Movement & Sport Sciences - Science & Motricité
© ACAPS, 2020
https://doi.org/10.1051/sm/2020002

Movement & Sport Sciences
Science & Motricité

Available online at:
www.mov-sport-sciences.org

ARTICLE

An overview of soybean derived products for sportsmen

Kinga Kostrakiewicz-Gierałt*

Department of Tourism Geography and Ecology, Institute of Tourism, Faculty of Tourism and Recreation, University of Physical Education in Cracow, 31-571 Cracow, Poland

Received 20 October 2019, Accepted 14 February 2020

Abstract – Soybean *Glycine max* (L.) Merr. is a major leguminous crop of global importance with widespread applicability and economic value of its products in the national as well as the global market. The aim of the presented investigations was to review the experimental articles and patents referring to the application of soybean-based products for sportsman published in the period 1970-2019. The greatest number of papers and patents were published in the years 2010-2019 by researchers affiliated in the USA, China and Japan. Altogether, 64 patents and 39 experimental articles were recorded. The inventors patented the food supplements (in a majority), sportswear and devices enhancing protection of athletes during their sport activities. The greatest number of experimental articles was devoted to the impact of soy-based products use on athletes' health, the evaluation of the quality of the products, as well their acceptability by sportsmen.

Keywords: athletes, nutrition, soy, sport activities, sportswear

Résumé – Un aperçu des produits dérivés du soja pour les sportifs – Synthèse de l'état actuel des connaissances. Soja *Glycine max* (L.) Merr. est une culture légumineuse majeure d'importance mondiale dont les produits sont largement applicables et économiques sur les marchés national et mondial. Le but des enquêtes présentées était de passer en revue les articles expérimentaux et les brevets faisant référence à l'application de produits à base de soja pour sportifs publiés entre 1970 et 1919. Le plus grand nombre d'articles et de brevets ont été publiés au cours des années 2010-2019 par des chercheurs affiliés aux États-Unis, en Chine et au Japon. Au total, 64 brevets et 39 articles expérimentaux ont été enregistrés. Les inventeurs ont breveté les compléments alimentaires (en majorité), des vêtements de sport et des dispositifs améliorant la protection des athlètes lors de leurs activités sportives. Le plus grand nombre d'articles expérimentaux a été consacré à l'impact de l'utilisation des produits à base de soja sur la santé des athlètes, à l'évaluation de la qualité des produits et à leur acceptabilité par les sportifs.

Mots clés : athlètes, nutrition, soja, activités sportives, vêtements de sport

1 Introduction

According to numerous authors application of useful plants is valuable in both: nutrition enabling active and healthy life (*e.g.* Hever & Cronise, 2017), as well as in modern technology allowing sustainable development and production of environmentally friendly energy (*e.g.* Hood, 2016). The group of plants with versatile application is represented among others by soybean (soy) *Glycine max* (L.) Merr., which is a major leguminous crop of global importance and economic value of its products in both national and global markets. The total world production in the year 2017 amounted to over 352 million tonnes (Faostat, 2017), accounting for 56% of total global oil seed production (Wilson, 2008). Cultivation of *Glycine max* is very popular because of its high nutritional-value components such as proteins, oils, saccharides, minerals and phytochemicals (Garg *et al.*, 2016). Furthermore, soy foods receive significant attention to support the health improvements or health risks observed clinically or in vitro experiments in both animal and human. Soybean has a beneficial influence inter alia on osteoporosis and menopause, blood pressure and endothelial function, platelet aggregation and fibrinolytic activity (Messina, 2016). Soybean has antioxidant and antimicrobial properties (Ponnusha, Subramaniyam, Pasupathi, Subramaniyam, & Virumandy, 2011), as well as a beneficial influence inter alia on osteoporosis and menopause, blood pressure and endothelial function, platelet aggregation and fibrinolytic activity (Dixit, Antony, Sharma, & Tiwari, 2011; Messina, 2016). Due to their nutritive value, soybean-based products are recommended for vegetarian or vegan athletes (see *e.g.* Gupta, Prakash, & Gupta, 2016).

* Corresponding author: kinga.kostrakiewicz@awf.krakow.pl

Furthermore, soya oils, unsaponifiables and sterols are widely applied in the cosmetic industry as ingredients of emollients and skin conditioning products (Lin, Zhong, & Santiago, 2018). Moreover, soybean fibre can be used in the textile industry (Rijavec & Zupin, 2011). As reported by Li (2004), the soybean protein fibre, with its good affinity to human skin, has positive health effects. The fabric which uses soybean protein fibre has a soft handle and light texture, its moisture absorption performance is equivalent to cotton, and its permeability is also greatly better than cotton, ensuring comfort and health while being worn. Furthermore, it is worth mentioning that soy derived oils are widely used in the chemical industry. According to Nwokolo (1996), refined soybean oil may be converted into a wide range of important industrial oil products such as epoxy resins, esters, fractionates, alkyd resins, urethane and co-polymer oils and printing inks. Soybean oil is also used industrially in the manufacture of lubricating oils, lubricating greases and as plasticisers. Moreover, soy derived oils might be used to develop renewable fuels, replacing petroleum-based fuels in transport vehicles (Channi, 2016).

Considering the wide spectrum of industrial uses of soybean, the present paper reviews the studies on the application of soybean-derived products for sportsmen, including (i) nutritive food, (ii) clothes and (iii) other products.

2 Material and methods

2.1 The morphology and constituents of soybean *Glycine max*

Soybean *Glycine max* (L.) Merr. is an erect annual herb reaching 30-100 cm (Pladias, 2014-2019) and creating pinnate, 3-foliolate leaves. Soybean inflorescence is a raceme bearing 5-35 white, pink or violet self-pollinated flowers blooming in July and August. The pendulous, oblongated, brown, hairy pods measure 3-8 cm and grow in clusters of 3-5. The pods contain 2-4 ovoid or subspherical smooth seeds rich in oil and protein (Royal Botanic Gardens Kew, 2019).

Soybean represents an excellent source of high quality protein and contains all eight essential amino acids such as cysteine, tryptophan, leucine and lysine (Kovalenko, Rippke, & Hurburgh, 2006). According to Dixit *et al.* (2011) the principal soluble carbohydrates of mature soybeans are disaccharide sucrose, trisaccharide raffinose and tetrasaccharide stachyose. Oligosaccharides, raffinose and stachyose are non-digestible sugars, so contribute to flatulence and abdominal discomfort in humans and monogastric animals. The insoluble carbohydrates in soybeans, consisting of complex polysaccharides cellulose, hemicellulose and pectin, are classified as dietary fibre. Moreover, soybean contains monounsaturated and polyunsaturated fats (omega-3 and omega-6). Moreover, it contains phytosterols (β-sitosterol, campesterol and stigmasterol). Soybean also consists of phospholipids such as lecithin. Because lecithin possesses both a hydrophilic and a hydrophobic side chain, it serves to facilitate the bringing together of immiscible materials through, for example, the formation of emulsions. Apart from the aforementioned constituents, soybean also contains minerals (calcium, copper, iron, zinc, magnesium, phosphorus, potassium), as well as flavonoids (*i.e.* isoflavones, flavones, flavanols, aurones, chalcons, as well as red and blue anthocyanin pigments).

2.2 The literature survey

For this survey, a systematic approach for synthesising information through a dedicated step-wise process for selecting available peer-reviewed literature sources was applied. The author searched for peer-reviewed original full-text articles, dissertations and patents about the application of soybean-derived products for sportsmen using the ISI Web of Science (All Databases) and Scopus-indexed publications. These search engines were selected as they provide a comprehensive all-encompassing database for various interdisciplinary domains. The review focused literature documenting the application of soybean was published over the time interval from 1970 to 2019. Moreover, publications were searched for by browsing the Google Scholar internet search engine. The author used factorial combinations of the following keywords in the searches: ('*Glycine max*' or 'soybean' or 'soy') and ('athlete' or 'sport' or 'diet' or 'food' or 'nutrition' or 'wear'). The selection terms were examined from the title, abstract and keywords of the articles. The results included 153 hits from the ISI Web of Science (All Databases), 13,101 hits from Scopus, and 10,972 hits from the Google Scholar internet search engine on 7 May 2019. After the manual removal of grey literature (blog posts, letters, commentaries, reports, conference proceedings and meeting notes) from the lists of searches, the patents and peer-reviewed publications were selected. Then, the Abstracts were screened for relevance and eligibility. The only inclusion criterion of patents was their usefulness for sport practitioners. The inclusion criteria of articles were as follows: (i) investigations are relevant to the main subject of presented review, (ii) participants are people (clinical trials), (iii) no limits in age, weight, sex, nationality and number of participants, (iv) no limits in geographical location, as well as time period of investigations. The exclusion criteria of articles were as follows: (i) studies irrelevant to the main subject, (ii) investigations conducted on non-human species, (iii) repetitive publications (different parts of a single study were presented in two or more papers or studies based on a population that was part of an earlier publication). Finally, the author selected publications based on the scope which resulted in 26 records through the ISI Web of Science, 75 through Scopus and 53 from the Google Scholar internet search engine. Following the removal of duplicates (publications indexed in at least two databases) from all searches and an initial screening of full-texts, a final total of 101 records were selected to be reviewed. The inclusion criteria of articles were as follows: (i) observational, descriptive studies

