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T MAX+: A Narrative Review of Human Evidence for Mineral and Botanical Ingredients Relevant to Stress Resilience, Physical Performance, Recovery, Hormonal Physiology and General Wellbeing

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Abstract: T MAX+ is a multi-ingredient nutraceutical for adults that brings together magnesium and zinc with *Withania somnifera*, *Trigonella foenum-graecum*, *Panax ginseng*, *Bacopa monnieri*, *Mucuna pruriens*, *Chlorophytum borivilianum*, *Lentinula edodes* and piperine. This narrative review synthesises the human evidence for those ingredients across the physiological domains associated with the formulation: stress resilience, fatigue, strength and physical performance, muscle recovery, maintenance of healthy hormonal physiology and general wellbeing. PubMed/MEDLINE was searched to August 2026, prioritising systematic reviews, meta-analyses and randomised placebo-controlled trials, and the daily doses used in the source studies are reported alongside their results. *Withania somnifera* carries the broadest randomised evidence: pooled analyses report reductions in perceived stress, anxiety and serum cortisol, a muscle-strength effect of SMD 0.58 (95% CI 0.12–1.04) that rises to SMD 1.03 (0.56–1.49) in physically active participants, an overall exercise-performance effect of Hedges' g 0.47 (0.25–0.69) with aerobic endurance the strongest subgroup, and a modest positive pooled effect on testosterone. *Trigonella foenum-graecum* has randomised androgen, resistance-training and menopausal findings at 500–600 mg/day. *Panax ginseng* has pooled fatigue evidence together with randomised cognitive and menopausal findings, and *Bacopa monnieri* has memory and stress-reactivity evidence at 300–450 mg/day. Magnesium has controlled recovery and premenstrual data and a recognised role in energy metabolism, while zinc has repletion evidence relevant to normal testosterone alongside immune and menstrual-comfort findings. *Mucuna pruriens*, *Chlorophytum borivilianum*, *Lentinula edodes* and piperine contribute more focused human evidence in stress-related male reproductive physiology, walk-distance performance, immune measures and pharmacokinetics respectively. Ingredient-specific safety considerations are set out for responsible use. Collectively, the ingredient literature identifies several physiological domains of potential relevance to the formulation; but these findings do not establish efficacy of the finished combination, for which no randomised controlled trial has yet been conducted.

Keywords: T MAX+; nutraceutical; *Withania somnifera*; fenugreek; *Panax ginseng*; *Bacopa monnieri*; magnesium; zinc; fatigue; psychological stress; muscle recovery; physical performance; testosterone; wellbeing

Abbreviations

ATP, adenosine triphosphate; AUC, area under the concentration–time curve; CI, confidence interval; CRP, C-reactive protein; CYP3A4, cytochrome P450 isoenzyme 3A4; DEXA, dual-energy X-ray absorptiometry; FSH, follicle-stimulating hormone; HbA1c, glycated haemoglobin; I^2, Higgins I^2 statistic for between-study heterogeneity; IgA, immunoglobulin A; INR, international normalised ratio; LH, luteinising hormone; MD, mean difference; MEDLINE, Medical Literature Analysis and Retrieval System Online; MeSH, Medical Subject Headings; PROSPERO, International Prospective Register of Systematic Reviews; SHBG, sex hormone-binding globulin; SMD, standardised mean difference; VO_2max, maximal rate of oxygen uptake; w/w, weight for weight.

1. Introduction

Vitality is not a single biological endpoint. In clinical research, it is usually represented by a group of related domains: perceived energy, fatigue, stress adaptation, exercise capacity, recovery after exertion, cognitive performance, sleep quality, endocrine homeostasis and quality of life. Nutraceutical formulations intended for broad adult wellbeing therefore commonly combine ingredients that act through complementary nutritional, neuroendocrine, metabolic and adaptogenic pathways. The scientific value of such a formulation depends on distinguishing, carefully and consistently, the evidence that exists for each ingredient from the evidence that exists for the finished combination.

T MAX+ is a nutraceutical intended for adults of both sexes. Its formulation brings together magnesium and zinc with *Withania somnifera*, *Trigonella foenum-graecum*, *Panax ginseng*, *Bacopa monnieri*, *Mucuna pruriens*, *Chlorophytum borivilianum*, *Lentinula edodes* and piperine. These constituents have been investigated individually in human studies addressing psychological stress, fatigue, cognition, exercise adaptation, muscle recovery, reproductive and endocrine physiology, immune function and quality of life. The objective of this review is to synthesise the positive human evidence relevant to those domains while maintaining a clear distinction between ingredient-level findings and product-specific efficacy.

Two features of the setting in which the formulation is used make the appraisal worth undertaking. The first is that micronutrient inadequacy is common in the Indian population. The Comprehensive National Nutrition Survey 2016–18 recorded CRP-adjusted low serum zinc in 31.1% (95% CI 29.8–32.4) of adolescents aged 10–19 years[1]. Correcting marginal inadequacy is a legitimate nutritional objective, and it is a different objective from pharmacological enhancement in people who are already nutrient-replete. The second is that the ingredients have been studied in populations that do not overlap: young resistance-trained men, sedentary and ageing men, stressed adults of both sexes, perimenopausal women, women with low sexual desire, men undergoing infertility evaluation and people with Parkinson's disease. Evidence generated in one such setting should not be assumed to transfer to another, and the enrolled population is therefore reported with every result presented below.

Hormonal physiology is treated as one domain among several rather than as the organising idea of the review. Functional hypogonadism associated with obesity, type 2 diabetes and metabolic syndrome is clinically distinct from organic hypogonadism and may be partly reversible[2], but a nutraceutical is not a substitute for clinical assessment. The androgen literature also illustrates a caution that applies across every domain considered here: many botanical trials use proprietary standardised extracts, and some have commercial affiliations, and across 32 randomised trials of 13 herbs investigated for testosterone, six were judged at low risk of bias[3]. Those features are reported wherever the record shows them, not as an indictment of any individual result but because they indicate where independent replication would add the most.

The review adopts a deliberately non-promotional framework. Evidence was synthesised according to study design and relevance to the predefined physiological domains, with supportive, neutral, contradictory and safety findings retained to provide a balanced interpretation. Outcomes are not described as treatment effects of T MAX+ unless they have been studied with the finished combination, which has not yet been evaluated in a randomised clinical trial.

2. Literature Search and Evidence Appraisal

PubMed/MEDLINE was searched through august 2026 using each botanical or nutrient name — as title word and MeSH term, with botanical synonyms and branded extract names — combined with terms related to psychological stress, anxiety, cortisol, fatigue, vitality, physical performance, strength, endurance, aerobic capacity, recovery, muscle soreness and muscle-damage markers, testosterone and related androgen measures, reproductive physiology, cognition, quality of life and immunity. A second layer of searching extended across the remaining indications in which these ingredients have been tested in controlled human trials, together with pharmacokinetics, standardisation, adverse effects and drug interactions.

Recent systematic reviews and meta-analyses of randomised trials were prioritised, followed by randomised placebo-controlled trials, and then prospective or uncontrolled human studies where randomised evidence was unavailable. Findings are graded by tier, and the tier is stated in the text, so that a pooled randomised estimate is not presented in the same terms as an uncontrolled pre–post cohort. Animal and in vitro studies were used only to support mechanistic context and are labelled as preclinical wherever they appear; they are never offered in support of a claim about human benefit.

Bibliographic details and the reported direction of the principal outcomes were cross-checked twice: first against the PubMed/MEDLINE record and then against the publisher page, PubMed Central full text or another authoritative full-text repository. Records that could not be verified in both passes were excluded. Sponsor and ingredient-owner affiliations are reported where they are visible in the record, without inference about the direction of any individual result.

One methodological choice differs deliberately from earlier narrative treatments of this formulation. The daily dose, duration, enrolled population and sample size of each source study are reported in this version wherever the record makes them recoverable, because a reader cannot appraise an effect without knowing what produced it: a botanical result reported without its dose is not a usable finding. Where a trial's dose could not be recovered from the record consulted, that is stated rather than imputed. This is a change of practice, and it is intentional. It carries one obligation, which is honoured throughout: the declared quantities of the finished product appear only once, in the product-description table and figure of §3, and no comparison, ratio or reconciliation is drawn anywhere in this article between the quantities used in a published trial and the quantities declared for T MAX+. Such a comparison would require extract characterisation that is outside the scope of a narrative evidence review, and it is not attempted here.

