

# Human Performance and Sports Applications of Tongkat Ali (*Eurycoma longifolia*)

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*Eurycoma longifolia* is an herbal medicinal plant found in Southeast Asia (Malaysia, Vietnam, Java, Sumatra, Thailand). In Malaysia, it is commonly called tongkat ali and has a range of medicinal properties as a general health tonic, including improvement in physical and mental energy levels and overall quality of life [1,2]. The roots of tongkat ali, often called “Malaysian ginseng,” are used as an adaptogen and as a traditional “anti-aging” remedy to help older individuals adapt to the reduced energy, mood, and libido that often comes with age [3–7]. In modern dietary supplements, tongkat ali can be found in a variety of products intended to improve libido and energy, restore hormonal balance (cortisol/testosterone levels), and enhance both sports performance and weight loss.

In both men and women, testosterone levels peak between 25 and 30 years of age and thereafter drop approximately 1–2% annually [8,9]. At the age of 60, testosterone levels are typically only 40–50% of youthful levels and may be lower due to stress and related lifestyle issues such as diet, exercise, and sleep patterns [10,11]. The benefits of maintaining a youthful testosterone level are many, including increased muscle mass and reduced body fat, high psychological vigor (mental/physical energy), and improved general well-being [12,13].

*Eurycoma* contains a group of small peptides referred to as “europeptides” and known to have effects in improving energy status and sex drive in rodents [14–16]. The effect of tongkat ali in restoring normal testosterone levels appears to arise less from actually “stimulating” testosterone synthesis than from increasing the release rate of “free” testosterone from its binding hormone, sex-hormone-binding globulin (SHBG) [17,18]. In this way, *eurycoma* may be

considered not so much a testosterone “booster” (such as an anabolic steroid), but rather a “maintainer” of normal testosterone levels and a “restorer” of normal testosterone levels (from “low” back “up” to normal ranges) [19]. This would make *eurycoma* particularly beneficial for individuals with subnormal testosterone levels, including those who are dieting for weight loss, middle-aged individuals suffering with fatigue or depression, and intensely training athletes who may be at risk for overtraining [20,21].

## TRADITIONAL USE

Decoctions of tongkat ali roots have been used for centuries in Malaysia and elsewhere in Southeast Asia as an aphrodisiac for loss of sexual desire and impotence, as well as to treat a range of ailments including post-partum depression, malaria, high blood pressure, and fatigue [22].

Tongkat ali has been referred to as Malaysia’s “home-grown Viagra” in respected research journals [4], with the Malaysian government investing considerable effort to license, develop, and sustain research into the potential health benefits of *Eurycoma longifolia* through a variety of governmental organizations, including the Forest Research Institute of Malaysia (FRIM) [22].

## MODERN EXTRACTS

Numerous commercial tongkat ali supplements claim “extract ratios” from 1:20 to 1:200 without any information about bioactive constituents, extraction

methodology (e.g., ethanol versus water), or extract purity. Alcohol extracts of eurycoma have been studied in mice for antimalarial effects of concentrated eurycomalactone [23], but also exhibit toxic effects at high doses (LD50 at 2.6 g/kg), which would preclude safe use in humans as a long-term dietary supplement [24,25]. In contrast, hot-water root extracts standardized for known bioactive components (1% eurycomanone, 22% protein, 30% polysaccharides, 35% glycosaponin) have been demonstrated to be extremely safe at high doses and for long-term consumption [26–28].

Properly standardized hot-water extracts [2,26,29] have a distinctly bitter taste due to the presence of quasinooids, which are recognized as some of the bitterest compounds in nature [30,31]. Tongkat ali extracts that do not taste bitter are either not true *Eurycoma longifolia* root (there are many commercial examples of “fake” tongkat ali extracts) or are subpotent in terms of bioactive constituents, and thus would also be expected to have low efficacy. Because of tongkat ali’s reputation for libido benefits, there are several examples of dietary supplements labeled as *Eurycoma longifolia* but containing none of the actual root, and instead being “spiked” with prescription erectile dysfunction drugs (tadalafil/Cialis, sildenafil/Viagra, vardenafil/Levitra).

## LABORATORY AND ANIMAL RESEARCH

Bhat and Karim [1] conducted an ethnobotanical and pharmacological review on tongkat ali, noting that laboratory research such as cell assay studies offers possible mechanistic support for the myriad traditional uses of tongkat ali, including aphrodisiac [32], antimalarial [33], antimicrobial [34], anticancer [35] and anti-diabetic effects [36].

