

HERBS POTENTIALLY ENHANCING SPORTS PERFORMANCE

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ABSTRACT: *Herbs have a long history of use as traditional medicines to enhance athletic performance. The following herbs are currently used to enhance athletic performance, mostly regardless of scientific evidence of effect: Ginsengs, ephedra, guarana, Tribulus terrestris, kava, St. John's wort, yohimbine and ginkgo. Controlled studies for the potential ergogenic effects of herbs are limited and the results are controversial. Future research on ergogenic effects of herbs should consider identity and amount of substance or presumed active ingredients administered, dose, and duration of test period, proper experimental protocols, and measurement of psychological and physiological parameters and measurements of performance pertinent to intended uses. This review focuses mainly on most common herbs that are used to enhance athletic performance at present.*

Key words: Athletic Performance, Ergogenic Aid, Exercise, Herbs, and Sports

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INTRODUCTION

Herbs have been used by athletes to enhance performance since ancient times. Athletes looking to improve athletic performance, enhance immunity or manage a health concern may be interested in trying herbs in their diet. Herbs have a long history of use and it is conceivable that some herbs may be of benefit for athletes. However, quality research on herbs—both for health effects and performance enhancement on the athletic field is very limited (Støa Birketvedt et al., 2005; Sünram-Lea et al., 2005; Cockburn, 2006; Moazzami et al., 2007; Ely and Chevront, 2010; Hoffman, 2010; Neiman, 2010; Suchy et al., 2010; Doria et al., 2013). Despite their

long tradition of use by physically active persons, herbs have seldom been studied scientifically as a possible aid to physical performance.

Humans consume herbs to enhance their long-term endurance performance (e.g.; in running, cycling, rowing, swimming, walking, dancing, aerobics, cross-country skiing, and mountain climbing), to induce muscular hypertrophy and strength (eg; for bodybuilding, weight lifting, wrestling, strength sports and track and field events) to enhance performance in sport events, both competitive sports and recreational activities (Bucci, 2000; Williams, 2006). Some herbs are classified as adaptogens that assist normalization of body system functions altered by stress. Persons who exercise often use adaptogens because exercise is considered a form of stress (Ostojic, 2006). They believe that some herbs may help them to improve their performance, speed up recovery, maintain health and fitness during intense periods of training, increase muscle mass and reduce body fat (Chen et al., 2012). As the interest in sports nutrition has increased, so have the sales of herbs to improve performance (Rodriguez et al., 2000). This review studies the most commonly used herbs potentially enhancing sport performance.

Panax ginseng (Ginseng)

The most studied herb for human physical performance is ginseng. The term ginseng usually refers to the species *Panax ginseng*. Ginseng is available in many forms: whole root, root powder, steamed root powder, teas, tinctures and standardized root extracts (Popov and Goldway, 1973). Ginseng roots contain ≥13 positively identified, glycosylated steroidal saponins (ginsenosides) as likely active agents (Carr, 1986; Bahrke and Morgan, 1994; Chaung, 1995; van Breeman et al., 1995; Hobbs, 1996). Traditional use of ginseng is 3–9 g/d of powdered root, almost always combined with other herbs (Hobbs, 1996).

The efficacy of ginseng on physical performance was

evaluated in many trials (Engels et al., 1996; Morris et al., 1996; Engels and Wirth, 1997; Allen et al., 1998; Engels et al., 2001; Engels et al., 2003; Hsu et al., 2005; Yoon et al., 2008;) used healthy volunteers, including athletes as well as sedentary men. Most of these studies have shown that ginseng has no effect on different aspects of physical performance, such as aerobic performance (Engels and Wirth, 1997; Allen et al., 1998; Eschbach et al., 2000; Hsu et al., 2005; Ping et al., 2011), anaerobic performance (Morris et al., 1996; Yoon et al., 2008), fatigue (Yoon et al., 2008; Ping et al., 2011), lactate metabolism (Hsu et al., 2005; Kulaputana et al., 2007; Biondo et al., 2008; Ping et al., 2011;) or recovery from exercise (Engels et al., 2001; Engels et al., 2003). However, in addition to these negative results there are a few studies that showed positive effects of ginseng on immune response to acute exercise (Biondo et al., 2008), antioxidant activity (Kim et al., 2011), anti-fatigue activity (Wang et al., 2010) and endurance performance (Ping et al., 2011).

