Supplements as a Method of Influencing Muscle Ratigue in Tennis: A Study Review

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Abstract
The supplements that players use influence muscle fatigue before, during or after tennis and are essential along with other components in the development of a good athlete when talking about performance in sport.
Aim: The aim of this review study is to review the scientific papers on the subject of supplements used in tennis in order to see how they may or may not influence muscle fatigue.
Methods: We used the following databases: Google Scholar, PubMed and Research Gate using the following keywords: supplements in tennis, muscular fatigue and sports performance. Only articles focusing on supplements used by competitive players were selected. We identified 30 articles that met the inclusion criteria: articles published in English, focusing on supplements used by tennis players and available in full text. We excluded articles that did not detail the components of oral suplements and the ingestion protocol, studies available only in abstract form, articles that not targeted professional tennis players.
Results: We selected 20 articles that met the inclusion and exclusion criteria. The results shows that the ingestion of supplements has a positive effect on the prevention of muscle fatigue, as well as during and after exercise in order to facilitate recovery.
Conclusions: The ingestion of supplements by competitive tennis players is a method to reduce the muscular fatigue and improve recoverey after training and sports competitions.

Keywords*: supplements; tennis; muscular fatigue; sports performance.*

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1. Introduction

Tennis is a sport that is increasingly played at all levels. Over the years, the sport has undergone many changes, such as: different biomechanics of movement, increased intensity and duration of matches, more tournaments at performance level. It is one of the recognised sports played on different surfaces with different types of balls, indoors and outdoors. All of the above has an effect on the players' psyche and physique as they adapt to changing conditions from one competition to another in a relatively short time. Tennis is characterised by fast starts, changes of direction, quick breaks and a varied type of effort: maximum intensity effort alternating with long efforts of medium or low intensity, as well as the involvement of different muscle groups (Perry et al., 2004; Fernandez, 2009). The duration of a match is on average about 1h 30 min or more, some matches last even longer atmen's event in Grand Slam tournaments where they are played on the best of 5 sets system.

Pluim B. (2007) mentions this sport as one of the most appreciated and practiced sports worldwide. If practiced as a recreational sport, tennis is an ideal sport for physical improvement at the population level. Bringing numerous benefits, the vast majority keep playing it throughout their lives.

The supplements that players use influence muscle fatigue before, during or after tennis and are essential along with other components in the development of a good athlete when talking about performance in sport. Supplements are important when talking about energy stores, preventing and reducing fatigue (Thomas, Erdman & Burke, 2016). It is a key element in the development of any athlete's performance capacity, especially at junior age where it is a critical time for them (Fleming, Naughton & Harper, 2022). During prolonged exercise, such as tennis matches, carbohydrate ingestion is considered to be the most recommended diet for recovering skeletal muscle and nervous system capacity.

2. Material and methods

2.1. Data collection

Using the following electronic databases: Google Scholar, PubMed, Research Gate, we searched for articles using the following keywords: supplements; tennis; muscular fatigue; sports performance. In the second phase the keywords were used in combination to get the most accurate results. We selected only those articles that aim supplements on influencing fatigue in tennis players.

Eligibility criteria:

To be included in this review, scientific works must fulfill the following criteria: articles published in English, focusing on supplements used by tennis players and available in full text.

There have been excluded from the study: articles that did not detail the components of oral suplements and the ingestion protocol, studies available only in abstract form, articles that not targeted professional tennis players.

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3. Results and discussion

3.1. Results

From the diagram above (figure 1), a number of 1281 article were identified. Articles published between 1990-2000 (n=2), 2000-2010 (n=11), 2010-2022 (n=7). There has been more interest in this type of study recently. Some studies have used as supplements: carbohydrates (n=6), sports drinks (n=2), caffeine (n=7), creatine (n=2), bicarbonate (n=2), sodium citrate (n=1). These studies have always had experimental and placebo groups, the

subjects being competitive tennis players. The number of participants in the selected studies can be divided into the following categories: 0-10 participants (n= 8) and more than 10 participants (n= 12). Articles that included men in the study group (n= 14), that included only women (n=0), that included both genders (n= 6).