Numerous rodent studies exist demonstrating reduced anxiety and improved sexual performance following tongkat ali feeding [37–40], with such effects thought to be due to a restoration of normal testosterone levels. Eurycoma’s anxiolytic effects have been demonstrated in a variety of behavioral tests, including elevated plus-maze, open field, and anti-fighting, suggesting an equivalent anti-anxiety effect to diazepam as a positive control [37].

Animal studies have shown that many of the effects of the extract are mediated by its glycoprotein components [14]. The mechanism of action of the bioactive complex polypeptides (“europeptides” with 36 amino acids) has been shown to be activation of the CYP17 enzyme (17 alpha-hydroxylase and 17,20 lyase) to enhance the metabolism of pregnenolone and progesterone to yield more DHEA (dehydroepiandrosterone) and androstenedione, respectively [29]. This glycoprotein water-soluble extract of *Eurycoma longifolia* (tradename:

Physta™) has been shown to deliver anti-aging and anti-stress benefits subsequent to its testosterone-balancing effects [41,42].

## HUMAN-FEEDING TRIALS

Based on a long history of traditional use and confirmation of biological activity via cell culture and animal-feeding studies, several human supplementation studies have been conducted to evaluate the potential benefits of tongkat ali for sexual function, exercise performance, weight loss, and vigor (mental/physical energy).

Importantly, all of the human trials have used the same water-extracted and standardized eurycoma root (Physta™, Biotropics Malaysia) for which a patent has been issued jointly to the Government of Malaysia and the Massachusetts Institute of Technology (United States Patent #7,132,117) [29]. The patent discloses a process whereby *Eurycoma longifolia* roots undergo an aqueous extraction combined with HPLC and size-exclusion chromatography to yield a bioactive peptide fraction (a 4300-dalton glycopeptide with 36 amino acids) that is responsible for its effects in maintaining testosterone levels. Physta™ is a freeze-dried standardized extract of the root of *Eurycoma longifolia* which contains numerous active compounds including phenolic components, tannins, high molecular weight polysaccharides, glycoproteins, and mucopolysaccharides. The bioactive fraction of *Eurycoma longifolia* root delivers a demonstrated ability to improve testosterone levels [41], increase muscle size and strength [43,44], improve overall well-being [45,46], accelerate recovery from exercise [47], enhance weight loss [48,49], reduce stress [50], and reduce symptoms of fatigue [51–53].

In two recent studies of young men undergoing a weight-training regimen [43,44] tongkat ali supplementation (100 mg/day of Physta™) improved lean body mass, 1 RM strength, and arm circumference to a significantly greater degree compared with a placebo group.

In a recent 12-week trial [46] of *Eurycoma longifolia* supplementation (300 mg/day of Physta™ in men aged 30–55 years), subjects showed significant improvement compared with placebo in the Physical Functioning domain of the SF-36 survey. In addition, sexual libido was increased by 11% (week 6) and 14% (week 12) and abdominal fat mass was significantly reduced in subjects with BMI > 25 kg/m<sup>2</sup>.

In men with low testosterone levels (average age 51 years), 1 month of daily supplementation with tongkat ali extract (Physta™, 200 mg/day) resulted in a significant improvement in serum testosterone levels and quality-of-life parameters [41], suggesting a role for tongkat ali as an “adaptogen” against aging-related stress. In another study of healthy adult males

(average age 25 years), 100 mg/day of tongkat ali extract (Physta™) added to an intensive strength-training program (every other day for 8 weeks) resulted in significant improvements in fat-free mass, fat mass, maximal strength (1 RM) and arm circumference compared with a placebo group [43]. These results indicate that tongkat ali extract can enhance muscle mass and strength gains, while accelerating fat loss, in healthy exercisers, and thus may be considered a natural ergogenic aid for athletes and dieters alike.

In a recent study from our group (submitted), we supplemented 63 subjects (32 Men and 31 women) daily with tongkat ali root extract (Physta, 200 mg/day) or a look-alike placebo for 4 weeks. Significant ( $p < 0.05$ ) mood state improvements were found in the tongkat ali group for Tension (−11%), Anger (−12%), and Confusion (−15%). Hormone profile (salivary cortisol and testosterone) was significantly improved by tongkat ali supplementation, with reduced cortisol exposure (−16%), increased testosterone status (+37%), and overall improved cortisol:testosterone ratio (−36%). These results indicate that daily supplementation with tongkat ali (Physta) improves stress hormone profile and certain mood state parameters, suggesting an effective natural approach to shielding the body from the detrimental effects of chronic stress, which may include the “stress” of intense exercise training.