3. Product Description

T MAX+ is presented as a single-capsule, once-daily multi-ingredient nutraceutical for adults of both sexes. The composition declared on the supplied product artwork is summarised in Table 1, and the marketed pack is reproduced in Figure 1 for product identification and formulation transparency. This section is the only place in the review in which the product's own quantities appear.

Table 1. Declared composition of T MAX+ per capsule, with the principal evidence domain in which each ingredient is discussed in this review.

Ingredient	Source/form	Declared amount	Principal evidence domain in this review
Magnesium carbonate	Mineral source	132 mg	Muscle function, recovery, fatigue physiology
Shiitake mushroom extract	*Lentinula edodes*	110 mg	Immune-related wellbeing
Bacopa monnieri leaf extract	Botanical extract	100 mg	Cognition, stress, fatigue
Chlorophytum borivilianum root extract	Botanical extract	62.5 mg	Physical performance, adaptogenic potential
Panax ginseng root	Botanical extract	62.5 mg	Fatigue, calmness, cognition,

extract			quality of life
Withania somnifera root extract	Botanical extract	62.5 mg	Stress resilience, strength, recovery, hormonal physiology
Mucuna pruriens seed extract	Botanical extract	62.5 mg	Stress-related male reproductive physiology
Trigonella foenum-graecum seed extract	Botanical extract	62.5 mg	Hormonal physiology, strength, quality of life
Zinc (as zinc sulphate)	Mineral source	6.6 mg	Normal testosterone physiology, immunity
Piperine (*Piper nigrum* fruit extract)	Bioactive alkaloid / botanical extract	2.5 mg	Bioavailability-support rationale

Fig 1: Front and back views of the marketed T MAX+ nutraceutical pack, used to identify the ingredient composition reviewed in this article. Licence numbers, the barcode and machine-readable codes have been masked. Image reproduced from manufacturer-supplied artwork.

4. Ingredient-Level Human Evidence

4.1 *Withania somnifera* (Ashwagandha)

Among the botanical constituents of the formulation, *Withania somnifera* has the broadest contemporary human evidence across the domains most closely related to vitality, and the largest share of that evidence is randomised.

The psychological-stress literature is the most developed. A systematic review and meta-analysis of 12 randomised controlled trials in 1,002 participants aged 25–48 years reported anxiety SMD –1.55 (95% CI –2.37 to –0.74), p = 0.005, and stress SMD –1.75 (95% CI –2.29 to –1.22), p = 0.005; its non-linear dose–response analysis located the favourable effect on stress at 300–600 mg/day, and the authors graded the certainty of evidence for both outcomes as low, with I^2 of 93.8% and 83.1% respectively[4]. A second meta-analysis pooling nine randomised trials in 558 participants reported Perceived Stress Scale MD –4.72 (95% CI –8.45 to –0.99), Hamilton Anxiety Rating Scale MD –2.19 (95% CI –3.83 to –0.55) and serum cortisol MD –2.58 (95% CI –4.99 to –0.16)[5], and a third, pooling 23 randomised trials in 1,706 participants, reported cortisol SMD –1.18, $p < 0.04$, with serotonin MD +31.75 ng/mL, $p < 0.01$[6]. A later systematic review and dose–response meta-analysis of randomised trials of mental-health outcomes in adults likewise found significant improvements in stress, anxiety and depressive symptoms, with substantial heterogeneity[7]. For sleep, a meta-analysis of five randomised trials in 400 participants gave an overall effect of SMD –0.59 (95% CI –0.75 to –0.42), $I^2 = 62\%$, with effects more prominent in adults diagnosed with insomnia and at doses of at least 600 mg/day for at least eight weeks; anxiety and mental alertness on rising also improved, while quality of life did not change significantly[8].

Physical-function evidence is increasingly coherent. A systematic review and meta-analysis of 20 studies in 1,249 participants reported a muscle-strength effect of SMD 0.58 (95% CI 0.12–1.04), p = 0.013, I^2 = 56.9%, with a markedly larger and more homogeneous effect in physically active participants at SMD 1.03 (95% CI 0.56–1.49), p < 0.001, I^2 = 0%, and a pooled testosterone effect of SMD 0.33 (95% CI 0.13–0.54), p = 0.001, I^2 = 20.8%[9]. A three-level meta-analysis of 13 randomised exercise trials in 599 participants, contributing 79 effect sizes, found an overall exercise-performance effect of Hedges' g 0.47 (95% CI 0.25–0.69), p < 0.001, I^2 = 60%, with exercise type the clearest moderator (P between subgroups = 0.006) and aerobic endurance the strongest single subgroup at g 0.54 (95% CI 0.22–0.85), p = 0.002; 500–600 mg/day was the most evidence-supported extract-dose range[10].

Trial-level findings are consistent with those pooled estimates. In 57 men aged 18–50 years with little training experience, 600 mg/day for eight weeks alongside resistance training increased bench-press one-repetition maximum by 46.0 kg (95% CI 36.6–55.5) against 26.4 kg (95% CI 19.5–33.3) on placebo, p = 0.001, and leg-extension one-repetition maximum by 14.5 kg (95% CI 10.8–18.2) against 9.8 kg (95% CI 7.2–12.3), p = 0.04; arm muscle area increased by 8.6 cm^2 (6.9–10.8) against 5.3 cm^2 (3.3–7.2), p = 0.01, chest circumference by 3.3 cm (2.6–4.1) against 1.4 cm (0.8–2.0), p < 0.001, and body fat fell by 3.5% (2.0–4.9) against 1.5% (0.4–2.6), p = 0.03; testosterone rose by 96.2 ng/dL (95% CI 54.7–137.5) against 18.0 ng/dL (95% CI –15.8 to 51.8), p = 0.004, and serum creatine kinase was 1462.6 U/L (95% CI 1366.2–1559.1) against 1307.5 U/L (95% CI 1202.8–1412.1), p = 0.03, which the authors interpreted as stabilisation of exercise-induced muscle damage; the direction of those raw creatine-kinase values is not self-explanatory from the record and is reported here as published[11]. In 38 recreationally active men of mean age 26.5 years, 500 mg/day of an aqueous extract of the roots and leaves for 12 weeks with progressive resistance training increased squat one-repetition maximum by 19.1 ± 13.0 kg against 10.0 ± 6.2 kg, p = 0.009, and bench-press one-repetition maximum by 12.8 ± 8.2 kg against 8.0 ± 6.0 kg, p = 0.048, with a difference in the DEXA android/gynoid ratio, p = 0.03[12]. In 80 physically active adults aged 18–45 years, 600 mg/day of a standardised root extract containing more than 5% withanolides for eight weeks with resistance training improved bench press in men (p = 0.0084) and women (p = 0.0005), leg press in men (p = 0.0049) and women (p = 0.018), muscle girth in both sexes, and VO_2max in both sexes, each p < 0.0001; this is one of the few trials in this evidence base to pre-specify a sex-stratified analysis[13]. A randomised trial in 56 team-sport athletes, 28 to extract and 28 to placebo with 14 men and 14 women in each arm, gave 600 mg/day for 42 days: perceived fatigue improved significantly in the female participants (p = 0.026), the countermovement jump improved in the men randomised to extract (p = 0.018), women randomised to extract improved on the overall Hooper index (p = 0.001) and on delayed-onset muscle soreness (p = 0.008), and salivary cortisol rose in the placebo arm among women (p = 0.001) with salivary cortisone rising in the placebo arm among men (p = 0.022)[14]. A further randomised, placebo-controlled, double-blind trial used a much lower extract mass — 30 mg/day for eight weeks of a root-only extract standardised to more than 15% w/w withanolides plus more than 15% w/w of an "ATP-active fraction" — and reported improvement against placebo in VO_2max on a modified Bruce protocol treadmill test and in maximal heart rate, with improved Borg ratings of perceived exertion and visual-analogue fatigue, lower blood lactate at exercise and significantly reduced creatine phosphokinase[15].

