline (M = 405.1; SD = 59.14). In addition, the results showed that the scores of the 3rd collection, after ingestion of white grape juice for

14 days (M = 380.1; SD = 46.11) were lower than the results of the post-training week measurement ($p < 0.01$), and lower than the baseline results, although not significant ($p = 0.09$). Figure 2 presents the results mentioned. Regarding AST levels, Mauchly's sphericity test accepted the assumption of sphericity (Mauchly's W = 0.800; c2 (2) = 1.780, $p = 0.411$). The overall ANOVA-MDR result showed that there were significant differences in AST levels over time (F (2, 18) = 164.233, $p < 0.015$; *h2* = 0.372).

A posteriori analyses (Bonferroni's *post-hoc*) showed that there was a significant increase in the levels of the enzyme after the week of training (M = 31.8; SD = 8.9), compared with baseline (M = 24.5; SD = 4.9; $p = 0.039$). In addition, the results showed that the scores of the 3rd collection, after ingestion of white grape juice for 14 days (M = 25.1; SD = 4.8) did not present differences in the results of the post-week training measurement ($p < 0.151$) or in the results from baseline ($p = 1.00$).

Regarding CPK levels, Mauchly's sphericity test did not meet the sphericity assumption (Mauchly's W = 0.153; c2 (2) = 15.009, $p = 0.001$). The overall ANOVA-MR result demonstrated that there were statistically significant differences in CPK levels over time (F (2, 18) = 8.085, $p < 0.003$; *h2* = 0.473).

A posteriori analyses (Bonferroni's *post-hoc*) showed that there was an increase, but not significant, in the levels of the enzyme after the week of training (M = 442.3; SD = 270.5), compared with baseline (M = 219.1; SD = 98.22; p = 0.062). Also the results of the scores of the 3rd collection, after ingestion of white grape juice for 14 days (M = 187.4; SD = 71.8) did not show differences in the results of the post-training week measurement ($p < 0.05$) or in the results from baseline (p = 487.00). Figure 4 presents the results mentioned.

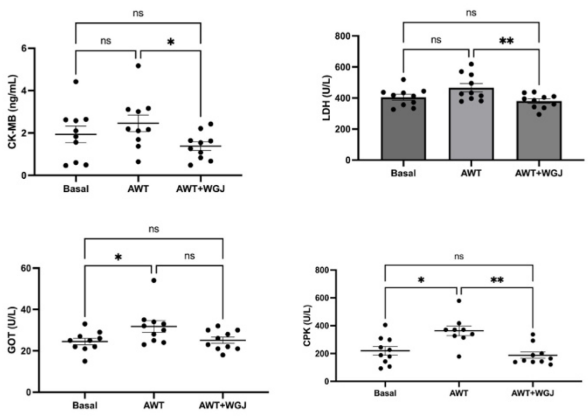

Figure 1. CK-MB, LDH, GOT and CPK levels in different timesxgroups, at basal, AWT (after week training) AWT+WGJ (after week training with white grape juice.

4. Discussion

This study aimed to evaluate the impact of white grape juice consumption for 14 days on muscle damage parameters in MT athletes from a team in the city of Caxias do Sul. The majority (80%) of the participants were in the age group between 20 and 29 years (mean 27.1 ± 5.95 years) and were male. It seems that, in this sport, men tend to be the majority, as also pointed out in other studies, in Sobieraj et al., [57] 77% of the sample was composed of men and whose mean age was 26.9 (± 8.1 years), a slightly higher average than that found in the studies by Baron [58] and Bassan et al., [59] where 6 and 10 athletes were evaluated and they had an average age of 25.5 and 25.8 years, respectively. Regarding ethnicity, 60% self-declared white, the same percentage whose marital status was 'married'. Unlike what was found by Machado and Medeiros [60], where 60% of the sample of MT fighters evaluated was single. Athletes especially those more involved in sports or professionals face many challenges that can cause stress in their lives e careers including individual results and romantic relationships [61]. In addition, most had completed high school, 100% of the sample reported working and 50% had a workload of 7-8 hours a day, with an average income between 1 and 3 minimum wages (60%). Regarding sleep, 80% of the sample reported sleeping between 6 and 8 hours a day. In the study by Tobaja et al., [62] the majority of 53.3% of the participants only studied and 73.3% had between 5 and 7 hours of sleep per day. There is a positive association between sleep and sports performance, especially with regard to specific skills such as strength and anaerobic power [63]. Sleep is a basic requirement for health and recovery and is related to homeostatic processes that replenish the main physiological and psychological functions of the human body [64]. There is controversy surrounding how much sleep an athlete needs per night, with recent studies by the *National Sleep Foundation* suggesting that healthy adults should get between 7 and 9 hours of sleep per night to perform daytime functions. Athletes are expected to get approximately 8 hours of sleep per night to prevent the neurobehavioral deficits associated with sleep loss [65].

