

Could food supplementation of athletes be sustainable?

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ABSTRACT

Nowadays the world's population is over 8 billion. Within the food industry, the rise of nutritional supplements and their increasing use is clear for all to see. More and more people are moving away from eating meat and trying vegetarian or vegan lifestyle. We also hear that meat-free lifestyle is healthier and can reduce the harmful effects of the greenhouse effect. However, this diet also requires more care to avoid deficiencies of various nutrients and minerals. Are there sustainable sports supplements? What can we as athletes do to ensure sustainability? In this study, we seek answers to these questions, among others.

Keywords: sustainability, nutrition, vegetarianism, food supplement, sport nutrition, food industry

1. Introduction

This study is a literature research about the sustainable athlete diet and supplementation. We have unveiled the importance of sustainability. We would like to get to know the readers about the new ways about sustainable athlete diet and the related research topics.

2. Literature review

1. The role of sustainability in food and agriculture

Agriculture produces a significant proportion of our food raw materials. As the market for food supplements itself is part of the food industry, it is worth observing what factors contribute to environmental and sustainability efforts, starting from the agricultural sector. In this section,

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we seek to highlight the need for, and potential of, sustainable food production. The positive effects of organic farming are worth mentioning. Among others, we can highlight the improved soil quality, increased biodiversity, reduced pollutant content (Panyor, 2020).

It is worth noting that the environmental impacts of food production affect not only the terrestrial but also the marine environment. Agriculture is a major contributor to resource depletion, consuming one third of all arable land, approximately 75% of all water resources and one fifth of all energy (Smil, 2000). It is therefore not surprising that direct greenhouse gas emissions from agriculture are the largest contributor to our total greenhouse gas emissions (IPCC, 2014).

Among the gases directly emitted by agriculture, carbon dioxide, nitrous oxide and methane are worth mentioning, as they are responsible for the majority of agricultural greenhouse gas emissions (IPCC, 2014). 65% of N_2O is produced by agriculture, as denitrification occurs when it is released into the soil as fertiliser (Bajželj et al., 2014, Miranda et al., 2015). Lower amounts of methane can come from rice production (Vermeulen et al., 2012). To a greater extent, it is a consequence of ruminant manure or intestinal fermentation (Gerber et al., 2013, Miranda et al., 2015). It can be said that the farm-to-table concept contributes to the environmental burden, with the meat industry and production being the largest contributors to greenhouse gas emissions. There is a growing number of countries where sustainability is included in dietary recommendations, but unfortunately this has not yet been implemented into the diets of athletes (Fritz et al., 2020).

Of course, we must not forget the food waste in industry and households. Worldwide, approximately one third of all food produced ends up in the trash (Gustavsson, 2011). In developed countries, consumer food waste is most significant (Parfitt, Barthel, 2010). In developing countries, food waste is more significant in production and harvesting. However, it is important to know that food waste can occur from harvesting to the point of delivery to the consumer, i.e. throughout the supply chain (Reynolds et al., 2015). A truly surprising and frightening figure is that 40% of food is wasted in the United States of America (Gunders, 2016). On a per person basis, that is 9 kg of food waste per month (Jones, 2016). This food waste contributes significantly to the depletion of our environmental resources. These discarded foods also account for a quarter of the methane gas produced in waste, contributing significantly to greenhouse gas emissions (Gunders, 2016).

A study of 123 students studying economics at a university in Hungary was carried out in relation to the United Nations Sustainable Development Goals. The statistical analysis proposed

a 3-factor design for the elbow test. The first is placed on students with a global mindset who are sensitive to world problems. The second is for pioneering students, where there is no identifiable reference order between sustainability goals. And the third factor includes people-centred deans who take people's needs into account (Berényi, 2023). Individualised development of environmental awareness means that environmental and social values and the corresponding forms of action and behaviour need to be communicated to individuals and that behaviours need to be fixed (Berényi, 2009).

The rise of healthy eating has also brought sustainability, as it can be said that such eating is more sustainable than large-scale food production. The use of natural resources can bring positive change, which can also reduce our carbon footprint (Simonyi, 2015). Fortunately, it can also be said that the European Union has made the sustainability of sport itself a priority, which of course has an impact on sporting events. As a result, we are seeing the emergence of sustainability guidelines in the protocols of more and more international sports federations (Faragó, 2024).

2. Supplementation sustainably

The most common supplements among athletes include protein powders and other protein-enriched protein bars, creams and other snacks. So whether your goal is weight loss, muscle gain or weight maintenance, a protein-rich diet can have a positive impact on achieving these goals. And more and more people are choosing plant-based diets, not only for their benefits to human health, but also for their positive effects on the environment.

If we see through of the shelves of the shops', we can see that most of the protein supplements are animal-based. The most common raw material of these supplements are cowmilk. There are so many products which are enriched with beef protein. Thanks to allergic diseases and sustainability breakthroughs and to vegan movements, nowadays the number of the plant-based products are increasing. The most common ingredient is pea protein which is followed by rice protein. The Hungarian Central Statistics Office's database shows that the quantity of the daily animal-based protein consumption in Hungary is decreasing since 2020 (ksh.hu, 2024).