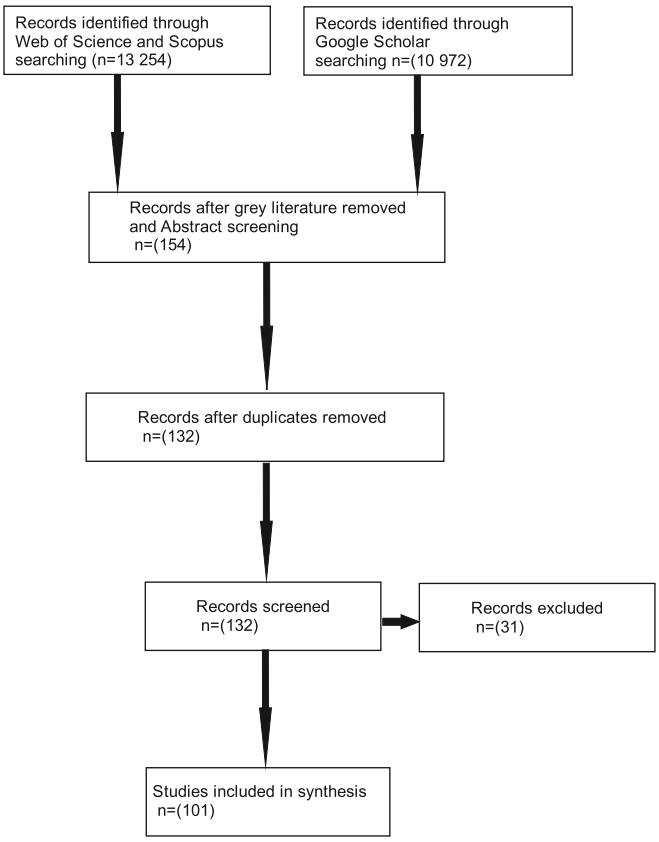

Figure 1. Simplified PRISMA flow chart detailing search results (after Moher, Liberati, Tetzlaff, & Altman, 2009).

(case report/case series), (ii) observational, analytical studies (case–control studies, cross-sectional studies, cohort studies), (iii) experimental studies (randomized controlled trials). The exclusion criteria of articles were as follows: (i) meta-analyses and (ii) review articles. The chart detailing search results is presented in Figure 1.

The normal distribution of the untransformed data was tested using the Kolmogorov-Smirnov one-sample test at the significance level of $P < 0.05$. Subsequently, the variance homogeneity was tested using the Brown-Forsythe test at the significance level of $P < 0.05$. As the distribution of characteristics in some groups of data was not consistent with the normal distribution and the variance was not homogeneous, the statistical analysis was based on the nonparametric Kruskal-Wallis H test for multiple comparisons was used to check the statistical significance of differences among the numbers of records in particular decades.

3 Results

The overview of the literature from 1970 to 2019 showed that the number of records including experimental papers and patents referring to application of soy-based products by sportsmen gradually increased in consecutive decades and was the greatest in the years 2010-2019 (Tab. 1). The greatest number of authors or inventors was affiliated in the United States of America, China and Japan (Tab. 2). Altogether, 66 patents and 35 experimental articles referring, among others, to dietary supplements and sportswear products were recorded.

Table 1. Number of experimental publications and patents connecting with application of soya products for sportsmen in particular time periods.

Time period (years)	Mean number of publications per year (±SD)	The value of H Kruskal-Wallis test; P value*
1970-1979	0.00 (±0.00)[a]	
1980-1989	0.40 (±0.52)[a]	
1990-1999	0.30 (±0.48)[a]	$H = 41.76,\ P < 0.001$
2000-2009	3.60 (±1.07)[b]	
2010-2019	6.00 (±1.89)[b]	

*The different letters in superscripts mean that differences among time periods are statistically significant.

Table 2. Geographic distribution of literature

Author affiliation	Number of publications	Percentage
USA	32	31.7
China	30	29.6
Japan	16	15.7
Canada	4	4.0
UK	4	4.0
India	3	3.0
Germany	2	2.0
Romania	2	2.0
Taiwan	2	2.0
South Corea	2	2.0
Australia	1	1.0
Chile	1	1.0
Italy	1	1.0
Poland	1	1.0

In case of multi-authored publications affiliation of first author was considered.

3.1 Food supplements

The performed overview showed in total 56 soy-based food supplements in a variety of forms (bars, tablets, powder and beverages) improving muscle and cartilage performance (39.3%), supplementing energy losses (26.8%), contributing to fatigue relieving and improvement of endurance capability (19.6%), as well as regulating rehydration and lipid metabolism (14.3%).

3.1.1 Products improving muscle and cartilage performance

Numerous researchers have patented nutritional compositions in both solid and liquid forms containing soy proteins contributing to skeletal muscle adaptation to

training (Brantman, 1987), optimising muscle performance during/after exercise (Bell, Forse, & Bistrian, 2001; Portman, 2002, 2003, 2006, 2010; Constantine, Dixon, Kramer, & Varhol, 2009), as well as promoting muscle wound healing (Fu, Liu, & Wei, 2017). Other authors have invented food supplements enabling effective lean body mass gain (Gardiner, Woodgate, Gilbert, & Thoburn, 2004, 2010; Weaver, 2007), enhancing the development of cartilage and muscle tissue (Berry *et al.*, 2014, , 2017; Fritz, 2004; Jenkins, 2015; Naito & Miura, 2011; Sagiya, 2012; Stone, 2002), strengthening the muscles (Ariga *et al.*, 2000, 2001; Berry *et al.*, 2014, , 2017), as well as shortening the time of physical recovery time, and enabling protection of myocardium, bone and muscle from injury, particularly in young people (Qiu, 2018). Furthermore, it should be added that Smith (2012) invented a recipe for an organic vegan protein shake mostly dedicated for athletes and body builders. Characteristics of products improving muscle performance are given in Table 3.

3.1.2 Products relieving fatigue and improving endurance capability

Several authors invented recipes for products relieving sports fatigue. To the aforementioned belong dairy food products (Jiao, Yang, Bao, & Zhu, 2013; Wang, 2014), milk containing, among others, soluble soybean polysaccharides (Li, 2014; Wu *et al.*, 2017), powder containing soy peptide (Li, Liu, Niu, & Wang, 2017), as well as astaxanthin wine (Zhu, Yu, Zhu, Li, & Liang, 2016). The exercise-enhancing food tablets containing soy proteins and increasing physical fitness were invented by Cresta (2009) and He (2018). Other inventions improve the endurance capability of the human body during motion (Nakajima, Murakami, & Sekiguchi, 2001; Sakamoto *et al.*, 2000; Zhang, Zhou, Geng, Yi, & Zhou, 2010). The characteristics of soy based products relieving fatigue is given in Table 4.

3.1.3 Products supplementing energy losses

Several authors invented nutritional bars comprising soybean protein, which might be used as meal replacement energy useful for sportsman (Cao, He, He, Huang, & Xu, 2017; Guo, Lv, Peng, Huo, & Xu, 2018; Michnowski, 1989; Palmer, Rudan, Gautam, Dagerath, & Patrick, 2005) St. Cyr & Johnson (2000) patented compositions for increasing energy, Orlando (2002) invented soy-based pasta low in fat and carbohydrates and high in protein, while Stein (1996) and Muraoka, Nishi, Nakamura, & Sakata (2010) patented a recipe for a soy protein-containing food dedicated to persons with high caloric needs such as athletes. Tsukuda, Hoshii, & Gottemoller (2003, 2008) invented a method of preparing easily dispersible granules comprising powdery soybean protein recommended particularly for athletes, while Zhou, Zeng, Jiang, & Wang (2010) invented a mode of preparation of acid-resistant and non-bitter soybean oligopeptide. Additionally, it is worth noting that recipes for preparation of soy-based dairy products (also based on traditional medicine) providing nutritional supplement and preventing anaemia and suitable for people after any exercise were patented by Zhou (2015) and Zhu *et al.* (2019). Apart from these, the patented functional food paste which can be used in a ready-to-eat form or as filling (Smith, Brown, & Holt, 2011), as well as a gel-like food supplement (Toyooka, Hamada, & Saitoh, 2019) should be mentioned. The characteristics of products supplementing energy losses are given in Table 5.

3.1.4 Products regulating water-salt balance and fatty acid metabolism

Several authors patented recipes for conditioning drinks containing soya protein suitable for amateur and professional athletes, regulating the physical capabilities of the body and compensating for salt loss (Wiesenberger, Kolb, & Engelhardt, 1984), enhancing fast rehydration (Jendrysik, Skrypec, & Kappes, 2007, 2010), or supplementing loss of water and energy (Sheldon, 2000; Zhang, 2016). Furthermore, a nutrient hydration bar containing soy proteins suitable for sportsmen was patented by Tobin & Tobin (2012).

Misawa, Takigawa, & Murase (2016) invented an extract of a tempeh-fungus-fermented soybean product, which is effective, amongst others, for activation of fatty acid metabolism, promotion of body fat burning, and prevention of obesity, while Lan (2018) patented a high protein dietary composition useful as sports diet food substitute and reducing blood lipid level. Characteristics of products regulating water-salt balance and fatty acid metabolism is given in Table 6.

3.2 Quality of soy-based products

The observations of de Penna, Bunger, Sansur, López, & Santana (1993) showed that the quality of soy-based candy bars for athletes packed in an aluminium foil performed at room temperature remains without significant changes over 30 days for the nut candy, and at least 60 days for the almond candy bar. Yanaka *et al.* (2010) evaluated the respective soy protein and isoflavone contents in 10 health foods and observed that the contents reported on the labels frequently exceed the actual values. Garg & Brar (2017) evaluated the plant-based bars for gym trainers and found the substantial content of amino acid and proteins in peanut and soya bars. Consequently, they recommended them as being more cost effective and more nutritious than commercial bars for increasing muscle mass.