Regarding the time of practice of the sport, 60% had been practicing it for less than 10 years, an average of 11.5 (± 7.7) years. This time is longer than that found in the studies by otherss (6.33 years) [58] and (5 years) [59], but similar to that found in the study by Sobieraj et al., [57] (11.08 years). Also, with regard to the training profile, 60% train more than 5 days a week, 80% reported being in the professional category, the same percentage that trains an average of 7 to 13 hours a week (average 9.3 ± 3.6 hours). This average is higher than that found by Sobieraj et al., [57] who found 7.58 hours of training per week in athletes who participated in competitions. Regarding the prevalence of lesions, these were reported by 70% of the sample. This prevalence is lower than that found in anothers studies, whose prevalence of lesions in MT was 87% [57]. and 88.2% [66]. In addition, 60% of the sample reported using supplements, these values are higher than those found in another study [62] where 26.7% of the athletes evaluated used some nutritional supplement. Cannataro et al., [67] making a critical review of the use of supplements by combat athletes, concluded that the prevalence of supplement use is high, however, often without a precise justification and that, specifically on this subject, the literature is still scarce and few supplements have a scientific basis for use in combat sports, namely, creatine, caffeine, bicarbonate and b-alanine).

Regarding the body composition of the athletes, the mean BF percentage was 10.62% (±3.52) corroborating corroborating other studies with athletes de MT, one of the studies, where evaluated seven athletes in pre-competition and whose average body fat percentage was 10.99% (±5.29) [69] and other in where evaluated 9 male athletes and finding a body fat percentage of 12% [69]. Another study carried out with professional MT athletes in Brazil [59], the average fat percentage was 7.5%. According to the *American College of Sports and Medicine*, the ideal BF for athletes is between 8% and 12% percent [70]. In order for athletes to obtain ideal BF% as well as better physical performance, it is important to maintain good eating habits, since athletes with lower levels of body fat remain less fatigued, this is especially important for fighting athletes [12].

The results of the present study indicate that the athletes evaluated, with a worse condition for men, have an energy consumption lower than the ideal needs to sustain the training load normally imposed on fighting athletes, which, in a longer term, can lead to Relative Energy Deficiency (RED) [71,72]. Through a review of the Brazilian literature, few studies were found whose objective was to evaluate the energy intake of MT fighters or fights in general. Cabral et al., [73] evaluating the nutritional status and adequacy of energy intake of weightlifting athletes, found that 83% of the athletes had energy intake below the recommended values, considering the high level of physical activity, promoting daily caloric deficiency. For men, the %NET was 81.2% and for women, 76.5%, although below the ideal, were higher than those found in the present study. In the present study, the athletes were not monitored by a nutritionist (data not shown). Scientific literature on athletic performance in fighters has emerged since 2010, but researchers examining mainly athlete profiling, time–motion analysis, weight-cutting strategies and psychological factors [74], but not in nutrition facts, carbohydrates, proteins and fats, specifically. The most published reviews on fight has focused on approaches such as muscle injuries [75] and physical and training characteristics [76]. Regarding the percentages of macronutrients ingested by the athletes, in the present study 52% were found for carbohydrates, 27% for proteins and 21% for lipids. This distribution is similar to what was found by Torres et al. [77] whose study was with mixed martial arts (MMA) fighters, where the average intake remained at 53% for carbohydrates, 23% for proteins and 23% for lipids, suggesting that, even in different modalities, but still in the field of combat, the amount of macronutrient intake of athletes is similar.