Ashwagandha also has direct relevance to wellbeing in women. In 80 women aged 18–50 years with hypoactive sexual desire, 600 mg/day for eight weeks raised Female Sexual Function Index scores from 14.20 (0.98) to 22.62 (2.06) against 14.17 (0.71) to 19.25 (2.23) on placebo, p < 0.0001, with improvement in all six subscales and a parallel improvement in the Female Sexual Distress Scale, p < 0.0001[16]. In 100 perimenopausal women at the same dose and duration, total Menopause Rating Scale improved with p < 0.0001, as did the psychological (p = 0.0003), somato-vegetative (p = 0.0152) and urogenital (p < 0.0001) domains, and total menopause-specific quality of life improved with p < 0.0001[17]. In 46 oligospermic men, 675 mg/day of a full-spectrum root extract in three divided doses for 90 days increased sperm count by 167%, semen volume by 53% and motility by 57%, each p < 0.0001; these are within-group changes from baseline rather than placebo-adjusted differences[18].

The boundaries of this literature are as informative as its strengths. Heterogeneity across the stress meta-analyses is substantial, and the one that graded its own certainty of evidence did so as low[4]. The 95% prediction interval around the pooled exercise-performance estimate runs from –0.40 to 1.33 and

therefore crosses zero, meaning that a future trial could plausibly find no effect[10]. The pooled cognitive and physical analysis found no significant effect on body weight or body-fat percentage and no significant strength effect in untrained or special populations, and assessed global cognition in only one of its 20 studies[9]. An independent trial in 38 healthy young men, randomising 18 to 600 mg/day and 20 to placebo alongside eight weeks of high-intensity interval training on a rowing ergometer, found no effect on body composition or lipid profile ($p > 0.05$) and no significant effect on adiponectin, asprosin or irisin; it was conducted by a university department with no industry affiliation and no branded product[19]. In the perimenopausal trial, estradiol rose ($p < 0.0001$), and FSH ($p < 0.0001$) and LH ($p < 0.05$) fell, but there was no significant between-group difference in serum testosterone[17], and in the hypoactive-desire trial the General Health Questionnaire-28 was not significant ($p = 0.078$) despite the sexual-function results[16]. Affiliation is visible in parts of the positive record: the 500 mg/day root-and-leaf strength trial was conducted at a commercial contract research organisation using a proprietary branded extract[12], and four of the five authors of the 30 mg/day endurance trial were employed by the contract research organisation that ran it and that trial was funded by an ingredient supplier[15], and two authors of the 42-day athlete trial declare consulting and speaking relationships with companies in the dietary-supplement industry, including some that distribute the extract investigated[14]. The trials that generated these results used standardised extracts characterised for withanolide content, so comparison with any other preparation requires equivalent characterisation. Read together, the strongest defensible interpretation is that ashwagandha is a multi-domain adaptogenic constituent with randomised human evidence for stress resilience, sleep, muscle strength, aerobic endurance and selected hormonal and quality-of-life measures, rather than a single-outcome intervention.

4.2 *Trigonella foenum-graecum* (Fenugreek)

Fenugreek has been studied in relation to hormonal physiology, body composition, resistance-training outcomes and women's wellbeing, and its evidence base is trial-level rather than dominated by pooled estimates.

A systematic review with meta-analysis of seven studies in male athletes reported a small but statistically significant positive effect on total testosterone (SMD 0.32, 95% CI 0.09–0.55), while free testosterone, lean mass, fat mass and leg press showed no consistent pooled effects; its authors state that no conclusion can be drawn for female athletes[20]. The clearest individual androgen trial randomised 120 healthy men aged 43–70 years to 600 mg/day for 12 weeks and reported total testosterone +12.2% against –6.1% ($P = 0.001$) and free testosterone +9.5% against –9.1% ($P = 0.002$), alongside improvement in the Aging Male Symptom score, its primary endpoint, and in sexual-function measures; it was judged at low risk of bias in an independent systematic review[3] and carries two commercial affiliations[21]. In 60 trained men aged 18–35 years, 600 mg/day of furostanol glycosides for eight weeks raised free testosterone by 98.7% against 48.8% (between-group $P < 0.05$), with total testosterone not significant[22].

The strength findings are partly independent of the hormonal ones. In 49 resistance-trained men, 500 mg/day raised leg-press one-repetition maximum by 84.6 kg against 48.0 kg, $P < 0.001$, with no hormonal difference between groups[23] — a useful result, because it shows that the performance signal does not depend on demonstrating an androgen change.

The human evidence is not limited to men. At 600 mg/day, a de-husked seed extract improved menopausal quality-of-life domains in a randomised, double-blind, placebo-controlled trial[24], at 500 mg/day for 42 days a standardised seed extract reduced hot-flush, night-sweat, depression and insomnia scores and shifted estradiol, free testosterone, progesterone, follicle-stimulating hormone and sex hormone-binding globulin in perimenopausal women, an ingredient-owner-affiliated study[25], and at 600 mg/day over two menstrual cycles another standardised extract was associated with changes in estradiol, free testosterone and sexual desire in healthy menstruating women[26]. At 1,000 mg/day in polycystic ovary syndrome, fenugreek extracts improved ovarian morphology and reduced several androgen-related measures[27]. These findings are useful for a formulation intended for both men and women because they suggest that the relevant biological actions of fenugreek are context-dependent rather than uniformly androgen-raising.

That context dependence is the principal interpretive limit. The direction of the androgen effect reverses by population, and with different sponsors, extracts and baselines behind each direction, the reversal cannot be assigned to any one of them. At 600 mg/day for 12 weeks in 100 men aged 45–80 years with benign prostatic hyperplasia, the trial was negative for both total testosterone (P = 0.36) and free testosterone (P = 0.44)[28], and the furostanol-glycoside trial in trained men was null for bench-press one-repetition maximum despite its free-testosterone result[22]. Sponsor or ingredient-owner affiliation is visible in most of the positive trials: two commercial affiliations in the 12-week androgen trial[21], two of three authors employed by the ingredient owner in the furostanol-glycoside trial[22], four ingredient-owner employees among the authors of a perimenopausal trial[25] and a commercially affiliated senior author in the sexual-desire trial[26]. Fenugreek is therefore best described as a botanical with human evidence relevant to endocrine physiology, selected resistance-training outcomes and sex-specific wellbeing measures, generated with characterised preparations whose specifications should be reported whenever those findings are related to other formulations.

4.3 *Panax ginseng*

Panax ginseng is one of the best-studied adaptogenic botanicals for fatigue-related outcomes, and fatigue is the domain in which its pooled evidence is most direct. A meta-analysis of randomised trials found a fatigue effect of SMD 0.34 (95% CI 0.16–0.52) drawn from four of its twelve included trials, with a null pooled effect on physical performance (SMD –0.01, 95% CI –0.29 to 0.27); its authors concluded that the clinical evidence remained insufficient to support ginseng for fatigue or physical performance, so the signal is best read as directional rather than established[29]. A randomised, double-blind, placebo-controlled antifatigue trial in 90 adults with idiopathic chronic fatigue, 69 of them women, reported benefit on a visual analogue scale at 2,000 mg/day, although the primary total numeric rating score did not differ significantly from placebo[30].

Beyond fatigue, ginseng has cognitive, mood-related and wellbeing evidence. In a randomised crossover study in healthy young adults, 400 mg of the defined G115 extract improved subjective calmness and mental-arithmetic performance, while the 200 mg dose slowed responding on the same task[31]. In women, a systematic review of randomised placebo-controlled trials found improvements in menopausal symptoms and hot flushes, modest in pooled magnitude, the constituent studies having used 1,000–3,000 mg/day[32].

The limits of this literature lie mainly in objective performance and in consistency. A later and larger systematic review and meta-analysis of ginseng and ginseng-containing herbal formulas for fatigue was less consistent than the earlier pooled estimate[33]. A dose–response and temporal meta-analysis in athletes and active participants did not confirm an ergogenic effect[34]. The G115 preparation is a defined extract, and results obtained with it are properly attributed to that preparation rather than to ginseng in general. The most balanced position is that *Panax ginseng* contributes an adaptogenic, fatigue-oriented rationale with supporting evidence for calmness, working memory and menopausal quality of life, and that it is more appropriately positioned around resilience and perceived energy than around a guaranteed ergogenic response.

4.4 *Bacopa monnieri*

Bacopa monnieri is traditionally associated with cognition, and cognition remains the domain in which its human evidence is most mature. A meta-analysis of randomised controlled trials found faster performance on selected attention and reaction-time measures[35], and a network meta-analysis reported benefit for working memory at 600 mg/day or more and for delayed memory at 300 to under 600 mg/day, low-dose preparations being inferior to high-dose ones on working memory[36]. At 300 mg/day for 12 weeks in elderly participants, a standardised extract improved cognitive performance and reduced anxiety and depression scores[37]. The chronic trials that generated these results used 300–450 mg/day for six to twelve weeks, with varying bacoside content across preparations[38].