Depending on the training goal, athletes need to consume 1.2-2.0 g of protein per kg body weight (Phillips & Van Loon, 2011, Thomas et al., 2016). In his research, Ernő Gyimes points out that the appropriate dose of protein is still a matter of professional debate. For certain groups, even higher protein intakes can be expected in the future (Gyimes, 2023). People are trying to test the effects of protein powders empirically. Most people use these products because they are quick to consume and they are also found to be useful for developing muscle mass

(Szabad et al., 2021). Plant-based proteins require further research, but a 3-month study showed that there was no difference in the results of athletes who consumed whey and pea protein for muscle gain and strength development (Babault et al., 2015).

Some forms of vegetarianism, such as flexitarian or other semi-vegetarian diets, and plant-based lifestyles are also becoming increasingly popular. Even occasional substitute meals that reduce animal products can significantly reduce the environmental impact of diets (Aleksandrowicz et al., 2016, Derbyshire, 2017). With the quality of plant-based proteins declining (Leser, 2013), higher protein consumption is recommended for non-meat consumers (Kniskern & Johnston, 2011). In any case, a more varied diet is recommended to avoid essential amino acid deficiencies. However, neither performance gains nor performance losses have been shown in vegan or vegetarian athletes (Lynch et al., 2018).

Figure 1. *Five steps to sustainable diets in athletes*

Area to reduce	Area to rethink and redo
1. Reduce animal-sourced foods (especially red and processed meat)	Increase plant-based foods; consider flexitarian, plant-forward approaches
2. Limit protein supplements	Practice food-first approaches using whole foods whenever possible
3. Reduce processed, frozen, and canned foods	Increase food literacy and prioritize locally grown, seasonal, fresh food
4. Reduce food waste	Teach purchasing, cooking, storage, food safety, and food literacy
5. Avoid unnecessary packaging	Use sustainable options but evaluate solutions in the light of food safety and food waste

Source: Meyer et al. (2020)

For athletes, a flexitarian diet can be a win-win strategy. This is because it can meet your protein needs and you are likely to get the right quality protein intake. It can also meet sustainability guidelines. And of course, the athlete can decide on his or her own principles whether to increase the number of plant-based meals or days (Meyer, 2020). It is very important to note that it is important to pay attention to the consumption of quality and safe food (Fabulya et al., 2015, Fabulya & Hampel, 2016).

Edina Lendvai and Csilla Slajkó's research shows that the cost of treating animal materials and sewage sludge is high, and that the reprocessing of these materials is not profitable for the food producing companies, but it is for the protein processing plants (Lendvai, Slajkó, 2017). János Csapó et al. mention in their book (2006) that with the utilisation of by-products from food

production could decrease the food waste. If we would exploit them then less unused protein resources would be. For example whey, blood and feathers from slaughterhouses could be used. However, it can be said that significant breakthroughs have already been made in the production of single-cell proteins. This means that microorganisms can produce a variety of proteins. *Candida* strains can grow in continuous fermentors on paraffin bases which are capable of producing significant amounts of proteins (Csapó et al., 2006).

It can therefore be concluded that, according to the current state of research, essential amino acids can be produced by fermentation as well as by chemical processes. Fermentation can produce L-lysine, L-threonine, L-tryptophan, L-isoleucine. And by chemical means, we can produce DL-methionine. The amino acids thus produced can be mixed with plant proteins to increase their biological value (Csapó et al., 2006).

According to health experts, vitamin B12, which is essential for the human body, is not provided in sufficient amounts only when consuming foods of plant origin. For this reason, the consumption of nutritional supplements and fortified foods may be justified. However, these can be produced by bacterial fermentation and do not require the consumption of animal products. They are mainly found in algae, animal products and foods produced by bacterial fermentation (Balogh, 2017).