Furthermore, the study carried out by Tobaja et al., [62] where the food consumption of 15 male MT athletes was evaluated, whose methodology was through a 24-hour recall, the authors found a percentage of carbohydrate consumption of 51% and 23% of proteins, the authors did not calculate the percentage value for lipids. In addition, Rossi et al., [78], who evaluated the food consumption of 20 male MT practitioners, through a 3-day food record, found a consumption of 27% of lipids, 52% of carbohydrates, exactly the same value as in the present study. Regarding protein intake, the authors evaluated only in grams per kg of weight (2.3g/kg) values higher than those found in this study (1.38 and 1.33 g/kg/weight for men and women, respectively).

The practice of exercise induces several cellular changes and muscle damage, mainly generated by the production of reactive species and oxygen and free radicals. Many efforts have been made to identify compounds or nutritional strategies capable of preventing, or at least mitigating, exercise-induced muscle damage and improving athlete performance. [79,80]. In this sense, studies have focused on the incorporation of bioactive ingredients, mainly from medicinal plants, in food, nutraceutical, and pharmaceutical supplements [79-81]. Among them, phenolic compounds have been the target of several studies. They constitute the largest group of secondary plant metabolites, derived from phenylpropanoids [80]. Due to their chemical structure, they exhibit antioxidant, anti-inflammatory, antimutagenic and vasodilatory properties [82,83] properties that are interesting, both for performance and sports recovery [84-87]. Supplementation with phenolic compounds appears to be a promising approach [86,87]. White grapes are rich in phenolic compounds of the non-flavonoid group, mainly phenolic acids (gallic, syringic, vanillic and ellagic acids), also flavonoids (catechin, epicatechin, procyanidins and quercetin). All of these phenolic compounds have been reported to have cardioprotective, neuroprotective, anticancer, antioxidant, anti-inflammatory, and antimicrobial properties [88,89].

In a recent review, Gonçalves et al., [86] concluded that phenolic compounds exert important benefits on exercise-induced muscle damage, as well as play a biological/physiological role in improving physical performance.

Regarding muscle damage parameters, many studies, both review and clinical, have evaluated the behavior of muscle damage marker enzymes (Creatine Kinase MB Fraction - CKMB, Lactate dehydrogenase - LDH, Oxaloacetic Transaminase - TGO and Creatine Phosphokinase - CPK) and their relationship with the consumption of certain foods rich in polyphenols [34, 84-86, 90,19], however, all have focused on purple-colored *grapes* and berries. However, in the study conducted by Dani et al., where the authors quantified the total levels of polyphenols, as well as anthocyanins and resveratrol, evaluating their antioxidant activity, in white and red grape juices, and concluded that although purple juices have a higher content of total polyphenols and antioxidant activity *in vitro* [35] compared to white juices, both juices showed excellent activity and can be used as antioxidants.

A study carried out by Gonçalves et al. [92] where ten adult male triathletes were evaluated with the ingestion of organic purple grape juice (300ml/day), in a period of twenty days, the authors observed positive effects on antioxidant capacity and microvascular function in endurance athletes. Similar work was conducted by Lima et al., [93] examining the effects of an anthocyanin-rich antioxidant juice applied to thirty young people divided into two groups where one consumed the juice and the other group consumed placebo for nine days (240 ml twice a day) where both groups ran downhill for 30 minutes. The authors concluded that the consumption of antioxidant juice benefits the recovery of muscle function and pain, also leading to attenuation of serum CK concentration after an exercise session. However, no study has been found, so far, evaluating the behavior of these enzymes in MT and, mainly, using white grape juice as an intervention. Martins et al., [94] conducted a randomized, *crossover*, double-blind placebo-controlled clinical trial using purple grape juice with male volleyball athletes**,** where athletes ingested 400 milliliters of juice or placebo (malto dextrin) per day for 14 days. The authors found a significant reduction in oxidative stress parameters with grape juice consumption.

Still within this context, Elejalde et al., [90] bring us that supplementation with grape polyphenols seems to have a positive effect against oxidative stress and, consequently, on induced muscle damage. These effects depend on the dose of the supplement, the length of the supplementation period, or the polyphenolic profile (total polyphenol content and distribution among polyphenolic families).