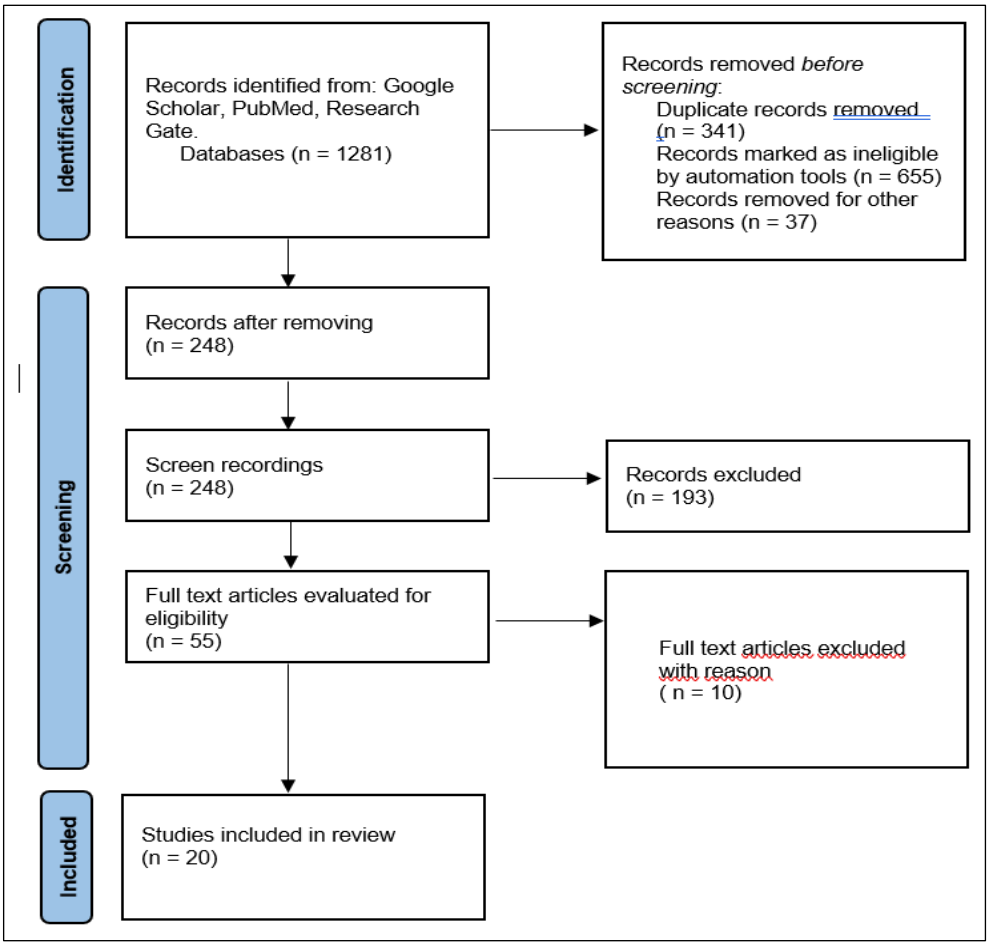

Figure 1. Prisma flow diagram

After the inclusion and exclusion criteria a number of 20 articles were included in review. The results show that ingestion of supplements significantly influences sports performance of tennis players both in competition and in simulated match.

Table 1. Articles used in the review

No. article	Target group	Protocols	Results
1. Peltier et al. (2013)	8 well-trained male tennis players (regional level-French Tennis Federation)	2 groups: ingesting placebo or sport drinks. The players had a dietary protocol before the 2 sessions to minimize variations in pre-exercise glycogen stores.	The group that ingested sports drinks had a better resoinse to perceived general and muscular fatigue than the placebo group.
2. Gomes et al. (2013)	12 male tennis players	5 days trial with 2 matches in 2nd and 4th days. Subjects ingested either a CHO or PLA beverage.	CHO supplementation did not affect players performance during the match. Blood glucose showed a higher trend concentration (p=0.06).
3. Chen et al. (2015)	10 healthy male and 10 healthy female (tennis, soccer, basketball)	Caffeine washouts 7 days prior to the experiment 2 sessions: caffeine session and the placebo session A capsule of 500ml water mixed with 6mg/kg caffeine placebo (diet flour, Sun Right, Taiwan).	Caffeine significantly improved isometric contractions by 5.9%
4. Gallo-Salazar et al. (2015)	14 young and healthy tennis players (10 male and 4 female)	2 experimental trials: First trial: players ingested a powdered caffeine-containing energy drink (Fure, ProEnergetics, Spain) dissolved in 250 mL of tap water = 3 mg caffeine. Second trial: identical drink with no caffeine content.	The preexercise ingestion of the caffeinated energy drink increased handgrip force by 4.0% ± 7.2% in the right hand and by 4.3% ± 7.2% in the left hand.
5. Op 't Eijnde, Vergauwen & Hespel (2001)	8 well-trained, young male tennis players	2 experimental protocols (creatine or placebo supplementation). 20 g of creatine monohydrate powder/day	creatine supplementation might improve performance in tennis. Ingestion of ~ 20±25 g ´ day±1 of creatine monohydrate
6. McRae & Galloway (2012)	22 nationally ranked tennis players (15 male, 7 female	Participants ingested either a 6.4% CHO-E drink (Lucozade Sport, GlaxoSmithKline Nutritional Healthcare, 281 mOsmol/kg) or a 0.0% placeboelectrolyte beverage (Lucozade Sport, GlaxoSmithKline	CHO-E trial had significantly higher success rates on all serves ($p < .05$; 66% ± 7% success on placebo vs. 68% ± 6% on CHO-E)