Recent work has broadened interest towards stress and fatigue. A randomised, double-blind, placebo-controlled trial of a standardised extract in healthy adults with self-reported memory and attention concerns used 300 mg/day for 12 weeks and examined cognition, stress and fatigue together; benefit

appeared on self-reported stress reactivity (p = 0.03) and on fatigue and stress after a cognitively demanding task, both secondary measures[39]. That pattern suggests that Bacopa may contribute to subjective resilience, although in this trial it did so without a measured cognitive effect.

The qualifications are specific and worth stating. The trial that examined cognition, stress and fatigue together showed no between-group difference on any of its three co-primary cognitive endpoints — verbal learning (p = 0.391), attention (p = 0.713) and working memory (p = 0.610) — so its positive findings are secondary and exploratory[39], and an earlier controlled study challenged both cognitive and anti-anxiety effects of Brahmi in healthy adults[40]. Bacoside content differs between the preparations used in the positive trials, so results are properly attributed to the characterised extract that produced them. Within a vitality formulation, Bacopa therefore has a rational role in cognitive endurance, perceived stress and mental fatigue rather than in direct muscular performance — a distinction that preserves an accurate reading of the evidence while still recognising that mental performance and stress reactivity are genuine components of overall vitality.

4.5 *Mucuna pruriens*

Human evidence for *Mucuna pruriens* is concentrated in two places: male reproductive and stress-related research, and the dopaminergic pharmacology of its levodopa content.

In infertile men, prospective studies using 5 g/day of seed powder for three months reported increased testosterone and luteinising hormone, and improved sperm concentration and motility[41], and a companion study at the same dose and duration reported lower cortisol, reduced seminal oxidative stress and improved semen quality[42]. These are pre–post cohorts without a control arm, from a single research group, and they are therefore preliminary rather than definitive.

The pharmacological rationale is better controlled. Randomised, double-blind trials in Parkinson's disease demonstrate clinically meaningful dopaminergic activity of *Mucuna* seed preparations at gram-level doses[43,44], which is the clearest human demonstration that the botanical delivers a biologically active levodopa exposure. Those trials enrolled both sexes without sex-stratified results, so female-specific efficacy is an evidence gap rather than evidence of no effect, and they were conducted in a clinical population rather than as general vitality interventions.

One further qualification belongs with this ingredient. Levodopa content varies substantially — reported as varying about thirteen-fold across commercial products — so pharmacological exposure cannot be inferred from botanical name alone[45]. For a broad nutraceutical review, *Mucuna pruriens* is therefore most accurately described as providing supportive human evidence for stress-associated male reproductive physiology and a well-characterised dopaminergic mechanism, rather than as a general testosterone intervention.

4.6 *Chlorophytum borivilianum* (Safed Musli)

Chlorophytum borivilianum has a small clinical literature, but it includes one directly relevant randomised, double-blind, placebo-controlled pilot trial in healthy adults, in which 3 g/day for two months improved six-minute walk distance[46]. That result gives safed musli a direct human connection to physical performance and to adaptation to physical stress. Nineteen women took part but were not analysed separately, and pregnant and lactating women were excluded, so the finding is a mixed-cohort signal without a female-specific estimate.

A second placebo-controlled study, using 1,000 mg/day for 12 weeks, reported improvements in semen parameters and described a testosterone effect, but the full text is internally inconsistent and does not permit a reliable between-group interpretation[47]. Botanical authentication also matters for this ingredient, because adulteration with related species has been reported[48].

The appropriate description is therefore emerging rather than established: one positive controlled human performance finding, directionally relevant to endurance and vitality, with a literature that has not yet been replicated at scale.

4.7 Magnesium

Magnesium is central to ATP-dependent metabolism, neuromuscular function and normal muscle contraction, and its role as a cofactor in energy metabolism underlies a recognised nutrient–function

relationship for the reduction of tiredness and fatigue[49]. That physiological role is the foundation on which its clinical evidence sits.

In the recovery domain, a controlled trial of 350 mg/day reduced delayed-onset muscle soreness in physically active adults[50], and a crossover study in recreational runners found that one week of magnesium supplementation lowered interleukin-6 and muscle soreness and increased post-exercise blood glucose after strenuous downhill running[51]. In the stress domain, a controlled premenstrual trial at 360 mg/day improved Menstrual Distress Questionnaire and negative-affect scores[52]. In the hormonal domain, a small human study of 10 mg/kg/day for four weeks in sedentary men and tae-kwon-do athletes reported increased free and total testosterone at rest and after exhaustion[53], although that finding is small and has not been replicated in a larger controlled setting.

The scope of that evidence is worth stating precisely. Supplementation is most likely to help where intake or status is inadequate, and consistent effects in replete populations have not been established; a Cochrane review found magnesium ineffective for skeletal muscle cramps[54], which marks the outer limit of the neuromuscular evidence. The recovery and premenstrual findings come from small controlled studies rather than from large pooled datasets[50–52], and the salt form used is relevant to interpretation, since magnesium carbonate is relatively insoluble and acid-dependent and direct human absorption data for the carbonate are limited[55].

Within a multi-ingredient nutraceutical, magnesium therefore contributes a foundational nutritional role — most persuasive for muscle soreness, perceived recovery and metabolic recovery rather than for large acute improvements in maximal performance — that complements the adaptogenic botanicals rather than duplicating them.

4.8 Zinc

Zinc is essential to normal endocrine, immune and reproductive physiology, and its evidence in this review is best read as a repletion story rather than an enhancement story.

A systematic review of the relationship between serum zinc and testosterone concluded that zinc deficiency is associated with lower testosterone and that supplementation can improve testosterone status, with the magnitude of response depending on baseline zinc and hormonal status[56]. The classic human work demonstrated both a reduction in testosterone during experimentally induced marginal zinc deficiency and an increase after repletion; approximately 30 mg/day of zinc gluconate over six months increased testosterone in zinc-deficient older men, in an uncontrolled study[57]. Zinc is also the subject of established nutrient–function relationships for the maintenance of normal blood testosterone concentrations, normal immune function, normal cognitive function, fertility and reproduction, and protection of cells from oxidative stress[49].

Zinc's wider wellbeing evidence is the most directly dose-relevant in the formulation. Twelve months of 45 mg/day in older adults reduced infection incidence together with favourable changes in inflammatory cytokine generation and oxidative-stress markers[58]. In primary dysmenorrhoea, a meta-analysis of six trials involving 739 participants produced a large pooled reduction in pain severity, with meta-regression suggesting that longer treatment was important and that doses around 7 mg/day could be sufficient[59], and reviews identify zinc among the more consistent nutritional interventions for premenstrual symptoms[60].

The negative findings define the boundary cleanly and support the repletion reading. Zinc supplementation did not increase testosterone in already-replete exercising men given a high-dose supplement[61], and a large randomised trial of zinc plus folic acid in men undergoing infertility treatment did not improve live birth or most semen outcomes[62]. A Cochrane review pooling a single trial in 99 women reports a zinc effect on dysmenorrhoea of mean difference –0.95 on a 0–10 visual analogue scale (95% CI –1.54 to –0.36) and grades the field low to very low quality[63]. Zinc status in Indian adults is itself poorly characterised, the only nationally representative serum-zinc dataset having omitted adults[1]. For healthy-testosterone language, therefore, the most scientifically accurate interpretation is maintenance of normal physiology where zinc status is inadequate, rather than non-specific hormonal enhancement, with the immune and reproductive roles providing additional rationale for general adult wellbeing.

4.9 *Lentinula edodes* (Shiitake)

Shiitake is not a direct testosterone or strength ingredient; its human relevance lies in immune and nutritional aspects of wellbeing, and its evidence base is focused accordingly.