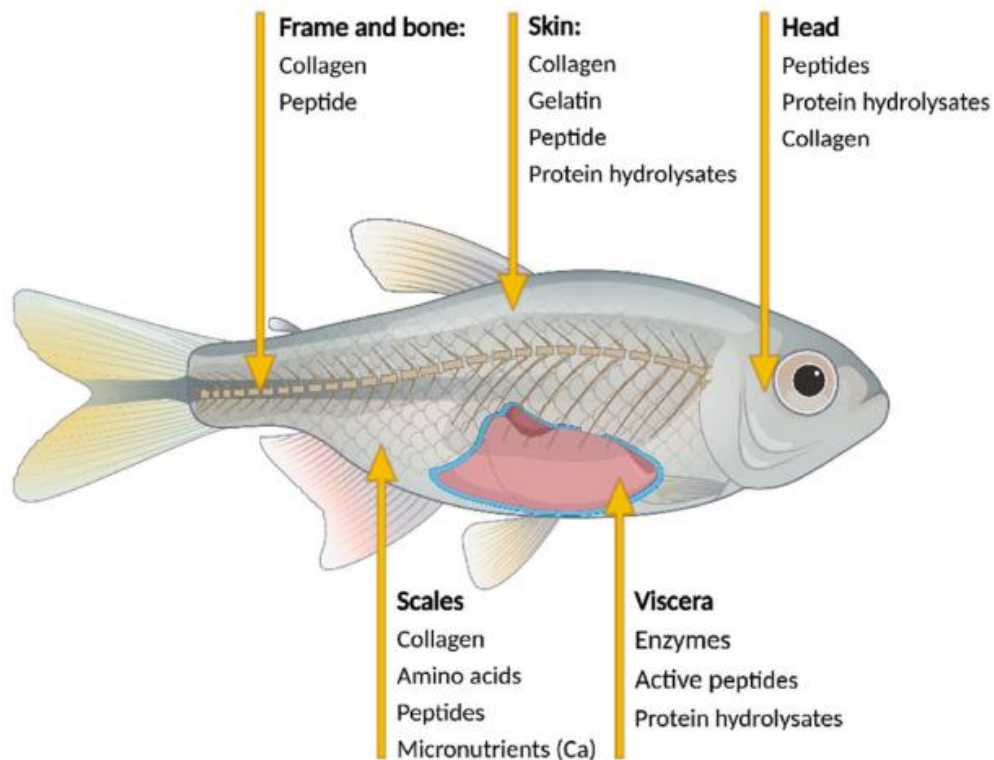
3. By-products of fish processing technology as sustainable raw materials

In 2012, the European Commission launched a long-term programme called "Blue Growth" to optimise natural resources. Protecting fish stocks from industrial pollution and, of course, protecting the environment are key elements. The Sustainable Development Goals must be achieved by 2030. The multi-purpose use of fish waste has many positive aspects. They have very good nutrient content, can be processed quickly, are relatively low cost and very accessible, and are becoming easier for researchers to study for protein (Yuan et al., 2024). However, we must also bear in mind that the biogenic and abiogenic substances that enter the fish habitat, the water, can be diverse and can have toxic, taste-tasting properties for the consumer (Benkő-Kiss, 2017).

One of the by-products of fish processing itself is collagen, which constitutes approximately 8-10% of the fish weight (Nurilmala et al., 2022). However, collagen is mainly extracted from pigs and cattle even today. However, the processing of fish collagen is receiving increasing attention due to various religions and diseases affecting mammals. Thus, this field of research has a history of more than 20 years (Yuan et al., 2024). Gelatin can also be extracted naturally

from fish skin. Thus, for dietary supplements, not only can collagen capsules be produced from fish processing waste, but also the density and hardness of capsules and gels can be influenced.

Figure 2. *Fish by-products and main proteins*



Source: Yuan et al. (2024)

However, not only collagen and gelatine can be extracted from fish by-products, but also proteins. For this purpose, we should use the enzymatic hydrolysis technique, which is nowadays a widely used process. Here, the main factors are pH, temperature, choice of enzyme-substrate ratio, homogenisation, degree of hydrolysis, which have a major and decisive influence on the biological value and functionality (Alahmad et al., 2022). Proteins can be hydrolysed from fish skin, head and visceral organs. The amino acids that build proteins can be extracted from the scales of scaled fish (Yuan et al., 2024).

In terms of sustainability, and considering fish gelatin as a by-product, it has great film-forming properties, low cost and good biodegradability. Also, we should not overlook the fact that religious restrictions make gelatine a suitable alternative for many more people. Research is still needed in reducing hygroscopicity, oxygen permeability, so modification of gelatin film formulations is still a focus, but it has great potential as it can be used to produce biopolymers (Mondal et al., 2022).

3. Results

The Earth's population is growing, greenhouse gas production and our overall carbon footprint on the environment seems to be increasing. In order to ensure that our planet can continue to serve us and that humanity can live in better conditions, we need to take steps to take better care of our environment and to take steps towards sustainability.

Agro-industry, food production is a very large emitter of greenhouse gases. In addition, various studies show that we could use more food by-products as food. New technologies and processes are also emerging one after the other to strengthen sustainability efforts. Overall, therefore, the impact on the current environment makes it worthwhile to pay more attention to research into alternative, new technologies for our own future and that of future generations.

There are already many options for nutrition and supplementation for athletes. Among the most widely used are nutritional supplements; the group of proteins is already a well-researched topic, with breakthrough results expected in the future. In conclusion, by making "Green Choices" based on the choice of the individual athlete, the nutrition and supplementation of athletes can be sustainable. These individuals need to be mindful of the source and quantity of the food and supplements they consume.

4. Discussion

There are many areas of sustainable agriculture, food and other consumer goods that need attention and further research. With the growing population of our planet, and thus the increasing demand for nutrients, in order to prevent the depletion of our earth's resources, researchers are tasked with finding solutions to help protect our environment. From creating higher quality nutrient-dense foods, to greenhouse gas emissions, to new and innovative sources of nutrients and ways to create them, there is much to research. And it will be worthwhile for industry and individuals to incorporate these innovative processes into their lives and diets, so that together we can work towards a sustainable future.

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