3.3 Experimental investigations of the effect of soybean derived products on athletes' health

Altogether, 26 publications were devoted to experimental investigations of effects of soybean derived products. The majority of investigation focused on the effect of soy proteins on the health of athletes. Observations were

Table 3. Characteristics of products improving muscle performance (in order of appearance in the text).

Patent	Main effects	Author(s) and year
Nutritional composition	A combination of amino acids (carnitine, glutamine, isoleucine, leucine and valine) provide diet supplements which employ branched amino acids (BAA) to promote muscle adaptation to strenuous exercise	Brantman (1987)
Dietary supplement	The reducing the symptoms of stress and improving performance by causing a reduction in the level of cytokines and prostaglandin E_2 (PGE_2)	Bell *et al.* (2001)
Sports drink composition	The optimizing muscle performance and extending endurance during exercise and preventing free radical buildup and muscle damage after exercise.	Portman (2002, 2003, 2006, 2010)
Sports beverage	The optimizing muscle performance during exercise	Constantine *et al.* (2009)
Beverage for sports people	The muscle wound healing and elimination of fat	Fu *et al.* (2017)
Food supplement for increasing lean mass and strength	The increase of nitric oxide production in the body, which plays an essential role in tonic and exercise-associated regulation of vasodilation and blood flow	Gardiner *et al.* (2004, 2010)
Composition and method for effective lean body mass gain	The invention provides methods for increasing lean body mass comprising administering a composition comprising effective amounts effective amounts of serum protein isolate, microfiltered whey protein concentrate, and whey protein isolate	Weaver (2007)
Charged nutritive proteins	The increase of muscle mass and strength	Berry *et al.* (2014, , 2017)
Phosphatidylserine-containing muscle development diet supplement	The suppression of the damaging release of excess levels of cortisol due to physical stress.	Fritz (2004)
Protein beverage	The branched chain amino acids metabolized directly into muscle tissue are the first amino acids used during periods of exercise and resistance training	Jenkins (2015)
Muscle-building agent	The increase of weight of the abdominal muscles and the musculus quadriceps	Naito & Miura (2011)
Confectionary used for supplementing protein	The soybean protein is effective for the health of athletes or sport amateurs aiming at reinforcement and restoration of muscles.	Sagiya (2012)
Food supplement	The invention relates to a food supplement, containing cartilage supplements such as chondroitin sulfate, glucosamine sulfate, and hyaluronic acid	Stone (2002)
High-protein food of plate form	The invention might be an aid for strengthening the muscles for athletes, weight reduction for obese persons, supplying nutrition to postoperative patients, improving nutritional balance of diets, and the like	Ariga *et al.* (2000, 2001)
Sports beverage	The invention shorts the time of physical recovery time, and enabling protection of myocardium, bone and muscle from injury	Qiu (2018)
Organic vegan protein shaker	A predominantly protein-based drink or shake is suitable to the professional athletes and body builders because it enables to achieve a net positive gain in muscle mass	Smith (2012)

carried out inter alia in population of canoeists and rowers (Drăgan, Stroescu, Stoian, Georgescu, & Baloescu, 1992), runners (Jiang, 2015; Wang, Li, Yang, Zhou, Gao, Xu, Fang, Gong, Gao, Wu, Cai, Shi, & Ge, 2004), cyclists (Shenoy, Dhawan, & Sandhu, 2016; Yeh, Chan, Hsu, & Liu, 2011), boxers (Shenoy *et al.*, 2016), swimmers (Xiaolu, 2013), taekwondo players (Son *et al.*, 2011), judo players (Bae *et al.*, 2012; Laskowski & Antosiewicz, 2003), gymnasts (Stroescu, Drăgan, Simionescu, & Stroescu, 2001) and others. At the same time it is worth mentioning, that the greatest number of investigations (58.3%) referred to activity of proteins, while lower number of studies denoted to activity of fats, fatty acids and oils (25.0%) or other constituents (16.7%).

Table 4. Characteristics of soy based products relieving fatigue (in order of appearance in the text).

Patent	Main effects	Author(s) and year
Dairy product for relieving sports fatigue	The dairy product has simple and easy to operate preparation method, and is good for recovering athletic ability	Jiao *et al.* (2013)
Food for relieving sports fatigue	Product has anti-fatigue function and smooth taste and is safe and convenient to eat, and preparation process is simple and low-cost	Wang (2014)
Sports nutrition milk tea powder	Sports nutrition milk tea powder used for increasing bone calcium, relieving fatigue and enhancing weight loss	Li (2014)
Sports nutritional fermented milk	Sports nutritional fermented milk useful for relieving fatigue	Wu *et al.* (2017)
Soy peptide powder	The soy peptide powder is useful in sports food, energy drink, and healthcare product for relieving fatigue	Li *et al.* (2017)
Astaxanthin wine	The delay aging, relieving sports fatigue and improving immunity	Zhu *et al.* (2016)
Tablet containing protein isolate	The provision carbohydrates for energy and/or protein for the support and repair of muscles	Cresta (2009)
Sports nutrition chewable tablet	The sports nutrition chewable tablet has effectively promotes the activity of cells in human blood and reduces the fatigue of human body after exercise	He (2018)
Composition removing risk factor during exercise	The removing risk factor during prolonged exercise The preventing athletic anemia	Nakajima *et al.* (2001)
Nutrient composition	The feeding at the time of physical exhaustion or fatigue due to exercise, suppression of formation of radicals by promotion of respiration during exercise, and supplementing vitamins	Sakamoto *et al.* (2000)
Composition comprising saccarides and peptides	The recovery after motion and alleviating fatigue of central nerves during sport exercises	Zhang *et al.* (2010)

3.3.1 Effects of proteins

The investigations evidenced that the soy protein supply contributes, among others, to a decrease of muscle damage and/or their recovery (Jiang, 2015; Shenoy *et al.*, 2016; Son *et al.*, 2011; Wang *et al.*, 2004), fatigue elimination (Drăgan et al., 1992; Jiang, 2015; Stroescu et al., 2001; Wang *et al.*, 2004; Xiaolu, 2013), an increase of lean body mass (Drăgan *et al.*, 1992; Wang *et al.*, 2004; Jiang, 2015), and protein synthesis (Drăgan *et al.*, 1992; Jiang, 2015). Moreover, soybean proteins intake induces the increase of strength indexes (Drăgan *et al.*, 1992), improves adaptation to training and/or athletic performance (Laskowski & Antosiewicz, 2003; Yeh *et al.*, 2011), improves aerobic energy supply and metabolic function (Berg *et al.*, 2012), as well as effect on blood profile and inter alia hormones contribution (Bae *et al.*, 2012; Burke *et al.*, 2012; Kraemer *et al.*, 2013; Malik & Parvinder, 2018). Apart from these, Wada *et al.* (2013) observed that a breakfast containing inter alia soy-derived products, morning sunlight and evening-lighting seems to be effective for athletes to maintain higher melatonin secretion at night, inducing easy onset of night sleep as well as a higher quality of sleep. Lai (2015) investigated the antioxidant properties of sports food soybean peptides and found that highly effective antioxidant soybean peptides products can be obtained through screening hydrolysis conditions. The review of investigations of the effects of the soy protein-rich food consumption on athlete health and endurance is given in Table 7.

3.3.2 Effects of fats, fatty acids and oils

Several researchers studied the effect of soy derived fats, fatty acids, oils on health of rowers (Takeuchi, Kasai, Taguchi, Tsuji, & Suzuki, 2002), ski jumpers (Chen, Robbins, & Zhang, 2017), soccer players (Kingsley, Wadsworth, Kilduff, McEneny, & Benton, 2005) and others. Takeuchi *et al.* (2002) noticed that soybean oil may have a lower potential (compared to medium-and long-chain fatty acids) to prevent hypertriglyceridemia and obesity caused by consumption of a high-fat diet. The investigations of Chen *et al.* (2017) showed the beneficial effect of administration of glucosamine and chondroitin sulphate in combination with avocado/soybean unsaponifiables in an elite group of young ski jumpers, with chronic pain or discomfort due to chondral injuries of the knee or ankle suffered during years of training and competition. Udani, Singh, Singh, & Sandoval (2009) found, that the intake of capsules containing soy oils resulted in a significant reduction in standardised measures of tenderness (pain or discomfort when an affected area is touched) and pain (perceived without touching) post-eccentric exercise. On the other hand,

Table 5. Characteristics of soy based products supplementing energy losses (in order of appearance in the text).