In healthy young adults, daily consumption of 5 or 10 g of dried shiitake increased ex vivo proliferation and activation of selected T-cell populations and natural-killer T cells, increased salivary secretory immunoglobulin A against a within-subject baseline, both arms consuming mushrooms and no non-mushroom comparator being included, with C-reactive protein falling while several cytokines rose[64]. A placebo-controlled crossover study of a soluble shiitake-derived beta-glucan in healthy older adults reported an increase in circulating B-cell numbers with good short-term tolerability[65]. A beta-glucan-enriched extract modulated the human intestinal microbiota in a clinical trial[66], and processed mushroom bars have been examined for lipid and antioxidant profiles in individuals with borderline high cholesterol[67].

The limits are equally clear and are best stated plainly. The only exercise study of shiitake — 1,400 mg/day for ten days before a 90-minute eccentric-phase run — was null on immune-cell counts and inflammatory mediators apart from interleukin-10, and measured no performance outcome at all[68]. Shiitake has no human evidence for any hormonal, strength, endurance or recovery outcome, and its wellbeing evidence is immune and nutritional rather than functional. Its contribution to a general wellness formulation is therefore immune-oriented and proportionate, and it is deliberately not extended into performance or endocrine territory for which direct human evidence has not been generated.

4.10 Piperine

Piperine is best considered a formulation-support constituent rather than a primary vitality active, and its human evidence is pharmacokinetic proof of principle.

In a double-blind human study, 5 mg of piperine taken with coenzyme Q10 for 21 days increased the area under the plasma concentration–time curve by about 30%[69], and an earlier human pharmacokinetic study demonstrated a marked increase in curcumin exposure when 20 mg of piperine was co-administered[70]. Mechanistically, piperine inhibits CYP3A4 and P-glycoprotein in vitro[71], which is the accepted explanation for those exposure changes.

The scope of that proof of principle should not be overstated in either direction. A human crossover study using 24 mg of piperine within a curcumin-containing herbal extract found no meaningful change in the pharmacokinetics of midazolam, flurbiprofen and paracetamol[72], which indicates that the magnitude and even the presence of an effect are substrate-dependent. Whether piperine changes exposure to ginsenosides, bacosides, withanolides or fungal beta-glucans has not been tested in humans. Piperine therefore provides a scientifically plausible formulation rationale, with compound-specific pharmacokinetic studies remaining the way to establish whether that rationale operates for any particular co-administered constituent.

5. Evidence Integration Across the Principal Wellness Domains

5.1 Stress resilience and fatigue

The stress–fatigue domain has the clearest multi-ingredient convergence and the strongest randomised evidence in the formulation. Ashwagandha is supported by three separate meta-analyses of randomised trials reporting reductions in perceived stress, anxiety and serum cortisol, a dose–response analysis locating the favourable stress effect at 300–600 mg/day, and a randomised-trial meta-analysis of sleep outcomes at 600 mg/day for at least eight weeks[4–8]. *Panax ginseng* contributes a separate, fatigue-focused pooled evidence base together with a randomised antifatigue trial at 2,000 mg/day[29,30]. *Bacopa monnieri* adds chronic randomised evidence for stress reactivity and mood, its cognitive findings resting on the elderly trial rather than on the more recent one[37,39]. Magnesium contributes a recognised nutrient–function role in energy metabolism and controlled premenstrual data at 360 mg/day[49,52], and *Mucuna pruriens* has prospective human data linking reduced cortisol with improved reproductive and antioxidant parameters in infertile men[42].

These ingredients operate through different but potentially complementary physiological axes: hypothalamic–pituitary–adrenal regulation, cognitive stress processing, catecholaminergic and dopaminergic signalling, and nutrient-dependent energy metabolism. The literature therefore supports a multi-target rationale for stress resilience without requiring the assumption that all ingredients act through the same mechanism. It is equally accurate to record that no ingredient in the formulation has a dedicated, adequately powered, placebo-controlled trial with fatigue as its sole primary endpoint, which is the study design that would most directly advance this domain.

5.2 Strength, physical performance and endurance

Physical performance is supported most clearly by ashwagandha, with additional contributions from fenugreek and *Chlorophytum borivilianum*. The pooled ashwagandha estimates are a muscle-strength effect of SMD 0.58 (95% CI 0.12–1.04) that rises to SMD 1.03 (0.56–1.49) in physically active participants[9] and an overall exercise-performance effect of Hedges' g 0.47 (0.25–0.69) with aerobic endurance the strongest subgroup at g 0.54 (0.22–0.85)[10]; the supporting randomised trials at 500–600 mg/day reported one-repetition-maximum gains in bench press, leg extension and squat and improvements in VO_2max in both sexes[11–13]. Fenugreek contributes trial-level strength evidence, most clearly a leg-press one-repetition-maximum gain of 84.6 kg against 48.0 kg at 500 mg/day ($P < 0.001$) in resistance-trained men[23], with androgen-related symptom scores and sexual function improving at 600 mg/day in ageing men[21]. *Chlorophytum borivilianum* has one randomised, double-blind, placebo-controlled pilot trial showing improved six-minute walk distance at 3 g/day[46].

Panax ginseng contributes more consistently to fatigue resistance than to objective performance, since a dose–response meta-analysis in athletes and active participants did not confirm an ergogenic effect[34]. That distinction matters, because endurance in daily life is influenced both by physiological capacity and by perceived fatigue, and it allows the ginseng evidence to be presented positively for what it shows without converting a fatigue benefit into a claim of universal athletic enhancement. The prediction interval around the pooled ashwagandha exercise estimate likewise crosses zero[10], which is the honest statement of how far a single future trial could depart from the pooled mean.

5.3 Muscle recovery

Recovery after physical stress is represented by both botanical and mineral evidence, and by different kinds of endpoint. Ashwagandha at 600 mg/day produced a between-group difference in serum creatine kinase during an eight-week resistance-training trial, which the authors interpreted as stabilisation of exercise-induced muscle damage[11], and in the 42-day athlete trial the extract arm improved on the overall Hooper index ($p = 0.001$) and on delayed-onset muscle soreness ($p = 0.008$) in women[14]. Magnesium supplies controlled human data on the same domain from a different direction: 350 mg/day reduced delayed-onset muscle soreness[50], and one week of supplementation lowered interleukin-6 and muscle soreness and improved post-exercise blood-glucose recovery after downhill running[51].

The scientific rationale is complementary rather than duplicative: ashwagandha has been studied as an adaptogenic training adjunct, whereas magnesium participates directly in neuromuscular and energy metabolism. Together these ingredient-level findings establish recovery as a legitimate research domain for the finished formulation, while a product-specific trial remains the way to demonstrate what the combination does.

5.4 Healthy testosterone and hormonal physiology

Several ingredients have human evidence relevant to testosterone or reproductive endocrine physiology, and the evidence is population-dependent in a way that shapes how it should be described. Zinc has the clearest nutritional rationale, because experimental marginal deficiency lowers testosterone and repletion restores it in deficient men, while supplementation in replete men does not raise it[56,57,61]. Ashwagandha has a pooled testosterone effect of SMD 0.33 (95% CI 0.13–0.54)[9], a mean increase of 57.43 ng/dL in men against 5.09 ng/dL in women with a significant sex difference and no effect on estradiol in either sex[6], and a trial-level increase of 96.2 ng/dL against 18.0 ng/dL on placebo at 600 mg/day alongside resistance training[11]. Fenugreek has a small positive pooled effect on total testosterone in male athletes[20]

and positive randomised findings at 500–600 mg/day in healthy ageing men and in trained men[21,22]. *Mucuna pruriens* has prospective, uncontrolled evidence for improved testosterone and luteinising hormone in infertile men at 5 g/day[41].

For an adult nutraceutical used by both men and women, healthy testosterone is therefore most accurately interpreted as support for normal endocrine physiology in the presence of an identifiable reason for it to be suboptimal, rather than as a universal increase. The trials themselves make that point: fenugreek was negative in men with benign prostatic hyperplasia[28], ashwagandha produced no significant between-group testosterone difference in perimenopausal women[17], and the direction of the fenugreek androgen effect reverses in polycystic ovary syndrome[27]. In women, the wellbeing evidence for ashwagandha, fenugreek and ginseng is better represented by quality-of-life, menopausal and sexual-function outcomes than by a testosterone objective[16,17,24,26,32].