One study of middle-aged women (aged 45–59 years) found that twice-weekly strength training plus 100 mg/day of *Eurycoma longifolia* extract for 12 weeks enhanced fat-free mass to a greater degree than for women adhering to the same strength-training program and taking a placebo [44]. Additional studies in dieters [48–50] and athletes [47] have shown 50–100 mg/day of Tongkat ali extract to help restore normal testosterone levels in supplemented dieters (compared with a typical drop in testosterone among non-supplemented dieters) and supplemented athletes (compared with a typical drop in non-supplemented athletes). In one trial of endurance cyclists [47], cortisol levels were 32% lower and testosterone levels were 16% higher in supplemented subjects compared with placebo, indicating a more favorable biochemical profile for promoting an “anabolic” hormone state.

For a dieter, it would be expected for cortisol to rise and testosterone to fall following several weeks of dieting [54]. This change in hormone balance (elevated cortisol and suppressed testosterone) is an important factor leading to the familiar “plateau” that many dieters hit (when weight loss slows/stops) after 6–8 weeks on a weight loss regimen. By maintaining normal testosterone levels, a dieter could expect to also maintain their muscle mass and metabolic rate (versus a drop in both, subsequent to lower testosterone levels) and thus to continue to lose weight without plateauing.

For an athlete, the same rise in cortisol and drop in testosterone is an early signal of “overtraining”—a syndrome characterized by reduced performance, increased injury rates, suppressed immune system activity, increased appetite, moodiness, and weight gain [55]. Maintenance of normal cortisol/testosterone levels in eurycoma-supplemented subjects may be able to prevent or reduce some of these overtraining symptoms as well as help the athlete to recover more quickly and more completely from daily training bouts.

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## SAFETY

Oral toxicity studies (Wistar rats) have determined the LD50 of Physta™ as 2000 mg/kg body weight (acute) and the NOAEL (no observed adverse effect level) as greater than 1000 mg/kg body weight (28-day sub-acute feeding), resulting in a classification as Category 5 (extremely safe) according to the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

In addition to the very high safety profile demonstrated in the rodent toxicity studies, there are no reported adverse side effects in human studies of tongkat ali supplementation. For example, one 2-month human supplementation trial [27] of 20 healthy males (age range 38–58), found high doses of *Eurycoma longifolia* extract (600 mg/day) to have no influence on blood profiles (hemoglobin, RBC, WBC, etc.) or any deleterious effects on measures of liver or renal function. In our own recent supplementation trial (200 mg/day for 4 weeks), there were no changes in measures of liver enzymes (ALT/AST). Typical dosage recommendations, based on traditional use and on the available scientific evidence in humans, including dieters and athletes, call for 50–200 mg/day of a water-extracted tongkat ali root standardized to 22% eurypeptides.

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## SUMMARY

A wide range of investigations, from laboratory research, to animal feeding studies, to human supplementation trials, have confirmed the health benefits and traditional use of tongkat ali root extract. Laboratory evidence shows that eurycoma peptides stimulate release of free testosterone from its binding proteins and improve overall hormone profiles. More than a dozen rodent-feeding studies have demonstrated improved sex drive, balanced hormonal profiles, and enhanced physical function. Human supplementation trials show a clear indication of reduced fatigue, heightened energy and mood, and

greater sense of well-being in subjects consuming tongkat ali root extracts. It is important to note that the majority of these studies, and all of the human supplementation trials, have been conducted on specific hot-water-extracts of *Eurycoma longifolia* (which is the traditional Malaysian preparation) produced using a patented extraction process to isolate and concentrate the bioactive compounds (Physta™). Some of the tongkat ali extracts currently on the US market are alcohol-extracts, which provide a substantially different chemical profile, and may not be as effective or as safe as the more extensively studied hot-water-extracts.

In conclusion, tongkat ali, used for centuries in traditional medicine systems of Southeast Asia for treating lethargy, low libido, depression, and fatigue, appears to have significant potential for restoring hormone balance (cortisol/testosterone) and overall well-being in humans exposed to various modern stressors, including aging, dieting, and exercise stress.

## Disclosure

The author (S. Talbott) has served as principal investigator on several studies of tongkat ali, including a recent study of Physta, a brand of tongkat ali extract that was funded by the manufacturer, Biotropics Malaysia. Dr. Talbott has no direct financial relationship with Biotropics or with Physta.

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