No. article	Target group	Protocols	Results
		Nutritional Healthcare, 61 mOsmol/kg).	
7. Brink-Elfegoun et al. (2014)	8 male regionally-ranked tennis players	The diet was standardized as follows: fat 25%, protein 15% and carbohydrate 65%, plus 200 mL of mineral water at each meal. During the match day, participants had to drink a pre-match drink (500 mL of liquid), a drink during the match (750 mL/h) and a drink after the match (250 mL).	playing three simulated tennis matches in a thirty-six-hour period did not significantly decrease any of the physical performance measures 3 h after the last match
8. Vergauwen et al. (1998)	13 well-trained male Belgian tennis players	they ingested two capsules containing an initial bolus of either caffeine or placebo (glucose)	CHO feedings to improve stroke performance at the end of prolonged tennis play. Caffeine intake does not yield an additional beneficial effect to stroke quality.
9. Pluim (2006)	36 male tennis players	2 groups: creatine group and placebo group.	without extra strength training creatine supplementation is not effective at enhancing isometric strength in young male competitive tennis players
10. Wu et al. (2010)	9 male Division I college tennis players	Each participant -> 2 experimental trials: bicarbonate and placebo, in a randomized order. The participants consumed NaHCO3 (0.3 g kg-1 body mass) or placebo (NaCl, 0.209 g kg-1, equal amount of sodium) in 250 ml water.	NaHCO3 supplementation could prevent the decline in skilled tennis performance after a match.
11. Fernnadez-Elias et al. (2020)	11 professional male tennis players	70 mL of concentrated beetroot juice.	The ingestion of a shot of nitrate beetroot juice was ineffective to improve running performance and serve grip.
12. Cunha et al. (2019)	10 Brazilian nationally-ranked young male tennis players	Subjects ingested either sodium citrate (SC - 0.5 g.kg−1 BM in capsules of 500 mg) or a placebo (PLA).	All metabolic parameters increased after the ingestion before and after the match.

No. article	Target group	Protocols	Results
13. Hornery et al. (2007)	12 highly trained male tennis players	3.trials: placebo control and 3 interventions. Trials were separated by 48 hours to 7 days. Participants consumed approximately 14 mL · kg–1 · h–1 of a commercially available carbohydrate-loaded beverage (6%). The participants in the placebo group ingested a powder placebo to mask caffeine and a carbohydrate-free flavored drink.	Carbohydrate drink enhanced blood glucose concentration. Supplementation with a modest amount of caffeine increased serve velocity, specifically during the final stages of the simulated match.
14. Klein et al. (2012)	20 National Collegiate Athletic Association Division I tennis players (10 men; 10 women)	the ingestion of either 6 mg/kg of caffeine/ a placebo	Caffeine significantly improved performance.
15. Strecker et al. (2006)	10 male collegiate level tennis players	Players performed two 90 minute trials of simulated tennis playing against a ball machine. Participants ingested either 3mg/Kg of body weight of caffeine or placebo with 32 oz of carbonated soft drink.	The results of this investigation show a better performance on the forehand shot compared to backhand.
16. Juzwiak et al. (2008)	44 adolescent males aged 10–18 years. The players were placed into two groups based on age (10–13 years, n=17; 14–18 years, n=27)	4-day FD, EE via METS plus estimated BMR, DEXA.	CHO intake decreased recommendations (<5 g.kg.bm−1) in 32% of players. Protein intake increased recommended intakes in 73% of players; >1.5 g.kg.bm−1.
17. Mitchell et al. (1992)	12 tennis players (1o male and 2 female)	In one trial -> subject ingested a CHO solution 7.5 g * 100 mL, in the other trial -> ingested a water placebo artificially flavored.	The ingestion of CHO did not prevent a decrease in performance. Fatigue occured in 3 hours in the match, suggested by service speed and shuttle runs.