Toscano et al., [34] in a recent study evaluating the acute effect of a single dose of grape juice on parameters of oxidative stress, inflammation and muscle damage in recreational runners, in which fourteen male runners (39 ± 9 years old) participated, who performed two tests of running to exhaustion at 80% of VO2 max after ingestion of grape juice or a placebo drink. The authors collected blood samples before and immediately after the race, as well as 2 hours after supplementation. Total antioxidant capacity (CAT), creatine kinase (CK) and lactate dehydrogenase (LDH), among others, were analyzed. The results were promising, as the time to reach exhaustion was longer among those who consumed the juice (68.4 ± 29.7 *versus* 59.2 ± 27.8 minutes). And, this improvement in physical performance was accompanied by a 43.6% increase in post-exercise CAT compared to the baseline level. In addition, CK and LDH did not show alterations, that is, there was no increase in plasma enzymes. In the control group, none of these effects were observed. The authors concluded that the ingestion of a single dose of purple grape juice promoted an ergogenic effect in recreational runners, increasing the time from running to exhaustion and increasing antioxidant activity.

In the present study, we observed that white grape juice had an important protective role against muscle damage induced by *Muay Thai* training, however, discussions about its effect were hampered by the absence of studies using white juice as an intervention. Thus, we still have a great challenge regarding this theme, although many studies have been carried out with dark-colored *berries* and grapes, no study using white grape juice in athletes was found in the literature. In addition, in the literature, there are few studies with the participation of *Muay Thai* athletes, making it doubly impossible to make pertinent comparisons to this study. It is extremely important to carry out studies evaluating possible foods with the ability to mitigate muscle damage.

5. References

1. Ł. Rydzik, T. Ambroży. Int J Environ Res Public Health **18:6** (2021) https://doi.org/10.3390/ijerph18063088.

2. T. Ambroży, W. Wąsacz, A. Koteja, T. Żyłka, J. Stradomska, J. Piwowarski, L. Rydzik Journal of Kinesiology and Exercise Science **31:95** (2021) https://doi.org/10.5604/01.3001.0015.7582.

3. T. Vaseenon, P. Intharasompan, T. Wattanarojanapom, N. Theeraamphon, S. Auephanviriyakul, P. Phisitkul; J Med Assoc Thai **98:1** (2015)

4. T. Ambroży, K. Sterkowicz-Przybycień, S. Sterkowicz, A. Kędra, D. Mucha, M. Ozimek, D. Mucha. Journal of Kinesiology and Exercise Sciences **27:79** (2017) https://doi.org/10.5604/01.3001.0012.1430.

5. P.L. Bounty, B.I. Campbell, E. Galvan, M. Cooke, J. Antonio. Strength Cond J **33:1** (2011) https://doi.org/10.1519/SSC.0b013e3182044304.

6. M. Slimani, P. Davis, E. Franchini, W. Moalla J Strength Cond Res **31:10** (2017) https://doi.org/10.1519/JSC.0000000000002047.

7. W. Wąsacz, Ł. Rydzik, I. Ouergui, A. Koteja, D. Ambroży, T. Ambroży, P. Ruzbarsky, M. Rzepko. Int J Environ Res Public Health **19:14** (2022) https://doi.org/10.3390/ijerph19148451.

8. M. Slimani, H. Chaabene, B. Miarka, E. Franchini, K. Chamari, F. Cheour. Biol Sport **34:2** (2017) https://doi.org/10.5114/biolsport.2017.65338.

9. S. Gartland, M.H. Malik, M. Lovell A. Clinical Journal of Sport Medicine **15:1** (2005) https://doi.org/10.1097/00042752-200501000-00007.

10. T. Ambroży, Ł. Rydzik, Z. Obmiński, A.T. Klimek, N. Serafin, A. Litwiniuk, R. Czaja, W. Czarny. Int J Environ Res Public Health **18:8** (2021) https://doi.org/10.3390/ijerph18084342.

11. Detanico D., Dellagrana R.A., M.S. da Silva Athayde, R.L. Kons, Góes A. Sports Biomech. **16:1** (2016) https://doi.org/10.1080/14763141.2016.1206143.

12. L.V. Andreato, E. Franchini, S.M.F. de Moraes, J.V.D.C. Esteves, J.J. Pastório, T.V. Andreato, T.L.M. Gomes, J.L.L.Vieira. Rev Bras Med Esporte **18:1** (2012) https://doi.org/10.1590/S1517-86922012000100010.