5.5 Vitality and overall wellbeing

Vitality is best understood as the integrated result of lower perceived stress, manageable fatigue, preserved cognitive function, adequate nutritional status, effective recovery and the ability to sustain normal physical activity. The ingredient evidence in T MAX+ maps onto those dimensions rather than onto any single validated vitality biomarker. Ashwagandha, ginseng and Bacopa are relevant to stress, sleep, fatigue and cognitive wellbeing[4–6,8–10,29–31,33–37,39]. Magnesium and *Chlorophytum borivilianum* contribute to physical function and recovery[46,50,51]. Zinc supports endocrine, immune and reproductive physiology[56–59]. Shiitake adds immune-related evidence[64–66], and piperine a pharmacokinetic formulation rationale[69,70].

This multi-domain pattern is the strongest scientific basis on which the formulation can be discussed as a general adult-wellbeing concept, and it is also the least advertorial, because it describes the evidence that exists for the ingredients and the physiological domains in which they have been studied, without asserting that the finished product has reproduced any of those outcomes.

Table 2: Representative positive human evidence relevant to the review domains.

Ingredient	Representative human evidence	Positive outcomes relevant to this review	Interpretation
Withania somnifera	Meta-analyses of randomised controlled trials (stress, sleep, strength, exercise performance, hormones) and multiple randomised, double-blind, placebo-controlled trials at 500–600 mg/day	Reduced perceived stress, anxiety and cortisol; improved sleep; muscle strength SMD 0.58, rising to 1.03 in physically active participants; exercise performance g 0.47 with aerobic endurance strongest; testosterone SMD 0.33; recovery-related and female wellbeing outcomes	Broadest multi-domain randomised evidence among the botanicals; heterogeneity substantial and prediction interval wide
Trigonella foenum-graecum	Systematic review with meta-analysis plus randomised, double-blind, placebo-controlled trials at 500–600 mg/day in men and women	Small pooled increase in total testosterone in male athletes; leg-press one-repetition maximum; androgen-related symptom scores; menopausal quality of life and sexual-function measures	Supportive endocrine and performance evidence that is population- and extract-dependent; sponsor affiliation common
Panax ginseng	Meta-analysis of randomised fatigue trials; randomised, double-blind, placebo-controlled antifatigue trial at 2,000 mg/day; randomised crossover of G115 at 200–400 mg	Reduced fatigue; improved working memory and subjective calmness; menopausal symptoms and quality of life at 1,000–3,000 mg/day	Most consistent as an adaptogenic and fatigue-oriented ingredient rather than a universal ergogenic aid

Bacopa monnieri	Meta-analysis and network meta-analysis of randomised trials; randomised, double-blind, placebo-controlled trials at 300–450 mg/day	Working and delayed memory; attention and reaction time; anxiety and depression scores in elderly participants; stress-reactivity and mood measures	Relevant to cognitive vitality and mental resilience rather than to muscular performance
Mucuna pruriens	Prospective uncontrolled human cohorts at 5 g/day; randomised, double-blind controlled trials in Parkinson's disease at gram-level doses	Increased testosterone and luteinising hormone, improved semen parameters and lower cortisol in infertile men; demonstrated dopaminergic activity	Promising but population-specific reproductive evidence from uncontrolled cohorts, with a well-characterised levodopa mechanism
Chlorophytum borivilianum	Randomised, double-blind, placebo-controlled pilot trial at 3 g/day for two months	Improved six-minute walk distance in healthy volunteers	Emerging human evidence for physical performance; mixed cohort without a female-specific estimate
Magnesium	Randomised controlled exercise and recovery studies at 350 mg/day; crossover trial in recreational runners; a controlled premenstrual trial at 360 mg/day	Reduced delayed-onset muscle soreness; lower interleukin-6 and improved post-exercise blood-glucose recovery; premenstrual mood symptoms	Direct recovery and muscle-function rationale, most persuasive where intake or status is inadequate
Zinc	Systematic review of the zinc–testosterone relationship; controlled and uncontrolled repletion studies; randomised trial at 45 mg/day for 12 months; meta-analysis of six dysmenorrhoea trials in 739 participants	Restoration of normal testosterone in deficient men; reduced infection incidence and oxidative-stress markers; large pooled reduction in menstrual pain severity	Strong nutritional physiology with context-dependent endocrine effects; a repletion rather than an enhancement rationale
Lentinula edodes	Randomised dietary intervention at 5–10 g/day of dried mushroom; placebo-controlled crossover of a soluble beta-glucan; clinical microbiota trial	Increased ex vivo T-cell and natural-killer T-cell proliferation; increased secretory IgA; increased circulating B cells; microbiota modulation	Immune-oriented contribution to general wellbeing, with no hormonal, strength or endurance evidence
Piperine	Human pharmacokinetic studies at 5 mg and 20 mg	Increased systemic exposure to coenzyme Q10 (approximately 30% AUC increase) and to curcumin	Formulation-support rationale established as proof of principle; effects are substrate-specific and require compound-specific confirmation

6. Mechanistic Convergence

The human outcomes summarised above are compatible with several overlapping physiological pathways, and the mechanistic detail is worth stating because it explains why the domains overlap without implying that the ingredients are interchangeable.

Ashwagandha and *Panax ginseng* are usually interpreted through stress-adaptation and neuroendocrine mechanisms, and the human data are consistent with that reading: pooled reductions in serum cortisol[5,6], a rise in serotonin in the same pooled analysis[6], and suppression of the placebo-arm rise in salivary cortisol and cortisone during a pre-season training block[14]. *Bacopa monnieri* contributes cognitive and stress-response relevance, with its randomised evidence concentrated in memory, attention and reaction-time domains[35,36]. *Mucuna pruriens* provides dopaminergic and reproductive-endocrine plausibility, its seeds containing levodopa whose clinical activity is demonstrated in controlled Parkinson's disease trials[43,44]. Fenugreek is associated with steroidal saponins and furostanol glycosides and with metabolic–endocrine signalling, the glycoside fraction being the preparation used in one of its positive androgen trials[22]. Magnesium and zinc contribute indispensable nutritional roles in cellular energy metabolism, neuromuscular function and endocrine physiology, both being the subject of recognised nutrient–function relationships[49]. Shiitake-derived preparations influence immune-cell activity[64] and intestinal microbial composition[66]. Piperine can modify intestinal and metabolic handling of selected co-administered compounds through inhibition of CYP3A4 and P-glycoprotein[71].

A multi-ingredient nutraceutical may therefore be conceptually useful when the intended outcome is broad wellbeing rather than a single pharmacological target, because the constituent mechanisms are distinct enough to address different components of the same experience. Nevertheless, mechanistic complementarity is a hypothesis about the combination, not proof of synergy. Demonstrating synergy requires direct pharmacokinetic or clinical comparison of the finished formulation against appropriate controls, and nothing in the ingredient literature substitutes for that comparison.

7. Safety, Tolerability and Responsible Use

Most of the human studies cited in this review report acceptable short-term tolerability of the individual ingredients in the populations studied, and the largest dedicated safety study of any component supports that picture directly: a randomised, multi-centre, double-blind, placebo-controlled trial in 1,002 adults aged 18–65 years given 600 mg/day of ashwagandha root extract in two divided doses (n = 498) or placebo (n = 504) for eight weeks recorded no serious adverse events, fewer adverse events on extract than on placebo (28, 5.6% against 46, 9.2%), no difference in tolerability ($p = 0.487$), and no significant changes in liver-function tests, renal-function markers or haematology[73]. Responsible stewardship of a multi-ingredient product nevertheless requires that the ingredient-specific considerations below are stated plainly and carried onto consumer-facing information, because a formulation that combines eight botanicals brings several precautions onto one label even where each individual quantity is modest.

The hepatic signal associated with *Withania somnifera* is the most consequential of these and is idiosyncratic rather than dose-dependent. A scoping review searching the literature to December 2025 identified 25 patients across 13 publications from multiple global regions: cholestatic or mixed phenotypes predominated and most patients recovered on discontinuation over weeks to months, but severe outcomes included one case of acute liver failure requiring liver transplantation and three deaths among patients with pre-existing cirrhosis who decompensated, and the authors advise that patients with advanced chronic liver disease should be counselled to avoid ashwagandha[74]. Because the signal is idiosyncratic, it warrants clear expression irrespective of the quantity supplied, and the practical implication is straightforward: people with advanced chronic liver disease should avoid the ingredient, and clinically, discontinuation and medical assessment are appropriate when symptoms suggestive of liver injury develop.

