



Effectiveness of Plant Adaptogens in Sports: Bibliometric Study and Prospects for Use

Igor V. Goncharenko^{1,2*}, Viktoriia A. Pastukhova¹, Halyna V. Lukyantseva¹

¹Department of Medical and Biological Sciences, National University of Physical Education and Sports of Ukraine, Kyiv, Ukraine

²Department of Environmental Monitoring, Institute for Evolutionary Ecology of the National Academy of Sciences of Ukraine, Kyiv, Ukraine

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Abstract

Rehabilitation of professional athletes faces objective difficulties associated with excessively intense loads and a short period between competitions. The use of plant adaptogens can improve the quality of the recovery process and reduce the time required for athletes to recover. The main purpose of the study was to review the use of adaptogens in sports; to analyze the dynamics of scientific publications over a 50-year period (1970-2024), and to determine the highest priority areas for their use in sports. The analysis was carried out using a bibliometric approach based on the PubMed / Scopus resources with the classification of outcomes by year, branch of science and individual adaptogens. The share of publications for the last 5 years was calculated as an indicator of the current research trend. An exponential trend of increasing the number of publications has been established, and over the past 5 years, their share has amounted to 28.3% of the number over a 50-year period. Despite the traditional popularity of *Panax ginseng*, other plant adaptogens have also recently shown an increase in publication activity, especially in studies of the adaptogenic properties of *Rhodiola rosea* (38.8% of publications over the last 5 years). The analysis of publications allowed us to classify the most promising directions of their use in sports. Various publications have noted effects such as increased athletic performance, normalization of stress hormones after competitions, acceleration of healing of injuries, stimulation of muscle mass gain, an antidepressant effect, as well as acclimatization during intercontinental flights and preparation for competitions in unfavourable conditions.

Keywords: Complementary and alternative medicine; Plant adaptogens; Sports; Bibliometric study; Literature review; Sports performance

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*Corresponding Author: Igor V. Goncharenko

Department of Medical and Biological Sciences, National University of Physical Education and Sports of Ukraine, Kyiv, Ukraine

Email: goncharenko.ihor@gmail.com

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Introduction

The rehabilitation of professional sports athletes faces objective difficulties associated with excessively intense loads and a short period between competitions [1-4]. The training cycle of an athlete necessarily includes a recovery period [5]. Ignoring this indisputable fact, shortening it, not paying due attention to it, or poorly performed recovery can lead to accelerated wear and tear on the body, accelerate the ageing process, and create the preconditions for chronic distress. The use of plant adaptogens plays a significant role in reducing the time required for recovery after training and improving the quality of the recovery process [6-9].

The recovery period is the time required for the body to recover from intense physical activity. It is individualized for each athlete and depends on many factors, including training intensity, duration of competition, physical fitness, and general health [10]. The recovery period includes several aspects:

- Regeneration of muscle tissue – recovery involves the healing of microtraumas, renewal of protein structures and energy reserves in the muscles [11].
- Recovery of the nervous system - intense training causes overstrain and exhaustion of the nervous system.
- Restoration of energy resources - the recovery period allows you to restore glycogen stores in the muscles.
- Preventing fatigue - fatigue is a consequence of nervous system exhaustion and leads to a decrease in athletic performance, increased risk of injury and loss of motivation.

The purpose of the study is to analyze the literature on the use of adaptogens in sports, to identify the most priority areas of their use, to analyze the dynamics of scientific publications on individual plant adaptogens over a 50-year period (1970-2024) and over the past 5 years.

Materials and Methods

The materials used for the analysis were scientific articles on the use of plant adaptogens in medicine and sports, according to PubMed, Scopus, and websites of individual journals. Given that the topic of adaptogens is very broad, we did not aim to highlight the mechanisms of their effect on the body in detail, as these aspects are still little known. Therefore, our task was first of all to identify those areas where the use of plant adaptogens is most promising in terms of high-quality recovery of the athlete's body and preparation for intense training and competitions.

Publication activity was analyzed using data from the PubMed library (<https://pubmed.ncbi.nlm.nih.gov>), the full name of PubMed Central®, is the largest full-text biomedical library created by the National Center for Biotechnology Information (NCBI) in 1997 (<https://www.ncbi.nlm.nih.gov>). It has basic tools

for bibliometric analysis, including citations by year, searching with Boolean constructs, and significant time coverage (most of it after 1966) with 26.8 million records with links to full-text versions.