No. article	Target group	Protocols	Results
18. Kushwah (2019)	10 university level male tennis players	High Carbohydrate Drink (H-CHO) 17.5 g/ 100 ml of water High Electrolyte Drink (H-ED) 21.8 g/ l of water Carbohydrate-Electrolyte Drink (CHO-E): commercially available Gatorade sports drink. The dose was 100 ml lemon-lime flavored Gatored + 6% carbohydrate.	CHO-E ingestion during the simulated tennis match rises the Na, K+, BGL, and SR and reduces the BLa and BT than other fluid supplement.
19. Strecker (2007)	10 skilled male tennis players ranked between 4.5 and 6.0 on the USTA scale	CHO-E ingestion during the simulated tennis match elevates the Na, K+, BGL, and SR and reduces the BLa and BT than other fluid supplement. The participants ingested a gel capsule with either 3 mg. Kg-1 of body weight (BW) of caffeine or placebo + 32 oz carbonated soft drink was consumed with both caffeine and placebo.	Ingestion of 3 mg/Kg BW of caffeine improves tennis skill performance in the end of a match play.
20. Munson et al. (2020)	12 British nationally-ranked tennis players	Participants consumed a 250 ml sodium-containing beverage (10, 20, 50 mmol/L) or a placebo (0 mmol/L), and continued to consume 1,000 ml of the same beverage at set periods during the 1-h training session.	Consuming 50 mmol/L of sodium before and during a 1-h tennis training session reduced urine osmolality and improved groundstroke performance in nationally-ranked tennis players.

3.2. Discussion

This study aims to show a link between the ingestion of supplements and the effect it does or does not have on the sports performance of tennis players. Most of the articles were focused on testing subjects during a match or a simulated match using the ball machine in training. Participants in the study being assigned to an experimental group and a placebo group and vice versa (Munson et al., 2020; Juzwik et al., 2008; Hornery et al., 2007). Another author's view on supplementation is thus very important to maintain an optimal level of fluids before, during and after the tennis training or match. High temperature is known to increase the risk of dehydration leading to

injury and reduced sports performance (Myers, et al., 2018; Klein et al., 2012; Kovacs, 2006).

Poire et al. (2019) study comparing a group of athletes who took caffeine as a supplement vs. the placebo group found that those who used caffeine performed better in sprints, but experienced stomach discomfort, service accuracy was not affected. Compared to tennis, caffeine ingestion had no effect on the accuracy of free throws and 3-pointers in basketball and football where the shots were not improved after caffeine supplementation (Abian et al., 2015; Krasnanova et al., 2014). Sodium bicarbonate helps prevent a decrease in player performance during a match or training session in a study in which 9 professional players received a diet protocol (Wu et. al., 2010). According to Brink-Elfegoun et al. (2014) after playing 3 simulated-matches did not significantly decrease any of the physical performance of the players. Another supplement that helps increase performance in tennis is sodium citrate. In this study, 10 male tennis players had increased their metabolic parameters after the ingestion (Cunha et al., 2019). Also other studies on female tennis players show that a protein-based diet can be achieved more easily with the help of information on the number of training hours (Gropper et al., 2003).

4. Conclusions

This study shows that supplements can be used as a method to prevent and reduce muscle fatigue after matches or training and to recover from physical activity. An important factor is to choose an appropriate dosage that is specific for the sport and the player and to select the right time to use supplements: before, during and after a match or training session. In addition to preventing fatigue and maintaining performance capacity, the speed of the groundstrokes has also been improved especially when talking about service.

Nutritional supplements such as carbohydrates, caffeine, creatine, bicarbonate and sodium citrate as well as energy sports drinks help athletes in preventing and reducing muscle fatigue. Intervention with supplements

adapted to the players is essential when the optimal level of hydration must be maintained, especially at times of high temperature during a tournament.

The ingestion of supplements by competitive tennis players is a method to reduce the muscular fatigue and improve recoverey after training and sports competitions.

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