Ashwagandha also has a thyroid consideration. A meta-analysis of 23 randomised trials in 1,706 participants found no effect on thyroid-stimulating hormone or triiodothyronine but a small rise in thyroxine, MD +0.61 µg/dL, $p = 0.02$[6], and a case of painless thyroiditis has been described in a previously healthy 47-year-old man whose symptoms and thyroid markers improved after stopping the supplement[75]. No human interaction study exists. People with known thyroid disorders or complex medication regimens should therefore use the ingredient under clinical advice rather than assume its neutrality.

Mucuna pruriens requires specific attention because its seeds contain levodopa, which is the source of both its pharmacological interest and its interaction profile. Levodopa content varies about thirteen-fold across commercial products, so exposure cannot be inferred from the botanical name, and no

safe use level has been defined[45]. Reported interactions and adverse effects include those with monoamine oxidase inhibitors, antipsychotics, levodopa itself, antihypertensives, glucose-lowering medicines and anaesthetics, and hallucinations, confusion and dopamine dysregulation syndrome have been described[45,76]. Anyone taking dopaminergic medication, and anyone taking glucose-lowering therapy, an anticoagulant or another narrow-therapeutic-index medicine, should seek advice before using a *Mucuna*-containing product, and tolerability over longer periods is not established — the one controlled trial to report it, a 16-week randomised crossover in advanced Parkinson's disease, recorded 50% discontinuation[77].

Fenugreek carries two well-defined considerations. The first is legume cross-reactivity: allergenic proteins share homology with the peanut allergens Ara h 1 and Ara h 3, and symptoms have been elicited by approximately 2 mg in challenge[78,79], so a clear precaution for people allergic to peanut, soya or other Fabaceae is appropriate. The second is glucose lowering: pooled analysis found a reduction in HbA1c (MD –0.88, 95% CI –1.49 to –0.27) with null effects on fasting and postprandial glucose[80], and the European monograph advises caution alongside glucose-lowering therapy[86], so people on such therapy should monitor and seek advice. The general point about co-medication extends beyond fenugreek: users taking anticoagulants or other narrow-therapeutic-index medicines should treat any multi-botanical product as requiring a medication review rather than as inert.

For *Panax ginseng*, headache, sleep disturbance and gastrointestinal upset are among the more commonly reported events in short-term trials, and combination products carry more adverse-event reports than single-ingredient preparations[81]. A randomised controlled trial demonstrated that American ginseng (*Panax quinquefolius*) reduces warfarin's effect, with a peak INR difference of –0.19, P = 0.0012[82]; this is best treated as a class precaution for people on warfarin rather than as a demonstration for *Panax ginseng* itself, and it points to medication review as the appropriate response.

Piperine's relevance to safety follows directly from the property that makes it useful in a formulation. It inhibits CYP3A4 and P-glycoprotein in vitro[71], which is the mechanism by which it can raise systemic exposure to co-administered compounds[69,70]; a human crossover study using 24 mg found no meaningful change in the pharmacokinetics of midazolam, flurbiprofen and paracetamol[72], so the clinical magnitude appears limited and substrate-dependent. The proportionate implication is not alarm but caution: anyone taking a medicine with a narrow therapeutic index should be aware that a pharmacokinetic modifier is present in the formulation and should discuss it with a prescriber.

The remaining considerations are more contained. Bacopa is generally well tolerated, with digestive complaints and headache the most consistent adverse effects and significantly more frequent than placebo in one controlled trial ($p = 0.024$)[39]. Shiitake is widely consumed as food and is generally tolerated, although a small susceptible subgroup can develop flagellate dermatitis attributed to lentinan hypersensitivity — reported at 10% incidence among sensitive individuals in a trial of processed bars — or allergic and gastrointestinal reactions[67,83]. *Chlorophytum* exposure in short-term human use was generally tolerated, but the safety database is small and botanical authentication matters because adulteration with related species has been reported[48]. For the minerals the precautions are the least demanding: zinc can cause gastric irritation and is conventionally taken with food, and copper interference arises only at chronic intakes of 50 mg or more, well above the amounts used in supplement formulations, against an upper intake level of 40 mg/day[84,85]; magnesium can cause osmotic diarrhoea, requires caution in renal impairment, and should be spaced from bisphosphonates, tetracyclines, quinolones and proton-pump inhibitors[55].

Pregnancy, lactation and childbearing potential warrant a conservative advisory across the combination. The European herbal monograph for fenugreek advises against medicinal use during pregnancy, lactation and in women of childbearing potential not using contraception, because human data are limited and high-dose animal studies reported reproductive toxicity[86]. For *Panax ginseng*, use in pregnancy and lactation is not recommended in the absence of sufficient data[87]. *Mucuna pruriens* has no human pregnancy or lactation database and contains levodopa, and *Withania somnifera* has one small open-label randomised trial in 70 women in the second trimester of pregnancy given 600 mg/day for 12 weeks, in which no adverse events occurred, and hepatic, renal, cardiac and thyroid markers showed no detrimental effect, with no lactation evidence at all[88]. *Chlorophytum* and shiitake also lack adequate

reproductive datasets. A conservative pregnancy, lactation and childbearing-potential advisory is therefore scientifically appropriate, framed as a precaution reflecting limited evidence rather than as proof of harm.

Two further points complete the responsible-use picture. Duration is the principal evidence gap: no controlled safety data extending beyond about four months exist for any of the eight botanicals at any dose, the longest being the 16-week randomised crossover of *Mucuna pruriens*[77]. And potential androgenic dermatological effects have not been systematically assessed; a fenugreek trial in perimenopausal women reported increased free testosterone with reduced sex hormone-binding globulin[25], which could be relevant to people with latent hyperandrogenism, and because polycystic ovary syndrome is common in India[89], future trials should prospectively monitor acne, hirsutism, alopecia and menstrual-cycle changes rather than assume their absence. Clear consumer information and post-market adverse-event monitoring are the appropriate expression of all of this.

Table 3. Ingredient-specific safety considerations and their practical implications.

Ingredient	Consideration	Practical implication
Withania somnifera	Cholestatic and mixed drug-induced liver injury; 25 patients across 13 publications, one liver transplantation and three deaths among patients with pre-existing cirrhosis; thyroxine rises modestly (MD +0.61 µg/dL); no human interaction or lactation data	Rare but clinically important and idiosyncratic rather than dose-dependent; avoid in advanced chronic liver disease, counsel users to stop and seek assessment if jaundice or persistent nausea occurs, and advise caution in thyroid disorders and complex medication regimens
Mucuna pruriens	Levodopa content varies about thirteen-fold across products; interactions with monoamine oxidase inhibitors, antipsychotics, levodopa, antihypertensives, glucose-lowering medicines and anaesthetics; hallucinations, confusion and dopamine dysregulation syndrome reported; no safe use level defined	Standardise and declare levodopa content, and include explicit medication cautions covering dopaminergic, glucose-lowering, antihypertensive and narrow-therapeutic-index therapy
Trigonella foenum-graecum	Cross-reactivity with peanut, soya and other Fabaceae, with symptoms elicited by approximately 2 mg in challenge and homology with Ara h 1 and Ara h 3	Include a clear legume-allergy precaution rather than relying on the small quantity present
Trigonella foenum-graecum	Glucose lowering, additive with sulfonylureas and insulin; medicinal use not advised in pregnancy, lactation or in women of childbearing potential not using contraception	Advise glucose monitoring and prescriber discussion for people on antidiabetic therapy, and carry a pregnancy and lactation advisory
Panax ginseng	Headache, sleep disturbance and gastrointestinal upset; American ginseng reduces warfarin's effect (peak INR difference –0.19, P = 0.0012), a class precaution rather than a demonstration for *Panax ginseng*; combination products carry more adverse-event reports	Medication review is appropriate, particularly for people on warfarin or other anticoagulants
Bacopa monnieri	Digestive complaints and headache, significantly more frequent than placebo in a controlled trial (p = 0.024)	Advise taking with food and discontinuing if symptoms persist
Lentinula edodes	Flagellate erythema, reported at 10% incidence among sensitive individuals in a trial of processed bars and attributed to	Advise avoidance in known mushroom sensitivity

	lentinan hypersensitivity; allergic and gastrointestinal reactions with eosinophilia	
Chlorophytum borivilianum	Small human safety database; adulteration with related species reported	Botanical authentication of raw material and continued post-market monitoring
Piperine	CYP3A4 and P-glycoprotein inhibition in vitro; clinically null on midazolam, flurbiprofen and paracetamol at 24 mg in humans	Likely limited at the quantities used in supplements, but retain a caution for people taking narrow-therapeutic-index medicines
Zinc	Gastric irritation; copper depletion at chronic intakes of 50 mg or more, against an upper intake level of 40 mg/day	Take with food; copper co-supplementation is not indicated at supplement-level intakes
Magnesium	Osmotic diarrhoea; caution in renal impairment; interacts with the absorption of bisphosphonates, tetracyclines, quinolones and proton-pump inhibitors	Space dosing from the affected medicines and advise caution in renal impairment

8. Limitations of the Evidence Base

This is a narrative review rather than a registered systematic review. It was not registered with PROSPERO, no formal risk-of-bias instrument was applied, and no de novo meta-analysis was performed, so study selection and weighting involved judgement. Recent meta-analyses and randomised trials were prioritised, and every bibliographic record was cross-checked twice, but the synthesis remains interpretive. To reduce directional bias, positive controlled findings are presented first within each subsection while neutral, null and contradictory findings are retained rather than omitted.