The analysis of publication activity was based on a bibliometric approach (Figure 1). The search queries used were "adaptogens", "adaptogens AND sports", "adaptogens AND medicine", including the full text of the documents. We determined the number of publications for the period 1970-2024, which is best represented in the PubMed database, as well as for the last 5 years. The share of publications for the last 5 years was calculated as an indicator of the current dynamics of publication activity. The proportion of publications for each herbal adaptogen species was also calculated. We do not claim that such a figure is indicative of the efficacy of a particular substance. However, such a figure may well indicate the priorities of scientific research, especially if we are talking about the last 5-year period.

We devoted the discussion of our article to the analysis of the most promising areas for the use of adaptogens in sports. The purpose of this part of the literature review was to classify publications from the websites of various scientific journals. Although the mechanisms of action of many adaptogens are not fully known both in science and in medicine, evidence has already accumulated that turns plant adaptogens into an integral part of the recovery period in athletes.

Results

Figure 2 shows an increasing exponential trend in the issue of adaptogens over a 50-year period, especially in the last twenty years. The decline in the curve in the current year is the result of the delay required to index all articles and does not affect the overall trend.

Since the early 2000s, the number of publications devoted to adaptogens has been growing sharply, which proves the growing interest in their use. Potential drivers stimulating growing interest in the study of adaptogens are associated with increased levels of stress in modern life, their natural origin, significant accumulated experience of use in alternative medicine, as well as the search for new methods of maintaining health and improving the quality of life and preventing various diseases. In the future, the growing trend of adaptogen research is likely to continue, given the growing discrepancy between stress levels and the body's adaptive capabilities.

The leaders in research activity by country (according to the Scopus database) are India (14%) and the United States (12%) (Figure 3). This distribution is uneven since the first four countries account for 48% of all publications, that is, almost half.

The distribution proportions are influenced by population size, certain traditions of naturopathic medi-

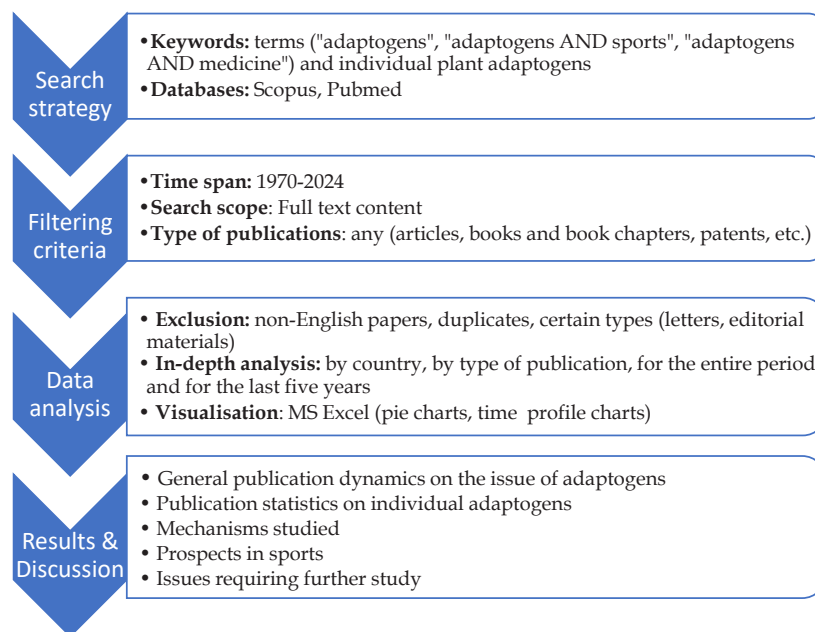


Figure 1. Research protocol for the bibliometric study and further logic of analysis