Patent	Main effects	Author(s) and year
Plant energy bar	The plant energy bar has balanced and comprehensive nutrient, improves antioxidant capacity, immunity and can be used as a substitute for energy	Cao *et al.* (2017)
Tsamba energy bar	The energy bar has rich nutrition and high protein content, and is convenient to carry	Guo *et al.* (2018)
Nutritional athletic bar	The provision quick energy and the supplementation of vitamins and minerals suitable for hikers skiers, mountain climbers, athletes	Michnowski (1989)
Nutrition bar	The nutrition due to elevated levels of soy protein, and the assistance in weight loss The increase of lean muscle mass and strength suitable for athletes	Palmer *et al.* (2005)
Compositions for increasing energy *in vivo*	The treatment of reduced energy availability resulting from strenuous physical activity, illness or trauma	St. Cyr & Johnson (2000)
Soy-based pasta	The increase of protein intake with low carbohydrate intake, particularly beneficial for dieters (*e.g.* gymnasts)	Orlando (2002)
High energy food products	The provision of energy for the athletes (*e.g.* marathon running) or other persons with high caloric needs	Stein (1996)
Powdery soy protein food	The protein supplementation after exercise adequate to athletes and elderly persons with declined digestive functions	Muraoka *et al.* (2010)
Easily dispersible granules of soybean protein	The formation and maintenance of muscle with lack of accumulation of excess calorie as fats in the body of athletes	Tsukuda *et al.* (2003, 2008)
Composition comprising saccarides and peptides	The improvement of endurance capability of the human body in motion	Zhou *et al.* (2010)
Soybean milk	The invention prevents from sport anemia	Zhou (2015)
Sports fermented dairy product	The sports fermented dairy product is useful for treating multiple exercise-induced fatigue, injury, physical dysfunction and decreased immunity	Zhu *et al.* (2019)
Functional food paste	The nutritional product for the recreational athletes, such as bikers, campers, and hikers	Smith *et al.* (2011)
Gel-like food composition	The supplementary food suitable for physical condition management of sportsmen, facilitating the secretion of insulin, which stimulates protein synthesis	Toyooka *et al.* (2019)

Table 6. Characteristics of products regulating water-salt balance and fatty acid metabolism (in order of appearance in the text).

Patent	Main effects	Author(s) and year
Protein containing conditioning drink	The compensation of the salt loss, accompanying protracted physical exertion, especially at high atmospheric temperatures	Wiesenberger *et al.* (1984)
Sports drink acid blend	The rehydratation the body and replenishing lost electrolytes and carbohydrates after performing physical activities. A novel acidulant blend substantially reduces the level of aftertaste of typical sports beverages	Jendrysik *et al.* (2007, 2010)
Thickened hydrolyte isotonic beverage	The restoring lost water and regaining electrolyte balance	Sheldon (2000)
Student sports drink	The student sports drink can quickly supplement water and energy after drinking and help to quickly recover	Zhang (2016)
Nutrient hydration bar	The provision of enhanced hydration retention and energy which is extremely effective in enhancing exercise and sports performance	Tobin & Tobin (2012)
Peroxisome proliferator activated receptor (PPAR) activator	The soybean product fermented with the tempeh fungus is responsible for PRAR activation, promoting fatty acid metabolism, body fat burning and improvement of physical endurance	Misawa *et al.* (2016)
High protein dietary composition	The reduction of blood lipid level	Lan (2018)

Table 7. Review of investigations of the effects of the soy protein-rich food consumption on athlete health and endurance (in order of appearance in the text).

Aim of investigations	Main results	Author(s) and year
The recovery effect of soybean peptide solid beverage on athletes in endurance events	The intake of soybean polypeptide (i) promotes the increase of serum testosterone and lean mass weight, (ii) cuts down the serum creatine kinase for middle-distance runners	Jiang (2015)
The effects of consumption of isolated soy protein on exercise induced muscle damage (EIMD) in athletic population	Biochemical markers of inflammation, muscle damage, and oxidative stress, demonstrated an increase in the mean values following EIMD both before and after supplementation, whereas the degree of increase is less following soy consumption	Shenoy *et al.* (2016)
The effect of soybean peptide on muscle damage index and testosterone and cortisol concentration	The intake of soybean peptide resulted in: (i) lowering level of creatine phosphokinase, lactate dehydrogenase, aldolase, as well as concentration of plasma cortisol, (ii) not significant increase of concentration of plasma testosterone	Son *et al.* (2011)
The biological effects of daily consumption of soybean peptides	The intake of soybean peptides resulted in: (i) an increase in body weight, especially in lean body mass and cyclic total testosterone level, (ii) a decrease level in serum creatine kinase	Wang *et al.* (2004)
The biological effects of Supro isolated soy protein supply	The soy protein supply induced increased of body mass (especially by lean body mass), strength indexes, serum proteins, haemoglobin and total calcium and significant decreases of urinary mucoproteins and fatigue after training sessions	Drăgan *et al.* (1992)
The effect of supplementation with SUPRO Brand Isolated Soy Protein on the metabolic and hormonal response in elite female gymnasts undergoing strenuous training	The intake of soy proteins resulted in increase in lean body mass and serum levels of prolactin and a decrease in serum alkaline phosphatase	Stroescu et al., 2001
The effect of sports nutrition on exercise capacity	The intake of soybean peptides energy drinks contributed to elimination of fatigue and covering the distance in shorter time	Xiaolu (2013)
The effects of protein supplementation on adaptation process to increased demands of training	The supplementation of a normal diet with soy protein improved the aerobic and anaerobic performance	Laskowski & Antosiewicz (2003)
The effects of a proprietary blend of soybean peptides, taurine, *Pueraria isoflavone*, and ginseng saponin complex (STPG capsule) on exercise performance in humans	The intake of STPG capsules was effective in promoting utilization of free fatty acids and improving exhaustive cycling test performance	Yeh *et al.* (2011)
The effect of soy protein supplementation on the changes in endurance capacity as well as in metabolic, hormonal and inflammatory markers induced by endurance training	The soy protein supplementation improved running performance and aerobic energy supply and metabolic function in healthy sports students	Berg *et al.* (2012)
The effect of soybean peptide on antioxidant enzymes, cortisol hormone and inflammatory cytokine levels	The soy protein supplementation increased the antioxidant status and decreases the level of plasma cortisol, tumor necrosis factor-alpha and interleukin	Bae *et al.*, 2012
The characteristics of plasma amino acid (AA) responses to the intake of proteins at rest and after exercise	Completing exercise before ingesting protein sources did not cause statistically significant changes in the pattern of delivery of amino acids and leucine	Burke *et al.* (2012)
The assessment of the effects of soy and whey protein supplementation on sex hormones following heavy resistance exercise in resistance trained men	The findings demonstrated that 14 days of supplementation with soy protein influences the weaker increase of cortisol following resistance exercise	Kraemer *et al.*, 2013
The effect of the developed drinking cereal power on the blood profile of young athletes	The eight weeks supplementation of multi grain drinking powder resulted in the increase of haemoglobin and blood glucose level	Malik & Parvinder (2018)

Table 7. (continued).

Aim of investigations	Main results	Author(s) and year
The effect of a combination of tryptophan-rich breakfast and light with low colour-temperature at night on enhanced melatonin secretion and earlier sleep	There was a significantly positive correlation between total hours the participants spent under incandescent light at night and the frequency of feeling sleepy. The salivary melatonin concentration in people eating protein-rich food containing soybeans and vitamin B6-rich foods such as bananas was higher than in control group	Wada *et al.* (2013)
The comparison of antioxidant activity of hydrolysates of chosen enzymes using soybean protein as substrate	The hydrolysates of bromelain, neutral protease and alkaline protease have stronger reducing capacity as well as ability of eliminating superoxide anion free radicals and hydrogen peroxide than others	Lai (2015)

Table 8. Review of investigations of the effects of consumption of the soy-derived fats, fatty acids and oils on athlete health and endurance (in order of appearance in the text).

Aim of investigations	Main results	Author(s) and year
The effects of dietary medium- and long-chain fatty acids (TML) and soybean oil on serum lipid levels and body fat	There was no difference in energy intake between the soybean oil diet and the TML diet. The rate of variation of serum triacylglycerol concentration and body fat mass were significantly lower after a consumption of the TML liquid diet than the soybean oil liquid diet	Takeuchi *et al.* (2002)
The effects of combination of glucosamine, chondroitin sulfate, and avocado/soybean unsaponifiables on function of young, elite athletes with chronic pain or discomfort due to chondral injuries of the knee or ankle	The use of the supplement did not completely eliminate pain but it revealed a general, durable improvement of sportsman health	Chen *et al.* (2017)
The efficacy of a dietary supplement, BounceBack, to alleviate the severity of delayed onset muscle soreness (DOMS) after standardized eccentric exercise	The intake of BounceBack capsules resulted in trends towards reductions in plasma indicators of inflammation (high sensitivity C-reactive protein) and muscle damage (creatine phosphokinase and myoglobin)	Udani *et al.* (2009)
The effects of 750 mg of soybean-derived phosphatidylserine or a placebo, administered for 10 days, on markers of oxidative stress, perceived soreness, and muscle damage initiated by intermittent exercise immediately followed by an exhaustive run	The suplementation in phosphatidylserine effected in increase of concentrations of plasma gamma-tocopherol and had no effect on plasma concentrations of vitamin C, alpha-tocopherol, retinol, and beta-carotene. Serum cortisol concentrations, perceived soreness, markers of muscle damage (creatine kinase and myoglobin), and lipid peroxidation (hydroperoxides and conjugated diene lag times) were elevated to an equal extent following exhaustive exercise after supplementation in phosphatidylserine and intake of placebo	Kingsley *et al.* (2005)
The effects of soybean-derived phosphatidylserine, administered 7 days prior to eccentric exercise and for 2 days following exercise, on delayed onset of muscle soreness and markers of muscle damage, inflammation, and oxidative stress that followed prolonged downhill running	Downhill running led to elevations in perceived soreness, creatine kinase activities, myoglobin concentrations, interleukin-6 concentrations, and lipid hydroperoxide concentrations. The supplementation did not significantly attenuate these responses	Kingsley *et al.* (2006a)
The effects of 750 mg of soybean-derived phosphatidylserine, administered for 10 days, on exercise capacity, oxygen uptake kinetic response, neuroendocrine function, and feeling states during exhaustive intermittent exercise	The supplementation had a significant effect on exercise time to exhaustion. Supplementation did not significantly affect oxygenkinetic mean response times, serum cortisol concentrations, substrate oxidation, and feeling states during the trial	Kingsley *et al.* (2006b)

Table 9. Review of investigations of the effects of consumption of the soy-derived saccharides, dietary fibre and isoflavones on athlete health and endurance (in order of appearance in the text).