13. C.A. Sá, G. Benneman, C. Silva, A. Ferreira. RBNE **9:53** (2015)

14. R. Beneke, T. Beyer, C. Jachner, J. Erasmus, M. Hütler. Eur J Appl Physiol **92:4-5** (2004) https://doi.org/10.1007/s00421-004-1073-x.

15. G.R. McLatchie. Injury **8:2** (1976) https://doi.org/10.1016/0020-1383(76)90049-8.
16. M.L. Schwartz, A.R. Hudson, G.R. Fernie, K. Hayashi, A.A. Coleclough. J Neurosurg **64:2** (1986) https://doi.org/10.3171/jns.1986.64.2.0248.
17. M.B. Sánchez-Puccini, R.E. Argothy-Bucheli, J.F. Meneses-Echávez, C.A. López-Albán, R. Ramírez-Vélez. Int J Morphol **32:3** (2014) https://doi.org/10.4067/S0717-95022014000300045.
18. A. Aloui, A. Tayech, M.A. Mejri, I. Makhlouf, C.C.T. Clark, U. Granacher, H. Zouhal, A.B. Abderrahman. Front Physiol **13** (2022) https://doi.org/10.3389/fphys.2022.774546.
19. Fong S.S.M., G.Y.F. Ng. Phys Ther Sport **12:2** (2011) https://doi.org/10.1016/j.ptsp.2010.07.001.
20. D. Detanico, J. Dal Pupo, E. Franchini, S.G. Dos Santos. J Strength Cond Res. **29:4** (2015) https://doi.org/10.1519/JSC.0000000000000746.
21. J. Nilsson, S. Csergo, L. Gullstrand, P. Tveit, P.E. Refsnes. J Sports Sci **20:11** (2002) https://doi.org/10.1080/026404102320761822.
22. A. Crisafulli, S. Vitelli, I. Cappai, R. Milia, F. Tocco, F. Melis, A. Concu. Appl Physiol, Nutr Metab **34:2** (2009) https://doi.org/10.1139/H09-002.
23. Ł. Rydzik, M. Mardyła, Z. Obmiński, M. Więcek, M. Maciejczyk, W. Czarny, J. Jaszczur-Nowicki, T. Ambrozy. Biology (Basel) **11:1** (2022) https://doi.org/10.3390/biology11010065.
24. R. Diniz, F.B. Del Vecchio, G.Z. Schaun, H.B. Oliveira, E.G. Portella, E.S. da Silva, A. Formalioni, P.C.C. Campelo, L.A. Peyré-Tartaruga, S.S. Pinto. J Strength Cond Res **35:1** (2021) https://doi.org/10.1519/JSC.0000000000002657.
25. C.J. Gavagan, M.G.L. Sayers. PLoS One **12:8** (2017) https://doi.org/10.1371/journal.pone.0182645.
26. P.F. da Silva, Martins A.C.S. EFDeportesCom, Revista Digital **160** (2011)
27. A.V. da Silva. TCC UNESC (2015) http://repositorio.unesc.net/handle/1/3095
28. A. Basli, S. Soulet, N. Chaher, J.M. Mérillon, M. Chibane, J.P. Monti, T. Richard. Oxid Med Cell Longev (2012) https://doi.org/10.1155/2012/805762.
29. S. Aditya, S.J. Ohh, M. Ahammed, J. Lohakare Anim Nutr **4:2** (2018) https://doi.org/10.1016/j.aninu.2018.01.004.