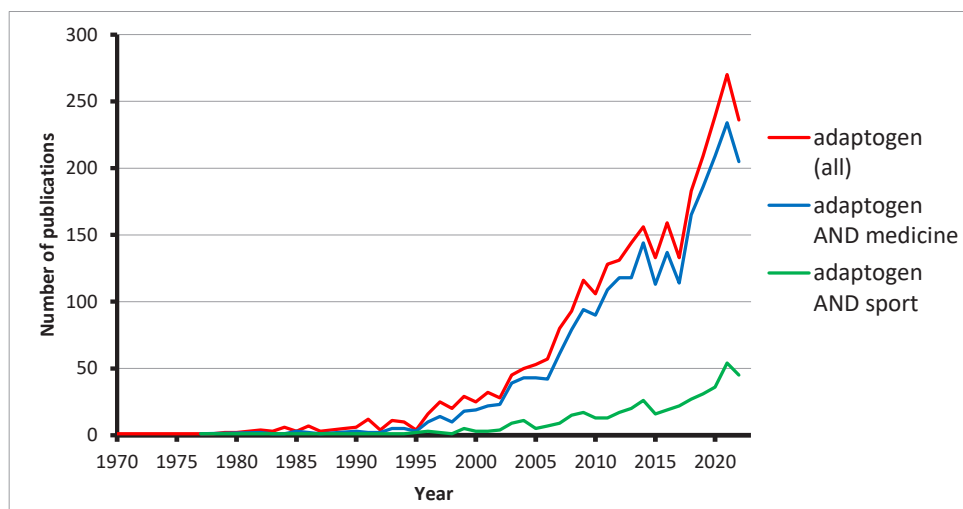


Figure 2. Dynamics of publication activity on the issue of adaptogens by years according to PubMed database (1970 – 2024)

articles, 73% (Figure 4). It is the format that is most optimal for displaying the results of modern scientific experiments. In turn, this indicates an active phase of research on the issue of adaptogens.

The distribution of publications by area of knowledge indicates the main directions of research activity (Figure 5). It is mainly aimed at medical properties and use in medicine (22%). However, they are also intensively studied for their biochemical composition and pharmacological properties, as evidenced by publications in the fields of pharmacology (20%) and biochemistry

cine, especially in India, which is a world leader in this matter, and the high cost of such research. At the same time, the last factor is not the key one, since a small number of publications occur even in economically prosperous countries, such as South Korea (4%), Germany (3%) and others. Thus, the number of publications correlates to some extent with economic and demographic factors, but the main and determining factor is the tradition of complementary and alternative medicine in a particular country.

The bulk of publications devoted to adaptogens are

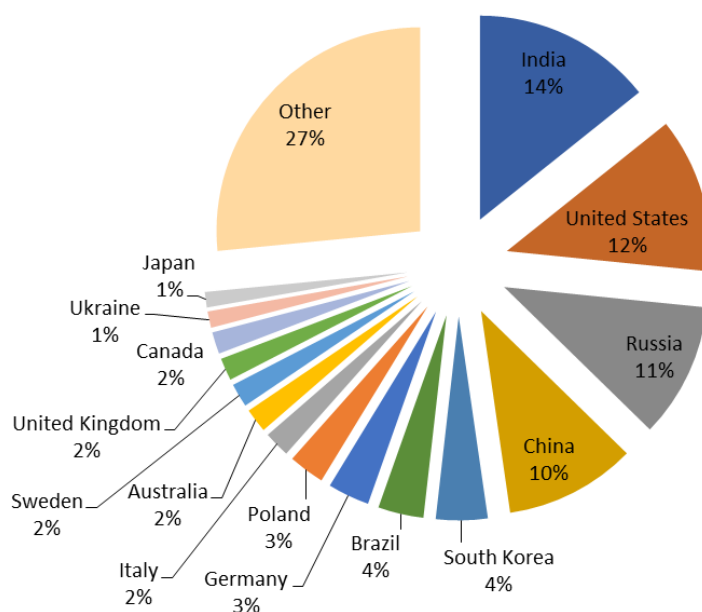


Figure 3. Distribution of the number of publications on plant adaptogen issues by countries

(17%) (Figure 5).

Table 1 shows the results of the analysis of publication activity on the issue of adaptogens according to the PubMed database. Bibliometric data were calculated separately for term mentions as well as for different herbal adaptogens.

The share of publications for the last 5 years is significant and amounts to 28.3%, given that this period is only 1/10 of the total analyzed period. Almost half of the publications (49.9%) are devoted to the use of adaptogens in medicine. The number of similar papers in the sports literature is much smaller – 6.6%, which should be interpreted as a great potential for research in this area. The proportion of publications over the past 5 years in both medicine and sports ranges from 24.6% to 33.8%, which means that the trend toward increased interest in adaptogens in both fields is significant.

Ginseng (*Panax ginseng*) accounts for the largest number (more than 70%) of publications, but this is more of an inertial process due to its long-standing use in medicine. Other adaptogens, such as aralia (*Aralia* sp.) and maral root (*Rhaponticum carthamoides*), are less studied - the percentage of their publications is 0.8% to 1.0%. However, the share of publications for the last 5 years for these species is just as high (27.9% - 34.5%), i.e. the research on less "popular" adaptogens is also being conducted with increasing intensity.