Rather than the physical performance, studies on psychomotor functions which may effect the performance in certain athletic events have given more positive results (Ziemba et al., 1999; Kennedy et al., 2001; Scholey and Kennedy, 2002; Kennedy et al., 2002; Heo et al., 2008; Lee et al., 2008) comparing to negative results (Cardinal and Engels, 2001; Sunram-Lea et al., 2005). Although the widespread utilization in sports, ginseng was not shown to enhance physical performance with strong evidence (Lee et al., 2008) and enhanced physical performance after ginseng administration in well-designed investigations remains to be demonstrated (Bahrke et al., 2009). Different types of the herbs, combinations with other herbs, different doses in the studies may have created the controversial results. It is difficult to accept ginseng as an ergogenic with the related literature.

***Ephedra* (Ma-huang) and Ephedrine Alkaloids**

Another important herb commonly used to enhance exercise performance, Ephedra; from the plant *Ephedra sinica*, has been used as a herbal remedy in traditional Chinese medicine for 5,000 years for the treatment of asthma and hay fever, as well as for the common cold (Abourashed et al., 2009). More recently it has been used in the form of dietary supplements for the purposes of increasing energy and alertness, enhancing athletic performance, or weight loss (Ghosh and Ghosh, 2010). There is evidence to conclude that short-term use of ephedra with or without caffeine promotes modest short-term weight loss (Shekelle et al., 2003). It was also shown that ephedra significantly decrease the body mass index without changing resting metabolic rate in obese women (Kim et al., 2008). *Ephedrine* has a thermogenic ability both without (Morgan et al., 1982; Astrup et al., 1984; Astrup et al., 1985; Nielsen et al., 1993; Evans and Miller, 1997;) and with (Astrup et al., 1991; Dulloo et al., 1992; Astrup and Toubro, 1993) caffeine. Herbal combinations containing ephedrine plus caffeine and other herbs may reproduce short-term thermogenic and metabolic effects that are conducive to body fat loss (Kim

et al., 2008). Ephedra has been shown to be ergogenic for anaerobic exercise, especially when taken with caffeine (Jacobs et al., 2003) and caffeine-ephedrine combination significantly improved time to exhaustion during intense physical activity (Bell et al., 1998).

Unlike other herbs, the active ingredients like ephedrine and related alkaloids (mostly ephedrine, pseudoephedrine, norephedrine, methylephedrine, methylpseudoephedrine and norpseudoephedrine) are well characterized (Anonymous, 1989; Bent et al., 2003). These compounds directly and indirectly increase blood pressure, heart rate, cardiac output, and peripheral vascular resistance (Hardman et al., 2001; Bent et al., 2003). Ephedrine acts as a sympathomimetic agent both by directly stimulating beta-receptors and by causing release of norepinephrine from sympathetic nerves. The risk of cardiovascular events with use of ephedra has been reviewed independently and extensively and has been shown to be associated with both ischemic and hemorrhagic stroke, cardiac arrhythmias including ventricular tachycardia, coronary vasospasm, acute myocardial infarction, tachycardia-induced cardiomyopathy, and sudden death (Theoharides, 1997; Haller and Benowitz, 2000; Vahedi et al., 2000; Samenuk, 2002; Foxford et al., 2003; Shekelle et al., 2003; Torpy et al., 2003; Flanagan et al., 2010).

In the past few years, ephedra and ephedrine-containing products have received considerable scrutiny because of safety concerns (Dhar et al., 2005). In 2004, ephedra was banned in the United States after it was linked to dozens of cases of cardiovascular adverse events including myocardial infarction stroke, and death (Cohen and Ernst, 2010). Ephedrine is a banned substance for amateur sporting events and use of *Ephedra* from dietary supplements is likely to disqualify athletes in drug-tested events (Bucci, 2000). *Ephedra* has an obvious ergogenic potential for many sport events alone or combined with other herbs, especially with caffeine. However, it can not be recommended as ergogenic nutritional supplement since it is in the WADA prohibited list 2014 at the moment and it may also increase the risk of cardiovascular events.