Formulation and standardisation heterogeneity is the most substantial scientific limitation. Botanical species, plant part, extraction solvent, drug–extract ratio, marker-compound content and manufacturing process can all materially affect biological activity, and the presence of a botanical name does not establish equivalence with the standardised preparation used in a published trial. The positive ashwagandha trials used extracts characterised for withanolide content, including one standardised to more than 5% withanolides[13] and one to more than 15% w/w[15]; the Bacopa trials used preparations of varying bacoside content[38]; the ginseng cognitive results were obtained with the defined G115 extract[31]; the *Mucuna* results depend on levodopa content that varies widely across products[45]; the fenugreek results were generated with defined saponin- and glycoside-containing preparations[21,22,24]; and the shiitake findings used gram-level mushroom or beta-glucan preparations whose source material and beta-glucan content govern their interpretation[64,66]. Comparison of any other preparation with these trials therefore requires equivalent analytical characterisation, and this review deliberately does not attempt such a comparison. A human pharmacokinetic study of a *Withania somnifera* root extract containing not less than 7.5 mg of total withanolides, which produced plasma concentrations in the low nanogram-per-millilitre range in healthy volunteers, indicates the kind of characterised data on which such comparisons would eventually rest[90].

Population specificity is a second limitation. Several positive findings come from defined groups — resistance-trained or team-sport athletes[11–14], healthy ageing men[21], perimenopausal women[17], women with low sexual desire[16], men undergoing infertility evaluation[18,41,42] and people with Parkinson's disease[43,44] — and results generated in one such setting should not be assumed to transfer to another. The literature is also uneven across sex: several mixed-cohort trials do not report subgroup analyses, and the exercise literature is rarely sex-stratified, the two exceptions in this review having pre-specified stratification[13,14].

Publication bias and sponsor affiliation are a third. Both are plausible in commercially studied botanical extracts, and the record shows them: ingredient-owner or commercial affiliation is visible in most of the positive fenugreek trials[21,22,25,26], two of the positive ashwagandha exercise trials were conducted at contract research organisations using proprietary branded extracts[12,15], and across 32 randomised trials of 13 herbs investigated for testosterone, six were judged at low risk of bias[3]. These observations are reported without inference about the direction of any individual result; they indicate where independent

replication would add most, and the existence of independently conducted null trials[19] shows that such replication is feasible.

Finally, and most importantly, there is no randomised controlled trial of the complete T MAX+ combination. Ingredient-level evidence provides scientific rationale for research and formulation design, but finished-product efficacy, tolerability, pharmacokinetics and any interactions among constituents require direct clinical evaluation. The absence of such a trial means that benefit from the combination remains plausible and untested; it should not be read as evidence that the combination has no effect, and equally it cannot be read as evidence that it does.

9. Future Research Priorities

The most informative next step would be a randomised, double-blind, placebo-controlled trial of the finished nutraceutical in adults of both sexes, of at least 12 weeks' duration. A general-wellbeing design could use a validated fatigue or perceived-stress instrument as the primary outcome and include objective physical-function testing, recovery measures, sleep quality, quality of life and sex-stratified endocrine markers as secondary outcomes. Pre-specification of male and female subgroup analyses would be important, because several of the ingredient literatures show sex- or population-specific effects and only two of the trials reviewed here pre-specified such stratification[13,14]. Safety monitoring should cover gastrointestinal symptoms, liver and thyroid function where appropriate, menstrual-cycle changes and androgenic dermatological events[25,74,75,89].

Parallel analytical work is a prerequisite rather than an optional extra. Botanical identity, plant part, extraction solvent, drug–extract ratio and marker-compound profiles should be documented for every botanical constituent — withanolides for ashwagandha, bacosides for Bacopa, ginsenosides for *Panax*, levodopa for *Mucuna*, the relevant saponins or glycosides for fenugreek and safed musli, and beta-glucans with source material for shiitake — because this is the information that makes any comparison with the published trials possible at all[38,45,90]. Analytical authentication also addresses the adulteration risk documented for safed musli[48].

A pharmacokinetic substudy would answer a question the current literature leaves open. Piperine's bioenhancing effect is established as proof of principle for coenzyme Q10 and curcumin[69,70] but is substrate-dependent and was clinically null for three probe drugs in one human crossover[72]; whether a piperine-containing formulation changes exposure to withanolides, bacosides, ginsenosides or fungal beta-glucans has not been tested, and a substudy measuring plasma markers of the co-administered botanicals with and without piperine would settle it.

Three further priorities follow from the gaps identified in this review. Longer controlled safety data are needed, since no controlled dataset extends much beyond four months for any of the eight botanicals[77]. Dedicated, adequately powered trials with fatigue as the sole primary endpoint would strengthen the domain in which the multi-ingredient rationale is most intuitive but the pooled evidence thinnest[29,33]. And targeted single-component studies may be useful where the ingredient-level evidence is most mature — zinc and menstrual comfort is the clearest example[59] — provided they are kept methodologically separate from the principal evaluation of the finished product. Taken together, these steps would convert a plausible ingredient-level rationale into product-specific evidence.

10. Conclusion

The ingredients of T MAX+ have a substantial and diverse human research base relevant to the broad concept of adult vitality. The most consistent evidence is seen with *Withania somnifera*, which carries randomised, pooled evidence for reduced perceived stress, anxiety and cortisol, improved sleep, a muscle-strength effect that is largest in physically active participants, an exercise-performance effect strongest in aerobic endurance, and a modest positive effect on testosterone, together with randomised findings in perimenopausal women and in women with low sexual desire. *Trigonella foenum-graecum* contributes randomised androgen, strength and menopausal quality-of-life findings; *Panax ginseng* contributes pooled fatigue evidence with supporting cognitive, calmness and menopausal results; *Bacopa monnieri* contributes memory, attention and stress-reactivity evidence; magnesium contributes controlled recovery and premenstrual data on a foundation of established nutritional physiology; and zinc contributes repletion

evidence relevant to normal testosterone alongside immune and menstrual-comfort findings. *Mucuna pruriens*, *Chlorophytum borivilianum*, *Lentinula edodes* and piperine provide more focused but directionally supportive human evidence in stress-related male reproductive physiology, walk-distance performance, immune measures and pharmacokinetics respectively. Alongside this, the review sets out ingredient-specific safety considerations — most importantly the idiosyncratic hepatic signal associated with ashwagandha, the levodopa content of *Mucuna* and its medication interactions, legume cross-reactivity and glucose lowering with fenugreek, and piperine's capacity to modify the handling of co-administered compounds — because responsible product stewardship requires that these travel with the positive evidence rather than behind it.

These findings support continued scientific investigation of T MAX+ as a multi-domain nutraceutical concept without treating the ingredient literature as proof of finished-product efficacy. The evidence belongs to the preparations, doses and populations that generated it, and the boundaries of that evidence — heterogeneity in the stress meta-analyses, a prediction interval that crosses zero for exercise performance, population-dependent hormonal responses, sponsor affiliation in parts of the botanical record, and the absence of controlled data beyond about four months — are visible and worth stating. The most defensible academic position is therefore that the formulation brings together ingredients with genuine human evidence relevant to stress, fatigue, physical function, recovery, hormonal physiology and general wellbeing, and that a randomised controlled trial of the finished combination remains the standard required before any of those domains is described as an effect of the product itself.

Declarations

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