The share of publications cannot be a criterion of the impact (effectiveness) on the body and reflects mainly the traditions of using adaptogens. In terms of the number of publications in the last 5 years,

Rhodiola rosea and *Schisandra chinensis* are even ahead of *Panax ginseng* and come out on top (38.8%). Given that *Schisandra* is also used as a food product, *Rhodiola rosea* should be ranked first in terms of the number of publications in recent years. According to some scientists, it is one of the most powerful adaptogens, surpassing even *Panax ginseng* in certain properties.

Discussion

Adaptogens: terminology and mechanisms

Adaptogens are natural, mostly plant-based, biologically active substances that increase the body's resistance to adverse factors of various nature (heat, cold, physical activity) and reduce the negative impact of their effects on the body [12]. The term "adaptogen" was coined in 1947 by M. Lazarev, who used it to refer to substances that, in his opinion, increase "the body's nonspecific resistance to stressful influences of various nature" [13].

The list of plant adaptogens is far from complete. It would be correct to distinguish between "classical" adaptogens, in which the adaptogenic effect is the main one (*Panax ginseng*, *Rhodiola rosea*, etc.), and plants with adaptogenic properties, the list of which is much longer. Among them are *Echinacea* (prevention of colds, improvement of immunity), *Salvia* (anti-inflammatory and wound healing properties), *Ashwagandha* (mild correction of insomnia), etc. In addition, drugs and food additives of animal origin (reindeer antlers, bee's milk, etc.) are also used as adaptogens. There are also adaptogens of synthetic

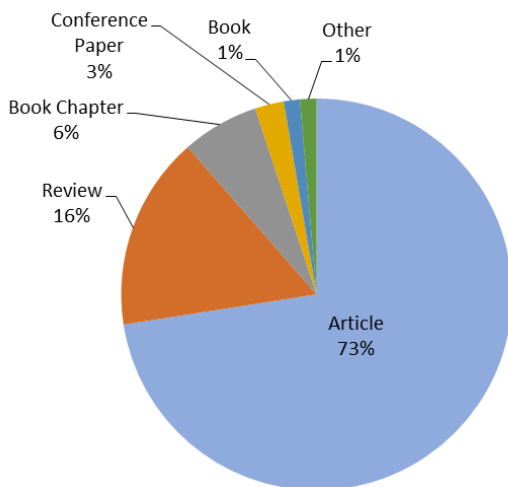


Figure 4. Distribution of the number of publications devoted to adaptogens by types of publications

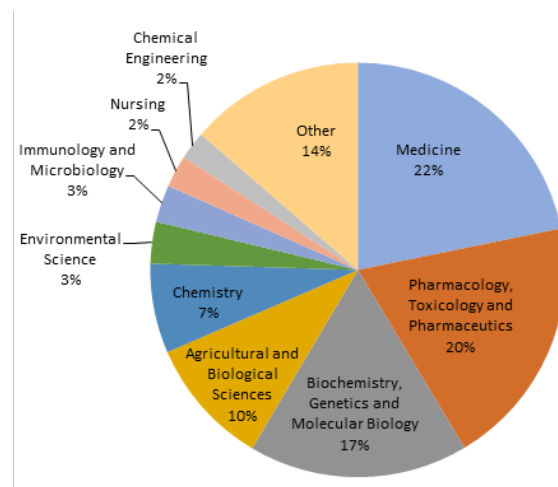


Figure 5. Distribution of the number of publications devoted to adaptogens by field of knowledge

origin, but both groups do not play a significant role in medicine, and therefore, from now on, we understand adaptogens as only products of plant origin.

The lack of a clear nomenclature and a clear understanding of the mechanism of action of adaptogens has several understandable reasons.

1. Complexity (mixture nature) of plant materials. All plant adaptogens contain not one, but a significant number of biologically active substances, and they affect different aspects of nonspecific adaptation.

2. Complexity of the functioning of the organism's systems: nervous, endocrine, and immune systems. These systems are primarily affected by stress, and the body's resistance and endurance depend on their resistance.

3. Measuring positive shifts (increasing resistance, reducing chronic stress, etc.) is quite difficult to measure. As a consequence, the nomenclature of adaptogens itself becomes blurred – so many body aspects are affected by their effects.