Aim of investigations	Main results	Author(s) and year
The effect of okara supplementation on fatigue and muscle damage over an exercise training season	The results demonstrated significant differences in blood levels of ammonia, free fatty acids, creatine kinase, myoglobin, and aspartate transferase between baseline and exercise training. However, those increased markers of fatigue and muscle damage were significantly decreased after the okara supplementation	Yang *et al.* (2015)
The effect of non-dairy chocolate beverage ingestion post glycogen-lowering exercise on performance during 20 km cycling time trial performance 4 hours later	The intake of chocolate milk, chocolate soy beverage, chocolate hemp beverage, low fat milk and artificially sweetened, flavoured beverage enhanced similarly the time trial performance	Upshaw *et al.* (2016)
The effect of simultaneous supplementation of 1.35 mg/day of vitamin K2 and 72 mg/day of soybean isoflavones for 30 days on bone metabolism in these athletes	The supplementation of soy isoflavones in combination with vitamin K2 exhibited an inhibitory effect of bone resorption	Sato *et al.* (2000)
To evaluate the relation between premenstrual syndrome (PMS) and equol production status in Japanese collegiate athletes	The equol production enhanced by soybean consumption improve the athletic performance, while lack of equol production increase risk of premenstrual syndrome (PMS). The lack of equol production and restriction of body weight were shown to be significant risk factors for poor athletic performance	Takeda *et al.* (2018)

other investigations showed that supplementation with soy-derived phosphatidylserine was not effective in attenuating the perceived muscle soreness, as well as markers of oxidative stress and acute inflammation following exhaustive running (Kingsley *et al.*, 2005, 2006a), but it improves exercise capacity (Kingsley *et al.*, 2006b). The review of investigations of the effects of consumption of the soy-derived fats, fatty acids and oils on athlete health and endurance is given in Table 8.

3.3.3 Effects of other constituents

Moreover, other researchers observed the effect of saccharides and dietary fibre. Yang, Tso, Huang, & Huang. (2015) showed that supplementation of Okara (soybean residue from soy milk production containing mostly crude fibres, proteins, lipids, and starch or simple carbohydrates) is beneficial to university baseball players who experience exercise training-related fatigue and muscle damage. The investigations of Upshaw, Wong, Bandegan, & Lemon (2016) showed, that post-exercise ingestion of chocolate soy beverages enhances glycogen resynthesis.

The effect of soybean isoflavone reducing the risk of estrogen-related diseases such as menopausal symptoms, breast cancer, osteoporosis, and cardiovascular disease has also been studied. Sato *et al.* (2000) found the positive result of vitamin K2 and soybean isoflavone supplementation in elite Japanese female long-distance runners. The authors observed, that supplementation may help reduce the risk of bone fracture. Investigations conducted in a group of Japanese collegiate athletes (Takeda, Ueno, Uchiyama, & Shiina, 2018) found evidence that consumption of soy isoflavones premenstrual symptoms such as anxiety or tension, fatigue, insomnia or hypersomnia, depressed mood and many others. The review of investigations of the effects of consumption of the soy-derived saccharides, dietary fibre and isoflavones on athlete health and endurance in given in Table 9.

3.4 The evaluation of acceptability and use of soy-based nutritional products by athletes

The investigations of Alberti, Sirtori, Iriti, & Arnoldi (2008) showed that soy-based food products are generally accepted by sportsmen regarding a sense of satiety, sense of energy and a desire to exercise. Therefore, they may provide a good way of pre-exercise nutrition in competitive athletes. The investigations of Bordi *et al.* (2003) conducted in a group of student athletes showed no remarkable differences in taste of a carbohydrate-protein beverage containing the isolated proteins from soy or from whey. Hayman (2008) evidenced the positive influence of an athlete nutrition education programme conducted in collegiate female athletes, which reflected in increase in knowledge about the relationship between nutrition and athletic performance. On the other hand, the investigations of Markowitz (2011) carried out in collegiate athletes from Coastal Carolina practicing different sport disciplines showed rare use of soy food products.

3.5 Other products

Ding (2015) patented a waterproof moisture-permeable sport suit comprising inter alia soybean fibre fabric layer. Ding (2016) invented a thin comfortable sportswear combination of wind-proof layer and warm-keeping layer that make it not only sportswear warm and ventilating, it

is also light, comfortable to wear, suitable for making the running easier and with activity. Wang (2016a) patented a waterproof ventilated shirt for outdoor sports which is made of soybean fibre and bamboo coal fibre, assuring good water resistance and air permeability. Moreover, the aforementioned author invented a breathable sport suit equipped with soybean fibre Wang (2016b), which has good moisture absorption performance and keeps the human body dry, a particularly important feature for outdoor sports. Wu, Zhang, & Li (2009) conducted investigations on improving the thermal-wet comfort of clothing during exercise. These authors noted that soybean fibre shows a lower damp sensation as well as a moderate sticky sensation during an exercise trial compared to other fabrics.

The majority of researchers patented sportsman-protecting inventions such as a disposable protective tooth movement set for use on the sports field (Yu *et al.*, 2014), a composition for reducing sports injury, especially for protecting cartilage tissue and skeletal muscle fibres (Yang, Bao, Liu, Zhu, & Jiao, 2013), a device covering the front portion of a hockey player's foot for protecting sportsman during play (Salama, Holden, & Kreisel, 2011), pads used among others in a bicycle seat and also for protecting an athlete against injury caused by pressure, shearing, friction, vibration and shock during athletic activities (Spence & Gardiner, 1988). Moreover, Barnes (2006) invented a ski vax formulation comprising soy wax appropriate for use on cross-country skis and downhill skis. Jiang, Zhang, & Zhang (2013) invented a material suitable for the covering of a sports floor surface comprising, among others, epoxidised soybean oil. Wood, Kirwan, Maggs, Meredith, & Coles (2015) tested the combustion performance of biodiesel containing soy oil for its potential application in motorsports and observed that its application enables the achievement of higher peak power outputs, a shorter ignition delay and more rapid combustion compared to other fuels.

4 Conclusions

The greatest number of publications focusing on application of soy-based products by sportsmen were published in the years 2010-2019, mainly by researchers affiliated in the USA, China and Japan. The inventors patented food supplements (in the majority), sportswear and devices enhancing protection of athletes during their sport activities. The greatest number of experimental articles was devoted to the impact of soy-based products use on athletes' health, the evaluation of quality of the products, as well their acceptability by sportsmen.

References

Alberti, G., Sirtori, C.R., Iriti, M., & Arnoldi, A. (2008). Acceptability of lupin protein products in healthy competitive athletes. *Sport Sciences for Health*, *3*(3): 65–71. https://doi.org/10.1007/s11332-008-0073-3.

Ariga, T., Manaka, T., Yamazaki, E., Obata, A., Fujii, N., Yamaji, N., Kikuchi, M., & Tsuruta, K., Watanabe, M. (2001). High-protein food of plate form. Google Patents. Patent number: US6333063 B2. Retrieved June 1, 2019, from https://patents.google.com.

Ariga, T., Yamazaki, E., Yamashita, K., Sasaki, M., Yamaji, N., & Ishii, N. (2000). Protein food. Google Patents. Patent number: US6045849A. Retrieved June 1, 2019, from https://patents.google.com.

Bae, S., Lee, D.K., Son, Ch-S., Lee, H.-S., Lee, Y.-B., Yoo, Y.-Ch., Park, J.-H., Hong, S.B., & Hwang, S.-Y. 2012. Effects of soybean peptide intake on antioxidant enzyme, cortisol and inflammatory cytokines in high school judo athletes. *Biomedical Science Letters*, *18*(1), 22–28.

Barnes, D (2006). Ski wax formulation. Google Patents. Patent number: US20060107870A1. Retrived June 1, 2019, from https://patents.google.com.

Bell, S., Forse, R., & Bistrian, B. (2001). Dietary supplement for individuals under stress. Google Patents. Patent number: US20010022980 A1. Retrieved June 1, 2019, from https://patents.google.com.

Berg, A., Schaffner, D., Pohlmann, Y., Baumstark, M.W., Deibert, P., König, D., & Gollhofer, A. (2012). A soy-based supplement alters energy metabolism but not the exercise-induced stress response. *Exercise Immunology Review*, *18*, 127–140.

Berry, D.A., Boghigian, B.A., Silver, N.W., von Maltzahn, G., Hamill, M., Chillakuru, R., & Kramarczyk, J.F. (2017). Charged nutritive proteins and methods. Google Patents. Patent number: US9611298B2. Retrieved June 1, 2019, from https://patents.google.com.

Berry, D.A., Boghigian, B.A., Silver, N.W., von Maltzahn, G., Hamill, M., & Chillakuru, R. (2014). Charged nutritive proteins and methods. Google Patents. Patent number: US8822412 B2. Retrieved June 1, 2019, from https://patents.google.com.

Bordi, P.L., Salvaterra, G., Cole, C., Cranage, D.A., Borja, M., & Choi, Y. (2003). A taste comparison of an isolated soy protein carbohydrate-protein beverage and an isolated whey protein carbohydrate-protein beverage. *Journal of Foodservice*, *14*(1), 23–33. https://doi.org/10.1111/j.1745-4506.2003.tb00175.x.