***Paullinia cupana* (Guarana)**

Guarana, a plant found in Brazil, has caffeine content 2-4 times that of regular coffee. Caffeine is a central nervous system stimulant, and it reacts with other chemicals to enhance the effectiveness of ephedrine. The body's response to caffeine is individual. For some it may cause shakiness, heart palpitations and low blood sugar levels. For others it may enhance athletic performance. Guarana seed typically contain: caffeine 2.55 %, tannins 16 %, saponins, theophylline and theobromine (small quantities) (Houghhton, 1995; Carlini, 2003; Scholey and Haskell, 2008).

It is claimed that guarana may increase the fat metabolism and energy expenditure, resulting reduced body fat which may be a beneficial physiological effect (Dulloo et al., 1989; Poehlman et al., 1989; Astrup et al., 1990; MacNaughton et al., 1990; Collins et al., 1994; Tagliabue et al., 1994;

Arciero et al., 1995; Deurenberg, 1995; Dulloo et al., 1999; Engels et al., 1999; Arciero et al., 2000; Koot and EFSA, 2011) for certain athletic events. Despite of the widespread utilization all over the world safety with long-term use requires further investigation (Boozer et al., 2001). Green tea- Guarana mixture is used for energy expenditure and fat oxidation (Be'rube'- Parent et al., 2005). Herbal supplements containing *Ephedra sinica* (ma-huang) and caffeine are widely sold on the market. Caffeine acts as an adenosine antagonist and may potentiate the effects of ephedrine by blocking the negative feedback of adenosine on release of norepinephrine (Dulloo and Miller, 1986a; Dulloo and Miller, 1986b; Astrup et al., 1991; Boozer et al., 2001). Ephedrine plus caffeine was reported to improve parameters of exercise performance such as oxygen consumption, time to exhaustion or carbon dioxide production (Dulloo and Miller, 1984; Dulloo and Miller, 1987). Improvement in muscle endurance during weight circuit training (Dulloo et al., 1991) and exercise performance during stationary biking (Dulloo et al., 1991) was also reported. Although its ergogenic potential; especially combination with *ephedra*; guarana can not be recommended as a nutritional supplement for athletes since it is in the current WADA prohibited list, just like *ephedra*.

Ginkgo biloba

It exerts its mode of action when its active ingredients, the flavonoids and terpenoids work in concert (Curtis-Prior et al., 1999). One of the tissue level effects is stimulated release of endothelium-derived relaxing factor, which may enhance muscle tissue blood flow through improved microcirculation (Cott, 1995). Such an effect could improve aerobic endurance by enhancing muscle tissue oxidation. Several studies (Blume et al., 1996; Peters et al., 1998) have shown that *Ginkgo biloba* improved exercise performance, as evaluated by walking distance, in patients with peripheral arterial disease (PAD). However, although *Ginkgo biloba* supplementation may improve exercise endurance in patients with PAD, there is no evidence that similar effects occur in healthy athletes.

Tribulus terrestris

In traditional folk medicine it is regarded as an aphrodisiac in addition to its beneficial claims on various conditions like inflammations, urinary infections, edema and ascites (Adaikan et al., 2001; Gauthaman et al., 2008). *Tribulus terrestris* has been popularly used as an aphrodisiac and enhancer of sperm production and more recently as an alternative to hormone replacement therapy in aging men and women (Gauthaman et al., 2008).

Supplement manufacturers claim that *Tribulus terrestris* can increase testosterone production by stimulating luteinizing hormone secretion from pituitary gland and therefore it may increase muscle mass and strength (Antonio et al., 2000). Dimitrov et al. (1987) found that tribestan (*tribulus* containing herbal preparation) increased plasma testosterone

levels and reversed sexual impotence in rams. Results published by Gauthaman et al. (2002, 2003) indicated that *Tribulus terrestris* could improve some aspects of male sexual behavior and enhance spermatogenesis in rats. Increased androgen levels have also been reported following *Tribulus terrestris* administration to primates, rats and rabbits (El-Tantawy et al., 2007; Gauthaman et al., 2008). In addition, there are clinical data indicating stimulatory effects of *Tribulus terrestris* on sperm quantity and quality and improved sexual response in men (Arsyad, 1996). On the other hand in a recent study, Martino-Andrade et al. (2010) showed that *Tribulus terrestris* did not stimulate endocrine sensitive tissues such as prostate, seminal vesicle, uterus and vagina in Wistar rats, indicating lack of androgenic and estrogenic activity in vivo despite a positive effect on rat sperm production (Martino- Andrade et al., 2010). Neychev and Mitev (2005) found similar results in human. Chronic ingestion of *Tribulus terrestris* extract influence neither directly nor indirectly androgen production in healthy young men.