It should be noted that at least in part of the medical community, there is some scepticism about adaptogens. This is due to the relatively small number of placebo-controlled and randomized studies. In defence of adaptogens, we say that it is not an argument against adaptogens, but is due to their multicomponent nature and complex effect. It is quite difficult to isolate their effect in "pure" form to measure in terms of evidence-based medicine. At the same time, the number of publications and their intensive growth in recent years convincingly prove the interest in this group.

Despite the absence of a clear nomenclature of adaptogens, they are recognized by common features of their impact. In particular, all adaptogens have a cumulative and non-specific character. To achieve a therapeutic effect, a course of treatment is required, optimally

for several weeks (the time varies from 7-10 to 21-30 days, usually two weeks). The adaptogenic effect is achieved through the modulation of various mechanisms, including the cellular level and the synthesis of protein regulatory molecules, as well as the various systems especially the endocrine one, including the hypothalamic-pituitary-adrenal axis, which is responsible for the body's response to stress.

The most studied adaptogens, as confirmed by numerous scientific papers (Table 1), include *Rhodiola rosea* and *Panax ginseng*. In addition to the adaptogenic effect itself, other beneficial properties have been shown for *Panax ginseng*:

- antidiabetic activity [14];
- antitumor properties [15,16];
- improving cognitive performance [17];
- immune-stimulatory effects [18];
- antithrombotic properties [19].

Most adaptogens show similar properties, but some have more pronounced one or another of them, which can find practical applications for solving certain problems. For *Rhodiola rosea*, for example, a large number of publications indicate strong effects on the heart muscle [20,21] together with angiomodulatory properties [22]. And given the heavy loads of athletic competition, we expect *Rhodiola rosea* to have even more potential than *Panax ginseng* specifically for athletes.

In any case, adaptogens are still in the active research phase. But already at this stage, it is clear that the commonality of the mechanisms of action of adaptogens is due to the commonality of the "final pathway". In particular, it is an increase in the functional capabilities of the body as a whole, elimination of asthenic conditions; immunomodulatory effect; prevention of colds; activation of glucose

phosphorylation; improvement of fat and protein metabolism; counteraction to the toxic effects of free radical oxidation; increased glycogen accumulation in muscles; mental performance, etc. As we can see, all these effects can be characterized as tonic or normalizing.

Prospects of use in sports

The use of adaptogens in sports has significant prospects even though the number of publications is inferior to research on them in medicine. By priority areas for the use of adaptogens in sports, we mean directions in which there is proven scientific research on the benefits of their use both in training and recovery periods.

1. Increased physical performance and fatigue reduction.

Most adaptogens can affect endurance, physical performance, and muscle strength. The special significance of plant adaptogens for increasing strength and endurance is that they are non-doping stimulants. Scientific publications on the use of adaptogens to increase strength in sports are the most numerous. *Panax ginseng*, *Eleutherococcus senticosus*, *Schisandra chinensis*, and *Rhodiola rosea* are generally mentioned in this regard [9,23]. The effect of the latter on the transverse striated muscle tissue, as well as on the heart muscle (increased contractility), is particularly strong, which is of key importance for athletes.

2. Normalization of the balance of stress hormones.

The ability of adaptogens to reduce the negative effects of stress factors can be confidently ranked second in terms of importance in sports. Professional sport is a stressful factor both in itself and against the

background of a modern lifestyle and environmental degradation. The normalizing effect of plant adaptogens is achieved through the influence on stress hormones. Excessive exercise leads to an imbalance of anabolic (testosterone and insulin) and catabolic (cortisol) hormones. Thus, the study on 78 athletes showed that a 2-week course of the well-known herbal adaptogens (*Eleutherococcus senticosus*, *Bryonia alba* and *Panax ginseng*) helps to restore the testosterone/cortisol ratio disturbed after intense physical activity [24]. The authors of the study propose to use the testosterone/cortisol ratio as a marker for assessing the plant adaptogens medication, which is optimally achieved in 18-20 hours after intense physical loads.

3. Accelerating recovery from injuries, regeneration of muscle tissue, and wound healing.

Recovering from injuries in sports can be a long and complicated process. Accelerating recovery, as well as normalizing distress, is a main task during the recovery period. With a busy training schedule, the time to recover and prepare for the next competition is a limiting factor for a sports career in the long run. Plant adaptogens help to accelerate and improve the process of tissue regeneration and improve wound healing. The most studied in this regard are *Rhodiola rosea*, *Eleutherococcus senticosus*, and *Schisandra chinensis* [25,26].