Brantman, E.R. (1987). Nutritional composition for enhancing skeletal muscle adaptation to exercise training. Google Patents. Patent number: US 4687782A. Retrieved June 1, 2019, from https://patents.google.com.

Burke, L.M., Winter, J.A., Cameron-Smith, D., Enslen, M., Farnfield, M., & Decombaz, J. (2012). Effect of intake of different dietary protein sources on plasma amino acid profiles at rest and after exercise. *International Journal of Sport Nutrition and Exercise Metabolism*, *22*(6), 452–462.

Cao, J., He, M., He, X., Huang, Y., & Xu, Z. (2017). Plant energy bar suitable for sports population, comprises plutonium, purple potato chips, expanded rice, almond, seeds, almond paste, cranberry, orange pudding, and soybean protein powder. Patent number: CN106820115-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Channi, E.K. (2016). Different biodiesel production technologies: a review. *Engineering and Applied Sciences*, *6*(9), 123–128.

Chen, A., Robbins, M., & Zhang, Z. (2017) The Effects of FCHG49® Glucosamine-TRH122® Chondroitin Sulfate-NMX1000® avocado soybean unsaponifiables on symptomatic chondral defects in elite ski jumpers. *Journal of Preventive Medicine & Healthcare*, *1*(4), 1017–1027.

Constantine, W.L., Dixon, A.S.A., Kramer, S., & Varhol, M.V. (2009). Sports beverage and method of making. Google Patents. Patent number: US20090162483A1. Retrieved June 1, 2019, from https://patents.google.com.

Cresta, A.K. (2009). Fitness and exercise-enhancing tablet containing protein isolate. Google Patents. Patent number: US20090226542 A1. Retrieved June 1, 2019, from https://patents.google.com.

de Penna, W.E., Bunger, A., Sansur, M., López, L., & Santana, R. (1993). Development of soy-based protein candy bars for athletes. *Archivos Latinoamericanos de Nutricion*, *43*(3), 241–247.

Ding, W. (2015). Waterproof moisture-permeable sport suit comprises polyacrylate coating, silk light cotton face material layer, clothes body comprising polyurethane layer, soybean fiber fabric layer and base cloth, and armpit part set with permeable layer. Patent number: CN204670453-U. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Ding, W. (2016). Thin comfortable sportswear comprises clothes main body set with strip groove and ventilating holes, windproof layer having PTFE microporous membrane layer, and warm-keeping layer having weft using soybean protein fiber. Patent number: CN205512547-U. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Dixit, A.K., Antony, I.J.X., Sharma, N.K., & Tiwari, R.K. (2011). Soybean constituents and their functional benefits. In *Opportunity, Challenge and Scope of Natural Products in Medicinal Chemistry* (pp. 367–383).

Drăgan, I., Stroescu, V., Stoian, I., Georgescu, E., & Baloescu, R. (1992). Studies regarding the efficiency of Supro isolated soy protein in Olympic athletes. *Revue Roumaine de Physiologie*, *29*(3-4), 63–70.

Faostat (2017). Retrieved 06/01, 2019, from http://faostat3.fao.org.

Fritz, R. (2004). Phosphatidylserine-containing muscle development diet supplement and anti-catabolic dietary nutrients. Google Patents. Patent number: US6673378B1. Retrieved June 1, 2019, from https://patents.google.com.

Fu, H., Liu, X., & Wei, L. (2017). Beverage for sports people, comprises soybean peptide, sweetener, sour agent, essence, salt, vitamins and water. Patent number: CN106666303-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Gardiner, P.T., Woodgate, D.E., Gilbert, M.S., & Thoburn, R. W. (2004). Food supplement for increasing lean mass and strength. Google Patents. Patent number: US6784209B1. Retrieved June 1, 2019, from https://patents.google.com.

Gardiner, P.T., Woodgate, D.E., Gilbert, M.S., & Thoburn, R. W. (2010). Food supplement for increasing lean mass and strength. Google Patents. Patent number: US7795204 B2. Retrieved June 1, 2019, from https://patents.google.com.

Garg, P. & Brar, J.K. (2017). Development and organoleptic evaluation of nutritious bars by using defatted peanut flour, roasted soybean seeds for gym trainees. *Chemical Science Review and Letters*, *6*(23), 2051–2057.

Garg, S., Lule, V.K., Malik, R.K., & Tomar, S.K. (2016). Soy bioactive components in functional perspective: a review. *International Journal of Food Properties*, *19*(11), 2550–2574. https://doi.org/10.1080/10942912.2015.1136936.

Guo, S, Lv, Y, Peng, X, Huo, Z, & Xu, J. (2018). Tsamba energy bar used for meal replacement energy bar or sports energy bar comprises soybean protein powder, highland barley, binder, butter, nuts and chocolate. Patent number: CN108936298-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Gupta, C., Prakash, D., & Gupta, S. (2016). Nutraceuticals for athletes. *Advances in Food Technology and Nutrititional Sciences*, *2*(2), 73–82. http://dx.doi.org/10.17140/AFTNSOJ-2-132.

Hood, E.E. (2016). Plant-based biofuels. *F1000Research*, *5*, F1000 Faculty Rev-185. https://doi.org/10.12688/f1000research.7418.1.

Hayman, A.J. (2008). Implementing a nutrition education program for collegiate female athletes to increase their knowledge on the relationship between nutrition and athletic performance. Unpublished Master Thesis of Arts in Education. Ohio, Defiance College. Retrieved June 1, 2019, from http://rave.ohiolink.edu/etdc/view?acc_num=def1281550523.

He, H. (2018). Sports nutrition chewable tablet comprises ginseng extract, dried orange peel extract, roselle extract, pollen hydrolysate, soybean protein isolate, whey protein, aminopolysaccharide, taurine, sweet orange powder, sorbitol and xylitol. Patent number: CN108741027-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Hever J., & Cronise R.J. (2017). Plant-based nutrition for healthcare professionals: implementing diet as a primary modality in the prevention and treatment of chronic disease. *Journal of Geriatric Cardiology*, *14*(5), 355–368. https://doi.org/10.11909/j.issn.1671-5411.2017.05.012.

Jendrysik, R., Skrypec, M.K., & Kappes, S. (2007). Sports drink acid blend to reduce or eliminate aftertaste. Google Patents. Patent number: US20070003670 A1. Retrieved June 1, 2019, from https://patents.google.com.

Jendrysik, R., Skrypec, M.K., & Kappes S. (2010). Sports drink acid blend to reduce or eliminate aftertaste. Google Patents. Patent number: US20100203197 A1. Retrieved June 1, 2019, from https://patents.google.com.

Jenkins, D.A. (2015). Protein beverage and method of making same. Google Patents. Patent number: US9220292B2. Retrieved June 1, 2019, from https://patents.google.com.

Jiang, Ch. (2015). Research of the recovery effect from soybean polypeptide solid beverage on athletes in endurance events. *Carpathian Journal of Food Science and Technology*, *7*(1), 5–12.

Jiang, X., Zhang, M., & Zhang, W. (2013). Material, useful for sports floor surface, comprises polypropylene, polyethylene, epoxidized soybean oil, glass fiber, calcium carbonate, butyl hydroxy anisol, antioxidant, lubricant, tourmaline powder, flame retardant and master batch. Patent number: CN103289201-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Jiao, Y., Yang, Z., Bao, H., & Zhu, L. (2013). Dairy product for relieving sports fatigue comprises cow's milk, whey protein powder, soybean protein peptide, carbohydrate, L-carnitine or its salt, acid, vitamin E, mineral substance, and water. Patent numbers: CN103070239-A; CN103070239-B. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Kingsley, M.I., Wadsworth, D., Kilduff, L.P., McEneny, J., & Benton, D. (2005). Effects of phosphatidylserine on oxidative stress following intermittent running. *Medicine & Science in Sports & Exercise*, *37*(8), 1300–1306.

Kingsley, M.I., Kilduff, L.P., Mceneny, J., Dietzig, R.E., & Benton, D. (2006a). Phosphatidylserine supplementation and recovery following downhill running. *Medicine and Science in Sports and Exercise*, *38*(9), 1617–1625. https://doi.org/10.1249/01.mss.0000229459.11452.a0.

Kingsley, M.I., Miller, M., Kilduff, L.P., McEneny, J., & Benton, D. (2006b). Effects of phosphatidylserine on exercise capacity during cycling in active males. *Medicine & Science in Sports & Exercise*, *38*(1), 64–71. https://doi.org/10.1249/01.mss.0000183195.10867.d0.

Kovalenko, I.V., Rippke, G.R., & Hurburgh, C.R. (2006). Determination of amino acid composition of soybeans (*Glycine max*) by near-infrared spectroscopy. *Journal of Agricultural and Food Chemistry*, *54*(10), 3485–3491. https://doi.org/10.1021/jf052570u.

Kraemer, W.J., Solomon-Hill, G., Volk, B.M., Kupchak, B.R., Looney, D.P., Dunn-Lewis, C., Comstock, B.A., Szivak, T.K., Hooper, D.R., Flanagan, S.D., Maresh, C.M., & Volek, J.S.

(2013). The effects of soy and whey protein supplementation on acute hormonal responses to resistance exercise in men. *Journal of the American College of Nutrition*, *32*(1), 66–74. https://doi.org/10.1080/07315724.2013.770648.

Lai, S.X. (2015). Preparation of antioxidant sports food soybean peptides. *Carpathian Journal of Food Science And Technology*, *7*(3), 126–135.