Rogerson et al. (2007) studied with elite rugby players and no significant difference between placebo and *tribulus* groups was noted for plasma total testosterone, luteinizing hormone or the urinary testosterone/epitestosterone ratio. Besides a statistically significant increase in estradiol levels was seen in the *tribulus* group. It appears that the aromatization pathway is stimulated to increase blood estradiol when ingested by healthy young male subjects (Rogerson et al., 2007). Obviously, changes in endogenous hormone levels following *Tribulus terrestris* administration are still controversial.

The literature for *Tribulus terrestris* mostly presents its clinical effects rather than effect on athletic performance; studies of its effect on physical efficiency are still missing (Milasius et al., 2010). While it was shown that supplementation with tribulus did not enhance body composition or exercise performance in resistance-trained male (Dimitrov et al., 1987), Milasius et al (2010) reported that it has a positive influence on athletes' anaerobic alactic glycolytic power and aerobic capacity. *Tribulus terrestris* is commonly used by bodybuilders for increasing testosterone levels. But scientific data do not support this claim. On the contrary it may even increase the aromatization of testosterone to estradiol which may be catastrophic for the bodybuilders.

***Piper methysticum* (Kava kava or Kava)**

Kava root contains kava lactones (kava pyrones). The neuropharmacologic effects of kava include analgesia, sedation and skeletal muscle relaxation, but not central nervous system depression. The mechanism is not clear, but blockage of the GABA or norepinephrine neuroreceptors may be involved (Blume et al., 1996; Rodriges et al., 2000). Kava is theorized to reduce excess anxiety and/or hand tremor that may disrupt performance in many sports, such as archery and pistol shooting. Kava has been marketed for its antidepressant or anti-anxiety effects, a possible alternative to prohibited or potentially risky ergogenics in such sports, such as alcohol and

beta-blockers (Peters et al., 1998). A recent meta-analysis has suggested that kava extract may be effective for reduction of anxiety symptoms (Antonio et al., 2000). Although it cannot be thought as ergogenic in many sport events, it may have a potential for some certain sports like archery or shooting.

***Hypericum perforatum* (St. John's wort)**

St. John's wort (SJW) consists of the dried parts of *Hypericum perforatum*. SJW contains many phytochemicals, including flavonoids, phenolic acids, sterols, tannins, two naphthodianthrone (hypericin and pseudohypericin) and aphloroglucinol derivative (hyperforin). (Pietta et al., 2003; Williams, 2006) SJW is used therapeutically as an antidepressant. Hyperforin is thought to be the primary active ingredient in antidepressant activity, but hypericin and pseudohypericin may also be important. All are thought to help maintain optimal brain neurotransmitter levels including serotonin, norepinephrine and dopamine (Blume et al., 1996; Rodriguez et al., 2000). SJW may be theorized to reduce anxiety and hand tremor in some athletes (Williams and Branch, 2002). Additionally, as serotonin is involved in appetite control, SJW is theorized to help inducing weight loss, which could confer a mechanical advantage to some athletes. Meta analyses of research with St. John's wort concluded that its effects on treatment of depression were inconsistent and confusing, some showing benefits comparable to standard antidepressant drugs while others not (Wheeler and Garleb, 1991; Barkauskas, 2007; Karłowicz-Badaskal et al., 2011). It may have an indirect ergogenic effect by increasing the mood or inducing weight loss; but unfortunately no research evaluating the potential ergogenic effect of SJW supplementation on exercise or sport specific performance has been studied.