30. L.L.T. Toscano, A.S. Silva, A.C.L. de França, B.R.V. de Sousa, E.J.B. de Almeida Filho, M.S. Costa, A.T.B. Marques, D.F. da Silva, K.F. Sena, G.S. Cerqueira, M.C. R. Gonçalves. Eur J Nutr **59:7** (2020) https://doi.org/10.1007/s00394-019-02139-6.
31. Y. Minegishi, S. Haramizu, T. Hase, T. Murase. Eur J Appl Physiol 111:9 (2011) https://doi.org/10.1007/s00421-011-1826-2.
32. L. Xianchu, L. Ming, L. Xiangbin, Z. Lan. Food Nutr Res **62** (2018) https://doi.org/10.29219/fnr.v62.1421.
33. M. Belviranlı, H. Gökbel, N. Okudan, K. Başaralı Br J Nutr **108:2** (2012) https://doi.org/10.1017/S0007114511005496.
34. L.T. Toscano, R.L. Tavares, L.T. Toscano, C.S.O. da Silva, A.E.M. de Almeida, A.C.T. Biasoto, M.C.R. Gonçalves, A.S. Silva Appl Physiol Nutr Metab **40:9** (2015) https://doi.org/10.1139/apnm-2015-0152.
35. C. Dani, L.S. Oliboni, R. Vanderlinde, D. Bonatto, M. Salvador, J.A.P. Henriques. Food Chem Toxicol **45:12** (2007) https://doi.org/10.1016/j.fct.2007.06.022.
36. D.J. García-Martínez, M. Arroyo-Hernández, M. Posada-Ayala, C. Santos Foods **10:7** (2021) https://doi.org/10.3390/foods10071532.
37. D.D. Zhou, J. Li, R.G. Xiong, A. Saimaiti, S.Y. Huang, S.X. Wu, Z.J. Yang, A. Shang, C.N. Zhao, R.Y Gan, H.B. Li Foods **11:18** (2022) https://doi.org/10.3390/foods11182755.
38. D.J. O'Byrne, S. Devaraj, S.M. Grundy, I. Jialal. Am J Clin Nutr **76:6** (2002) https://doi.org/10.1093/ajcn/76.6.1367.
39. S. Gartland, M.H. Malik, M. Lovell. Clin J Sport Med **15:1** (2005) http://doi.org/ 10.1097/00042752-200501000-00007
40. B.L. Caswell, S.A. Talegawkar, B. Dyer, W. Siamusantu, R.D.W. Klemm, A.C. Palmer. Food Nutr Bull **36:4** (2015) https://doi.org/10.1177/0379572115612631.
41. Venturini C.D., Engroff P., Sgnaolin V., El Kik R.M., Morrone F.B., da Silva Filho I.G, G.A. de Carli. Cien Saude Colet **20:12** (2015) https://doi.org/10.1590/1413-812320152012.01432015.
42. J.M. Conway, L.A. Ingwersen, B.T. Vinyard, A.J. Moshfegh. Am J Clin Nutr **77:5** (2003) https://doi.org/10.1093/ajcn/77.5.1171.
43. NEPA - UNICAMP. Tabela Brasileira de Composição de Alimentos - TACO 4a Edição Revisada e Ampliada. 4a ed. Campinas: 2011.
44. C.C. Douglas, J.C. Lawrence, N.C. Bush, R.A. Oster, B.A. Gower, B.E. Darnell. Nutr Res **27:4** (2007) https://doi.org/10.1016/j.nutres.2007.01.016.