Lan, X. (2018). High protein dietary composition useful as sports diet food substitute and reducing blood lipid level, comprises *e.g.* soybean peptide powder, isolated soy protein, chia seed, round plantain seed shell, maltodextrin and oat flour. Patent number: CN107692240-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Laskowski, R., & Antosiewicz, J. (2003). Increased adaptability of young judo sportsmen after protein supplementation. *Journal of Sports Medicine and Physical Fitness*, *43*(3), 342–346.

Li, C., Liu, J., Niu, X., & Wang, C. (2017). Preparing soy peptide powder useful in sports food, energy drink and healthcare product for relieving fatigue, comprises mixing low-temperature degreased soybean meal and water, extracting and subjecting to solid-liquid separation. Patent number: CN107385003-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Li, W. (2014). Sports nutrition milk tea powder used e.g. for relieving fatigue includes skim milk powder, whey protein powder, collagen powder, soy peptide powder, corn oligopeptide, inulin, maltodextrin, soluble soybean polysaccharide and L-carnitine. Patent numbers: CN103549015-A, CN103549015-B. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Li, Y.-Y. (2004). The Soybean Protein Fibre – A healthy & comfortable fibre for the 21st century. *Fibres & Textiles in Eastern Europe*, *12*(2), 8–9.

Lin, T.-K., Zhong, L., & Santiago, J.L. (2018). Anti-inflammatory and skin barrier repair effects of topical application of some plant oils. *International Journal of Molecular Sciences*, *19*(1), article number 70. https://doi.org/10.3390/ijms19010070.

Malik, S., & Parvinder, K. (2018). To study the effect of the developed drinking powder on the blood profile of athletes (16-17 years). *International Journal of Applied Home Science*, *5*(1), 232–238.

Markowitz, A. (2011). An Analysis of the Dietary Behaviors of Coastal Carolina University's NCAA Division I Student-Athletes. Honors Theses. Carolina, Coastal Carolina University. Retrieved June 1, 2019, from https://digitalcommons.coastal.edu/honors-theses/107.

Messina, M. (2016). Soy and health update: evaluation of the clinical and epidemiologic literature. *Nutrients*, *8*(12), 754. https://doi.org/10.3390/nu8120754.

Michnowski, J. (1989). Nutritional athletic bar. Google Patents. Patent number: US4832971A. Retrieved June 1, 2019, from https://patents.google.com.

Misawa, K., Takigawa, H., & Murase, T. (2016). PPAR activator. Google Patents. Patent number: US9301986 B2. Retrieved June 1, 2019, from https://patents.google.com.

Moher D., Liberati A., Tetzlaff J., Altman D.G., The PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med*, *6*(7): e1000097. https://doi.org/10.1371/journal.pmed.1000097.

Muraoka, A., Nishi, K., Nakamura, Y., & Sakata, T. (2010). Powdery soy protein and soy protein-containing food using the same. Google Patents. Patent number: US20100227040 A1. Retrieved June 1, 2019, from https://patents.google.com.

Naito, H., & Miura, S. (2011). Muscle-building agent. Google Patents. Patent number: US20110319315 A1. Retrieved June 1, 2019, from https://patents.google.com.

Nakajima, S., Murakami, T., & Sekiguchi, Y. (2001). Composition having capability of removing risk factor during exercise. Google Patents. Patent number: US6313167 B1. Retrieved June 1, 2019, from https://patents.google.com.

Nwokolo, E. 1996. Soybean (*Glycine max* (L.) Merr.). In *Food and Feed from Legumes and Oilseeds* (pp. 90–102). ISBN 978-1-4613-0433-3. https://doi.org/10.1007/978-1-4613-0433-3_8.

Orlando, C. (2002). Soy-based pasta. Google Patents. Patent number: US20020155206 A1. Retrieved June 1, 2019, from https://patents.google.com.

Palmer, A., Rudan, B., Gautam, A., Dagerath, M., & Patrick, M. (2005). Nutrition bar. Google Patents. Patent number: US20050181019 A1. Retrieved June 1, 2019, from https://patents.google.com.

Pladias (2014-2019). Database of the Czech flora and vegetation. pladias.cz Retrieved 06/01, 2019, from https://pladias.cz/en/taxon/data.

Ponnusha, B.S., Subramaniyam, S., Pasupathi, P., Subramaniyam, B., & Virumandy, R. (2011). Antioxidant and Antimicrobial properties of *Glycine max* – A review. *International Journal of Current Biological and Medical Sciences*, *1*(2), 49–62.

Portman, R. (2002). Sports drink composition for enhancing glucose uptake into the muscle and extending endurance during physical exercise. Google Patents. Patent number: US20020197352A1. Retrieved June 1, 2019, from https://patents.google.com.

Portman, R. (2003). Sports drink composition for enhancing glucose uptake into the muscle and extending endurance during physical exercise. Google Patents. Patent number: US20030064135 A1. Retrieved June 1, 2019, from https://patents.google.com.

Portman, R. (2006). Sports drink composition for enhancing glucose uptake into the muscle and extending endurance during physical exercise. Google Patents. Patent number: US6989171B2. Retrieved June 1, 2019, from https://patents.google.com.

Portman, R. (2010). Sports drink composition for enhancing glucose uptake into the muscle and extending endurance during physical exercise. Google Patents. Patent number: US7740893 B2. Retrieved June 1, 2019, from https://patents.google.com.

Qiu, S. (2018). Sports beverage comprises soybean polypeptide, sucrose, honey, longan juice, Asparagus extract, malic acid, citric acid, carboxymethyl cellulose, monopotassium phosphate, sodium dihydrogen phosphate, sodium chloride and magnesium chloride. Patent number: CN107712491-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Rijavec, T., & Zupin, Ž. (2011). Soybean Protein Fibres (SPF). Chapter taken from Recent Trends for Enhancing the Diversity and Quality of Soybean Products. ISBN: 978-953-307-533-4. Retrieved June 1, 2019, from https://www.intechopen.com/books/recent-trends-for-enhancing-the-diversity-and-quality-of-soybean-products/soybean-protein-fibres-spf-.

Royal Botanic Gardens Kew. (2019). Seed Information Database (SID). Version 7.1. Retrieved 06/01, 2019, from http://data.kew.org/sid.

Sagiya, K. (2012). Confectionery product containing vegetable protein. Patent numbers: JP2012249603-A; JP5848893-B2. Retrieved June 1, 2019, from https://patents.google.com.

Sakamoto, S., Okamatsu, H., Okamura, K., Takaichi, A., Okamoto, T., Fukuda, T. (2000). Nutrient composition. Google Patents. Patent number: US6037375A. Retrieved June 1, 2019, from https://patents.google.com.

Salama, S., Holden, M., & Kreisel, M. (2011). Hockey Foot Shield. Google Patents. Patent number: US20110067270 A1. Retrieved June 1, 2019, from https://patents.google.com.

Sato, T., Ohtani, Y., Yamada, Y., Yamakawa, K., Uchida, M., & Shimizu, H. (2000). Effect of vitamin K2 (menaquinone-7) and soybean isoflavone supplementation on serum undercarboxylated osteocalcin in female long-distance runners. *Food Science Technology Research*, *6*(4), 288–290. https://doi.org/10.3136/fstr.6.288.

Sheldon, K.L. (2000). Thickened hydrolyte isotonic beverage. Google Patents. Patent number: US6162471A. Retrieved June 1, 2019, from https://patents.google.com.

Shenoy, S., Dhawan, M., & Sandhu, J.S. (2016). Four weeks of supplementation with isolated soy protein attenuates exercise-induced muscle damage and enhances muscle recovery in well trained athletes: A randomized trial. *Asian Journal of Sports Medicine*, *7*(3), Article number e33528. http://asjsm.com/articles/56990.html.

Smith, R.A. (2012). Organic vegan protein shaker. Google Patents. Patent number: US20120128832 A1. Retrived June 1, 2019, from https://patents.google.com.

Smith, W.C., Brown, J.A., & Holt, S.K. (2011). Functional food paste. Google Patents. Patent number: US20110172142 A1. Retrieved June 1, 2019, from https://patents.google.com.

Son, Ch.-S., Lee, Ch.-S., Lee, J.-W., Lee, Y.-B., Park, M.-S., Yoo, Y.-Ch., Park, J.-H., Hong, S.B., & Hwang, S.-Y. (2011). The effects of soybean peptide intake on index of muscle damage and hormone concentration in taekwondo player. *Biomedical Science Letters*, *17*(3), 245–251.

Spence, W.R., & Gardiner, P. (1988). Method for producing pad structures with viscoelastic cores and article so made. Google Patents. Patent number: US4756949A. Retrieved June 1, 2019, from https://patents.google.com.

St. Cyr, J., & Johnson, A. (2000). Compositions for increasing energy in vivo. Google Patents. Patent number: US6159942A. Retrieved June 1, 2019, from https://patents.google.com.

Stein, T.P. (1996). High energy food products containing partially hydrogenated structured lipids. Google Patents. Patent number: US5571553A. Retrieved June 1, 2019, from https://patents.google.com.

Stone, K. (2002). Food supplement containing a cartilage supplement. Google Patents. Patent number: US6391864 B1. Retrieved June 1, 2019, from https://patents.google.com.

Stroescu, V., Dragan, I., Simionescu, L., & Stroescu, O.V. (2001). Hormonal and metabolic response in elite female gymnasts undergoing strenuous training and supplementation with SUPRO® brand isolated soy protein. *Journal of Sports Medicine and Physical Fitness*, *41*(1), 89–94.