***Pausinystalia yohimbe* (Yohimbine)**

Yohimbine is a herbal preparation from the bark of the *Pausinystalia yohimbe* trees that purportedly enhances plasma testosterone levels, promotes skeletal muscle hypertrophy, sexual vigor and decreases body fat (Galitzky et al., 1998; Berlan et al., 1991; Kucio et al., 1991; McCarty, 2002). Moreover, yohimbine has alpha 2-antagonistic properties, so this supplement could be used during fat loss procedures to increase the rate of fat mobilization and weight loss. Both proposed ergogenic effects of yohimbine, fat reduction and muscle hypertrophy could be of interest to athletes. It's been suggested that pre-exercise yohimbine administration increases lipolysis in refractory gynoid fat depots, thus promoting fat loss (Bucci, 2000).

The results of a more recent investigation of the effects of high-dose yohimbine supplementation on body composition and exercise performance in elite soccer players indicated that yohimbine supplementation does not have any effects on muscle mass, strength or exercise performance. However, the percentage of body fat significantly decreased in the yohimbine group compared to the control group. The subjects did not report any side effects from the yohimbine supplementation

(Williams, 2006). Ostojic (2006) noted that yohimbine supplementation appeared to be suitable as a fat loss strategy in elite athletes. However, there are not enough number of scientific studies currently available to support weight loss claims or increased testosterone levels and muscle strength/mass in athletes and more research is clearly needed before firm conclusions can be drawn.

Rhodiola rosea

It has been referred to as an herb used to enhance physical and mental performance (Ishaque et al., 2012). It is purported to improve resistance to stressors and to enhance physical performance, potentially by improving adenosine triphosphate turnover (Walker et al., 2007). It has been theorized to enhance endurance performance through a stimulating effect (Williams, 2006). Abidov et al (2003) showed a 24.6% increase in swimming time to exhaustion with *Rhodiola rosea* ingestion in rats. In human studies, it was shown that single dose *Rhodiola rosea* supplementation improved time to exhaustion by 3 percent on a cycle ergometer, but there was no change with chronic supplementation of 4 weeks in physically active men. Maximal strength, reaction times and movement time did not change with the supplementation either (De Bock et al., 2004). Walker et al. studied the effect of *Rhodiola rosea* ingestion on human skeletal muscle phosphocreatine recovery after exhaustive exercise in resistance-trained men and reported that it did not improve ATP turnover during or immediately after exercise, time to exhaustion or perceived exertion (Walker et al., 2007). Combination of *Rhodiola rosea* and *Cordyceps sinensis* was also evaluated in two studies with cyclists. Both studies showed no significant effects on oxygen dynamics, various physiological measures, or cycling time to exhaustion (Earnest et al., 2004; Colson et al., 2005). Studies with *Rhodiola rosea* showed no beneficial effect on athletic performance and are far from proving its ergogenic potential in athletes.

SUMMARY AND CONCLUSION

Herbs have been used from the ancient times to enhance physical performance. However, herbal treatments may not be safe and may have some serious side effects, particularly when used in excessive amounts or when combined with other herbs or drugs (Ernst, 2004; Kundart, 2005; Pittler et al., 2005). Commercially available herbal preparations also may contain prescribed pharmacological agents which may lead to positive doping tests (Maughan et al., 2004). Thus, physically active individuals who desire to use herbs should consult appropriate healthcare professionals beforehand because not all herbs are safe or permitted for use in sport.

This review focuses mainly on most commonly used herbs at present to enhance physical performance. Herbs like ginseng, *Ephedra* and *Tribulus* are used to improve performance (both endurance and strength), maintain health during intense periods of exercise, build muscle mass and reduce body fat. There is a dearth of controlled scientific studies on the effects of herbs on human exercise or sport (Williams and Branch, 2002;

Kundart, 2005). In brief, herbs to enhance human physical performance have little scientific study but it represents a large and valid field for future study. The poor regulation of herbs in many countries allows athletes and coaches to be the target of marketing campaigns based on exaggerated claims and hype rather than documented benefits. A systematic approach to educating athletes and coaches about herbs and managing their provision to athletes and teams, can allow sports people to include the successful use of these products with the activities that underpin optimal performance. Many herbs found on the market today have a long history of use as traditional medicines. The challenge for athletes, coaches and health professionals working with athletes is finding reputable research and resources to support or refute the claims for herbs.

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