45. S.C. Luy, O.A. Dampil. J ASEAN Fed Endocr Soc **33:2** (2018) https://doi.org/10.15605/jafes.033.02.07.
46. J.A. Harris, F.G. Benedict. **4:12** (1918) https://doi.org/10.1073/pnas.4.12.370.
47. J.J. Cunningham. Am J Clin Nutr **33:11** (1980) https://doi.org/10.1093/ajcn/33.11.2372.
48. B.E. Ainsworth, W.L. Haskell, A.S. Leon, D.R.J. Jacobs, H.J. Montoye, J.F. Sallis, R.S. Paffenbarger. Med Sci Sports Exerc **25:1** (1993) https://doi.org/10.1249/00005768-199301000-00011.
49. B.E. Ainsworth, W.L. Haskell, S.D. Herrmann, N. Meckes, D.R. Bassett Jr, C. Tudor-Locke, J.L. Greer, J. Vezina, M.C. Whitt-Glover, A.A. Leon Med Sci Sports Exerc 43:8 (2011) https://doi.org/10.1249/MSS.0b013e31821ece12.
50. V.S. da Silva, M.F.S. Vieira. Rev Bras Cineantropom Desempenho Hum **22** (2020). https://doi.org/10.1590/1980-0037.2020v22e70517.
51. T.G. Lohman. Advances in body composition assessment. Illinois: Champaign, IL: Human Kinetics Publishers; 1992.
52. J.V. Durnin, M.M. Rahaman. Br J Nutr **21:3** (1967) https://doi.org/10.1079/bjn19670070.
53. W.E. Siri. Nutrition **9:5** (1993).
54. E.M. Kouri, H.G.J. Pope, D.L. Katz, P. Oliva. Clin J Sport Med **5:4** (1995) https://doi.org/10.1097/00042752-199510000-00003.
55. T.B. VanItallie, M.U. Yang, S.B. Heymsfield, R.C. Funk, R.A. Boileau. Am J Clin Nutr **52:6** (1990) https://doi.org/10.1093/ajcn/52.6.953.
56. Field A. Discovering Statistics Using IBM SPSS Statistics. 5a ed. London: SAGE; 2018.
57. T. Sobieraj, K. Kaczmarczyk, A. Wit. Biomed Hum Kinet **15** (2023) https://doi.org/10.2478/bhk-2023-0004.
58. B.C. Baron. Perfil Antropométrico de Lutadores de Muay Thai de florianópolis - SC. Monografia. Universidade Federal de Santa Catarina, 2016.
59. J.C. Bassan, M.R. Ribas, J.S. Filho, H. Zonatto, D.C. Ribeiro, F.R.S. de Almeida. Revista Uniandrade **15:3** (2014)
60. L.M.A. Machado, K.C.M. de Medeiros. RBNE 11:65 (2017)
61. S.D. Eggleston. Athletes in Love: A Grounded Theory of Collegiate Athletes Navigating Romantic Relationships and Sports. Tesis. Texas Tech University, 2020.
62. D.M. Tobaja, A.C. Sesso, K. Christofoletti, R.N. Ferraz.. Http://WwwUnimepBr/Phpg/Mostraacademica/Anais/5mostra/Backup/5/147Pdf 2007.
63. N.P. Walsh, S.L. Halson, C. Sargent, G.D. Roach G.D., M. Nédélec, L. Gupta, J. Leeder, H.H. fullagar, A.J. Coutts, B.J. Edwards, S.A. Pullinger, C.M. Robertson, J.G. burniston, M. Lastella, Y. Le Meur, C Hausswirth, A.M. Bender, M.A. Grandner, C.H. Samuels. Br J Sports Med 2020 (2021) https://doi.org/10.1136/bjsports-2020-102025.
64. M. Lastella, G.D. Roach, S.L. Halson, C. Sargent. Eur J Sport Sci **15:2** (2015) https://doi.org/10.1080/17461391.2014.932016.
65. C. Sargent, M. Lastella, S.L. Halson, G.D. Roach. Chronobiol Int **31:10** (2014) https://doi.org/10.3109/07420528.2014.957306.
66. A.L. F. Tavares, A.D. de Lima, B.B. Busatta, C.P. Goulart, J.R.G. da Costa da, M.J.S. da Silva, A.R. de Carvalho, J.A. Storch. CEFE **20** (2022) https://doi.org/10.36453/cefe.2022.25472.
67. R. Cannataro, N. Straface, E. Cione. Human Nutrition & Metabolism **29** (2022) https://doi.org/10.1016/j.hnm.2022.200155.
68. M.R. Ribas, T. Bini, D.I.R. Ribas, K.S. Urbinati, J.C. Bassan. Coleção Pesquisa Em Educação Física **7** (2008)
69. A.L. Mortatti, A.Cardoso, E.F. Puggina, R.S. Costa. Efeitos da simulação de combates de muay thai na composição corporal e em indicadores gerais de manifestação de força. Conexões **11** (2013) https://doi.org/10.20396/conex.v11i1.8637639.
70. T.G. Lohman, L.A. Milliken. ACSM's Body Composition Assessment. 2020.
71. M. Mountjoy, J. Sundgot-Borgen, L. Burke, S. Carter, N. Constantini, C. Lebrun, N. Meyer, R. Sherman, K. Steffen, R. Budgett, A. Ljungqvist, K. Ackerman Br J Sports Med **49:7** (2015) https://doi.org/10.1136/bjsports-2015-094873.
72. A. Sim, S.F. Burns. J Eat Disord **31:9** (2021) https://doi.org/10.1186/s40337-021-00396-7.
73. C.A.C. Cabral, G.P. Rosado, C.H.O. Silva, J.C.B. Marins. Rev Bras Med Esporte 12:6 (2006) https://doi.org/10.1590/S1517-86922006000600009
74. J.C.A. Bueno, H. Faro, S. Lenetsky, A.F. Gonçalves, S.B.C.D. Dias, A.L.B. Ribeiro, B.V.C. da Silva,m C.A.C Filho, B.M. de Vasconcelos, J.C. Serrão, A. Andrade, T.P.S Júnior. Sports **10:6** (2022) https://doi.org/10.3390/sports10060080.
75. R.E. Thomas, B.C. Bennett. **46:2** (2018) https://doi.org/10.1080/00913847.2018.1430451.