4. Prevention of excessive inflammation.

Inflammation is the body's natural response to injury. However excessive or prolonged inflammation can slow down the recovery process. Plant adaptogens have anti-inflammatory properties and can help reduce inflammation. A leader in this regard is *Rhodiola rosea* [27,28] although anti-inflammatory properties are inherent in most adaptogens.

Table 1. The number of publications on adaptogens according to the PubMed database for the period 1970-2024 and the last 5 years.

Search query	Number of publications for the entire period	Number of publications for the last 5 years	Fraction (%) in the last 5 years	Fraction (%) in the category**
	By terms			
Adaptogen + Sport	65	16	24.6	6.6
Adaptogen + Medicine	494	167	33.8	49.9
Adaptogen	990	280	28.3	100
	By scientific name*			
<i>Panax ginseng</i>	11224	3847	34.3	72.9
<i>Rhodiola rosea</i>	1372	532	38.8	8.9
<i>Eleutherococcus senticosus</i>	872	232	26.6	5.7
<i>Schisandra chinensis</i>	1655	642	38.8	10.7
<i>Aralia mandshurica</i>	148	51	34.5	1.0
<i>Rhaponticum carthamoides</i>	129	36	27.9	0.8

*We have aggregated the results based on taxonomic scientific or the most used synonyms, such as *Panax ginseng* (Ginseng), *Rhodiola rosea* (*Sedum roseum*), *Eleutherococcus senticosus* (*Acanthopanax senticosus*), *Aralia mandshurica*, (*Aralia elata*), *Rhaponticum carthamoides* (*Leuzea carthamoides*).

**The proportion was determined by dividing by the total for individual plant species.

5. Activation of cellular metabolism.

The effect of plant adaptogens is mediated by cellular mechanisms of DNA synthesis and regulatory proteins. The final effect is to expand the adaptive capacity of the organism. This cannot be achieved without intensifying metabolism at the cellular level. This effect is inherent in most traditional adaptogens, such as *Rhodiola rosea*, *Panax ginseng*, *Aralia*, etc. [29].

6. Prevention of colds and immune imbalance.

The impact of chronic stress always affects the immune imbalance. Professional sport is complicated by modern living conditions. This inevitably leads to the risk of increased morbidity and susceptibility to infections. Plant adaptogens increase the body's resistance to infections [30]. This is also part of general (nonspecific) adaptation. While effects such as fatigue, overtraining and poor athletic performance are readily apparent, an imbalance in the immune system is more difficult to diagnose. It is not observed immediately, but due to chronic dysfunctional changes. Therefore, the use of adaptogens to prevent an imbalance of the immune system requires preventive measures, especially during the cold season.

7. Psychocorrection and antidepressant effect.

Sport is not only physical but also emotional stress. One of the tasks of sports medicine is to provide psychological support to athletes to help them cope with stress, maintain their motivation, and improve their psychological well-being. Depression in athletes is a serious condition that can negatively affect performance, motivation, and overall health. The antidepressant effect of plant adaptogens is associated with their indirect effects on brain neurotransmitters, including serotonin, dopamine, and norepinephrine, which affect mood, energy, and ultimately motivation to exercise [31,32].

8. Restore muscle mass and stimulate protein synthesis.

Intense physical activity leads to an imbalance of anabolism and catabolism and can lead to muscle loss. Studies on *Leuzea (Rhaponticum carthamoides)* are particularly interesting in terms of muscle mass gain. Among other plant adaptogens, its anabolic properties are the most pronounced, which is associated with the content of phytoecdysterones, natural analogues of testosterone. Recent studies have also shown that *Leuzea* has a stimulating effect on the production of insulin-like growth factor 1 (IGF-1), which in turn promotes muscle tissue anabolism [33]. This is all the more important because plant adaptogens are natural substances that are safe in reasonable dosages, unlike the use of synthetic testosterone because of side effects.

9. Acclimatization of athletes.

An unobvious but important fact that determines the prospects of adaptogens is their ability to prepare the body for sports competition in adverse conditions (in

mountainous, cold climates, etc.), during flights, and on continents with different time and climate zones. There are fewer studies in this area [34], but they are part of the overall picture – the ability of adaptogens to prepare the body for adverse factors of any nature, including cold, heat, high altitude, transcontinental flights, and hard competitions.