Takeda, T., Ueno, T., Uchiyama, S., & Shiina, M. (2018). Premenstrual symptoms interference and equol production status in Japanese collegiate athletes: A cross-sectional study. *Journal of Obstetetrics and Gynaecology Research*, *44*(3), 488–494. https://doi.org/10.1111/jog.13552.

Takeuchi, H., Kasai, M., Taguchi, N., Tsuji, H., & Suzuki, M. (2002). Effect of triacylglycerols containing medium-and long-chain fatty acids on serum triacylglycerol levels and body fat in college athletes. *Journal of Natural Science*, *48*, 109–114. https://doi.org/10.3177/jnsv.48.109.

Tobin, J.G., & Tobin, C.L. (2012). Nutrient Hydration Bar. Google Patents. Patent number: US20120282232 A1. Retrieved June 1, 2019, from https://patents.google.com.

Toyooka, K., Hamada, K., & Saitoh, H. (2019). Gel-like food composition. Google Patents. Patent number: US20190008197 A1. Retrieved June 1, 2019, from https://patents.google.com.

Tsukuda, K., Hoshii, Y., & Gottemoller, T.V. (2003). Easily dispersible granules of soybean protein and methods for preparing the same. Google Patents. Patent number.: US6514546B2. Retrieved June 1, 2019, from https://patents.google.com.

Tsukuda, K., Hoshii, Y., & Gottemoller, T.V. (2008). Easily dispersible granules of soybean protein. Google Patents. Patent number.: US7351441 B2. Retrieved June 1, 2019, from https://patents.google.com.

Udani, J.K., Singh, B.B., Singh, V.J., & Sandoval, E. (2009). BounceBack™ capsules for reduction of DOMS after eccentric exercise: a randomized, double-blind, placebo-controlled, crossover pilot study. *Journal of the International Society of Sports Nutrition*, *6*, 14. https://doi.org/10.1186/1550-2783-6-14.

Upshaw, A.U., Wong, T.S., Bandegan, A., & Lemon, P.W.R. (2016). Cycling time trial performance 4 hours after glycogen-lowering exercise is similarly enhanced by recovery nondairy chocolate beverages versus chocolate milk. *International Journal of Sport Nutrition and Exercise Metabolism*, *26*(1), 65–70. https://doi.org/10.1123/ijsnem.2015-0056.

Wada, K., Yata, S., Akimitsu, O., Krejci, M., Noji, T., Nakade, M., Takeuchi, H., & Harada, T. (2013). A tryptophan-rich breakfast and exposure to light with low colour temperature at night improve sleep and salivary melatonin level in Japanese students. *Journal of Circadian Rhythms*, *11*(1), Article number 4. https://doi.org/10.1186/1740-3391-11-4.

Wang, Q., Li, S., Yang, Z., Zhou, .I, Gao, H., Xu, Z., Fang, Z., Gong, S., Gao, J., Wu, Y., Cai, M., Shi, W., & Ge, Ch. (2004). The effects of soybean peptides supplementation on serum biomarkers in distance runners. *Chinese Journal of Sports Medicine*, *1*, 33–37.

Wang, X. (2016a). Waterproof ventilate shirt for outdoor sports, has second warp blend that is made of pearl fiber and ramie fiber, and second weft bend that is made of soybean fiber and bamboo coal fiber. Patent number: CN204908017-U. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Wang, X. (2016b). Breathable sport suit, has banana fiber equipped with soybean fiber that is fixed with blended body, and nylon material provided with multiple air holes and mounted with permeable eye screen cloth layer. Patent number: CN204888763-U. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Wang, Y. (2014). Food for relieving sports fatigue comprises soybean polypeptide, royal jelly powder, sucralose, Kara glue, konjak, sodium ascorbate, sodium citrate, potassium chloride, calcium hydrophosphate, and water. Patent number: CN103598581-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Weaver, E. (2007). Composition and method for effective lean body mass gain. Google Patents. Patent number: US20070154613 A1. Retrieved June 1, 2019, from https://patents.google.com.

Wiesenberger, A., Kolb, E., & Engelhardt, I. (1984). Protein containing conditioning drink. Google Patents. Patent number: US4486413A. Retrieved June 1, 2019, from https://patents.google.com.

Wilson, R. (2008) Soybean: market drivien research needs. In G. Stacey (ed.), *Genetics and genomics of soybean* (pp. 3-15). New York: Springer. Retrieved June 1, 2019, from https://doi.org/10.1007/978-0-387-72299-3.

Wood, B.M., Kirwan, K., Maggs, S., Meredith, J., & Coles, S.R. (2015). Study of combustion performance of biodiesel for potential application in motorsport. *Journal of Cleaner Production*, *93*, 167–173. https://doi.org/10.1016/j.jclepro.2014.12.091.

Wu, H.Y., Zhang, W.Y., & Li, J. (2009). Study on improving the thermal-wet comfort of clothing during exercise with an assembly of fabrics. *Fibres & Textiles in Eastern Europe*, *17* (4), 46–51.

Wu, J., Wang, Y., Wu, R., Li, M., Yue, X., Yao, D., Yang, Z., & Zhang, Z. (2017). Sports nutritional fermented milk useful for relieving fatigue, comprises spirulina, soybean oligosaccharides, soybean oligopeptide, taurine, vitamin-B12, nicotinamide, mixed starter and cow milk Patent number: CN106472670-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Xiaolu, W. (2013). The combination of sports nutrition regulation to improve exercise capacity. *Contemporary Sports Technology*, *10*, G804.3;R87.

Yanaka, K., Tousen, Y., Matsumoto, T., Takebayashi, J., Taku, K., Yamada, K., & Ishimi, Y. (2010). Food labeling and actual contents of soy protein and soybean isoflavones in health foods. *The Japanese Journal of Nutrition and Dietetics*, *68*(3), 234–241. https://doi.org/10.5264/eiyogakuzashi.68.234.

Yang, H.-F., Tso, T.K., Huang, Ch.-Ch., & Huang, W.N. (2015). Okara supplementation relieves fatigue and muscle damage that occur during exercise training. *Journal of Food and Nutrition Research*, *3*(5), 352–356. https://doi.org/10.12691/jfnr-3-5-10.

Yang, Z., Bao, H., Liu, Y., Zhu, L., & Jiao, Y. (2013). Composition for reducing sports injury and promoting sports injury repair comprises hydrolyzed collagen, soybean peptide, chondroitin sulfate, glucosamine, traditional Chinese medicine, *Haematococcus pluvialis*, vitamin, and mineral. Patent numbers: CN103082276-A, CN103082276-B. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Yeh, T.-S., Chan, K.-H., Hsu, M.-Ch., & Liu, J.F. (2011). Supplementation with soybean peptides, taurine, *Pueraria* isoflavone, and ginseng saponin complex improves endurance exercise capacity in humans. *Journal of Medicinal Food*, *14* (3), 219–225. https://doi.org/10.1089/jmf.2010.1096.

Yu, P., Chen, G., Ma, T., Sun, Z., Pang, J., Wu, X., Chen, Z., & Yu, C. (2014). Preparation of disposable protective tooth movement set for use in sports field, involves mixing chitosan, sodium carboxymethyl cellulose, glycerol, stearic acid, modified konjac glucomannan, and soybean oil, and molding obtained gel. Patent numbers: CN103788421-A, CN103788421-B. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Zhang, H., Zhou, L.Y., Geng, L., Yi, M., & Zhou, L. (2010). Composition comprising saccarides & peptides & uses thereof. Google Patents. Patent number: US20100173822 A1. Retrieved June 1, 2019, from https://patents.google.com.

Zhang, K. (2016). Student sports drink comprises soybean polypeptide, amino acid, nicotinic acid, taurine, vitamin, guarana extract, wheat germ extract, beta-carotene, apple juice, red bayberry juice, grapefruit juice, lemon juice and pure water. Patent number: CN106173682-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Zhou, C. (2015). Traditional Chinese medicine useful in soybean milk for preventing sports anemia, supplementing blood, protecting skin, beautifying, contains rhizoma imperatae, jujube, Chinese Angelica, radix rubiae, beetles, golden cypress and hyssop. Patent number: CN105123960-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Zhou, X., Zeng, J., Jiang, W., & Wang, C. (2010). Acid-resistant and non-bitter soybean oligopeptide, used in sports and supplement-type beverage, prepared by e.g. preparing soybean protein solution, heating, cooling, performing isoelectric point enzymolysis and centrifuging. Patent numbers: CN101787387-A; CN101787387-B. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Zhu, H., Xun, Y., Wang, S., Wei, L., Wang, L., Lu, C., Feng, L., Zhang, D., Xue, Y., Guo, H., & Han, M. (2019). Sports fermented dairy product comprises e.g. raw milk, glucose, soybean protein, casein, whey protein, yam, lily, malt oligosaccharides, vitamin E, Lactobacillus delbrueckii and Lactobacillus paracasei. Patent number: CN109042881-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Zhu, T., Yu, Y., Zhu, S., Li, T., & Liang, X. (2016). Astaxanthin wine useful for delaying aging, relieving sports fatigue and improving immunity, comprises base wine, natural astaxanthin, collagen, isomaltooligosaccharide syrup, soybean peptide and vitamin C. Patent number: CN106190722-A. Retrieved June 1, 2019, from https://apps.webofknowledge.com/.

Cite this article as: Kostrakiewicz-Gierałt K (2020) An overview of soybean derived products for sportsmen. Mov Sport Sci/Sci Mot, https://doi.org/10.1051/sm/2020002