76. A. Andrade, M.A. Flores, L.V. Andreato, D.R. Coimbra. Strength Cond J **41:1** (2019). https://doi.org/10.1519/SSC.0000000000000410.

77. Torres AAL, de Oliveira FB. EFDeportesCom **18:188** (2014).

78. L. Rossi, L. G. de Oliveira, L.A.R.S. Borges, A.F. Malavazzi. Science of Martial Arts **7:2** (2011).

79. D.J. Newman, G.M. Cragg. J Nat Prod **83:3** (2020). https://doi.org/10.1021/acs.jnatprod.9b01285.

80. M.C. Tenuta, B. Deguin, M.R. Loizzo, A. Dugay, R. Acquaviva, G.A. Malfa, M. Bonsei, C. Bouzidi, R. Tundis. **22:9** (2020). https://doi.org/10.3390/antiox9020184.

81. A. Ferreira, M. Rodrigues, A. Fortuna, A. Falcão, G. Alves. Food Res Int **103** (2018) https://doi.org/10.1016/j.foodres.2017.10.010.

82. Z.A. Bakkar, J. Fulford, P.E. Gates, S.R. Jackman, A.M. Jones, B. Bond, J.L. Bowtell. Appl Physiol **126:1** (2019). https://doi.org/10.1152/japplphysiol.00804.2018.

83. F.J. Leyva-Jiménez, J. Lozano-Sánchez, M. de la L. Cádiz-Gurrea, D. Arráez-Román D., A. Segura-Carretero A. Nutrients **11:7** (2019) https://doi.org/10.3390/nu11071646.

84. J. Bowtell, V. Kelly. Sports Med **49:suppl 1** (2019). https://doi.org/10.1007/s40279-018-0998-x.

85. D.O. Kennedy. Sports Med **49:suppl 1** (2019). https://doi.org/10.1007/s40279-018-1007-0.

86. A.C. Gonçalves, D . Gaspar, J.D. Flores-Félix, A. Falcão, G. Alves, L.R. Silva. Int J Mol Sci **23:9** (2022). https://doi.org/10.3390/ijms23094652.

87. M.C. Gonçalves. Dissertação. UERJ (2011).

88. M. Gupta, S. Dey, D. Marbaniang, P. Pal, S. Ray, B. Mazumder. J Food Sci Technol **57:4** (2020). https://doi.org/10.1007/s13197-019-04113-w.

89. J. Garrido, F. Borges. Food Res Int **54:2** (2013). https://doi.org/10.1016/j.foodres.2013.08.002.

90. E. Elejalde, M.C. Villarán, R.M. Alonso. J Int Soc Sports Nutr **7:18** (2021). https://doi.org/10.1186/s12970-020-00395-0.

91. A.R. Volpe-Fix, E. de França, J.C. Silvestre, R.V. Thomatieli-Santos. Foods **12:5** (2023). https://doi.org/10.3390/foods12050916.

92. M.C. Gonçalves, F.F. Bezerra, E.C.A. Eleutherio, E. Bouskela, J. Koury. Clinics **66:9** (2011). https://doi.org/10.1590/S1807-59322011000900005.

93. L.C.R. Lima, R.V. Barreto, N.M. Bassan, C.C. Greco, B.S. Denadai. Nutrients **11:10 (**2019). https://doi.org/10.3390/nu11102274.

94. N.C. Martins, G.P. Dorneles, A.S. Blembeel, J.P. Marinho, I.C.T. Proença, M.J.V.C. Goulart, G.B. Moller, E.P. Marques, D. Pochmann, M. Salvador, V. Elsner, A. Peres, C. Dani, J.L. Ribeiro. Complement Ther Med **54** (2020). https://doi.org/10.1016/j.ctim.2020.102570.