The directions of adaptogen medication in sports discussed above are not a complete list. They also can increase tissue resistance to oxygen deficiency; protect against the toxic effects of free radical oxidation; promote glycogen recovery; eliminate post-load acidosis; increase the threshold of fatigue, etc. But even taking into account these areas, adaptogens have significant prospects in sports at different stages of the training cycle, primarily during the recovery period, to counteract (resist) stress factors, and expand the body's functional capabilities.

Judging by the gap we initially identified in the number of publications in the fields of medicine in comparison with sports, some issues require further study. For example, should dosages really be different for athletes versus regular people? Is it possible to take adaptogens directly during or immediately after ultra-high loads? Is this not excessive stimulation of the nervous system, which can harm the athlete? What specific athletic qualities are improved by adaptogens?

Conclusion

The analysis of publication activity shows a significant interest in the use of plant adaptogens in life sciences, medicine, and sports. identified an increase in the number of publications, especially in recent years: about one-third of all publications over the 50-year period, 24.6%–33.8%, come from the last 5 years. This happens due to multiple reasons: the growth of stress factors, chronic diseases, deteriorating living conditions, poor nutrition, exposure to radiation, environmental pollution, etc.

There are relatively fewer references on adaptogens in the sports literature compared to the medical literature (6.6% versus 49.9%). Some scepticism may be due to a lack of understanding of their mechanisms, which, however, is not a consequence of their ineffectiveness. The lack of a stable nomenclature of adaptogens is also associated with the complexity of their biologically active substances, as well as with the complexity of the mechanisms they influence in the human body. To a certain extent, this makes it difficult to measure their effect in numerical terms. The situation is sometimes complicated by the insufficient quality of plant raw materials and the cumulative effect inherent in all adaptogens. Despite all this, we expect a continued trend of growth in publication activity on the issue of adaptogens, including extensive (expanding the list of plants with adaptogenic properties) and intensive

(identifying new properties) research in this area.

All the known effects of adaptogens on the body, including increased functional capacity, increased resistance to negative factors, prevention and elimination of stress effects, metabolic activation, tonic effects on the nervous system, normalization of the balance of stress hormones, etc., have direct and significant implications for the prospects of their use in sports. The use of adaptogens in sports is advisable at all stages of the training cycle, but especially during the recovery period. For example, to prevent conditions caused by the effects of intense exercise, physical and emotional stress, increased wear and tear, and injury to the body of athletes. During the preparation for competitions, the use of plant adaptogens is also important, given their tonic (stimulating) effect on the nervous system, but this effect is not the main priority. Adaptogens, like most natural substances, do not show specificity. In terms of sports performance, their effect on endurance and strength is more pronounced than on speed and coordination. One should always keep in mind that the main effect of adaptogens is cumulative and develops only during a 10-14-day course of use. This is the shortest period in which athletes need to start taking them in the pre-competition phase. As for the recovery period, taking adaptogens is most effective immediately after reducing sport loads and should last at least 10-14 days. Also, there is no point in resorting to taking adaptogens for too long (more than a month) because of the natural decrease in the effectiveness of such use.

Given the natural origin of adaptogens, their non-toxicity, low probability and reversibility of side effects, they have an advantage over pharmaceuticals in terms of their non-exhausting and safe effect in sports medicine. The absence of a strong effect should not be mistaken for no effect at all. The action of all substances of natural origin is complimentary to the human body, that is, it manifests itself only when requested to normalize certain functions. As soon as athletes' performance comes back to normal on the background of taking adaptogens, their effect becomes imperceptible, which can be mistaken for a lack of visible effect. That is, adaptogens are not aimed at leading to changes in metabolism, but, on the contrary, are aimed at returning metabolic parameters to normal.

Plant adaptogens are not doping drugs, they do not belong to psychostimulants, and one should not expect or demand a multiple increase in sports performance. They are not designed for that purpose by their very nature. Adaptogens cannot replace the need to replenish the body's energy resources, sleep and rest. Thus, the main priority of adaptogens in sports is not so much to shorten the recovery period as to make the training cycle more qualitative and comprehensive.

Plant adaptogens are an indispensable background against which to competently deploy nutraceutical support for an athlete for a long-term career, as the risks of increased body wear and tear are much higher in this category of people.

Conflict of Interests

The authors declare that there is no conflict of interest.

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