HERBS AND FUNCTIONAL FOODS FOR SPORT PERFORMANCE

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Nowadays herbal medicinal products and supplements are used by not less than 80% of people worldwide for some part of primary healthcare and the present link between plants and sport can be found in the concept of "functional foods". Many of these are available on the market and their effects change according to the type of sport, level of activity, the person and by environmental conditions of the place where the actiivities take place.

The use of plant foods that can enhance physical and mental performances is known since antiquity, for example athletes of the ancient Greece or Rome had specific diets during the periods of competitions and fightings. Nowadays herbal medicinal products and supplements are used by not less than 80% of people worldwide for some part of primary healthcare (Ekor, 2013) and the present link between plants and sport can be found in the concept of "functional foods". Functional foods actually contain secondary metabolites that plants produce for their own defence against stresses due to biological and physical environment, such as herbivores or excessive heat or cold. These metabolites play a role also in human adaptations and reaction to stresses (Jamwal *et Al.*, 2018), thus becoming our medicinal plants. Plants secondary metabolites can be grouped in three broad categories (Agostini-Costa *et Al.*, 2012): terpenes (such as volatiles, cardiac glycosides, carotenoids and steroids), phenolics (such as phenolic acids, coumarins, lignans, stilbenes, flavonoids, tannins and lignin), and nitrogen containing compounds (such as alkaloids and glucosinolates).
Past studies on drinks and foods referred mostly to carbohydrate, protein and fat content Nonetheless foods have a number of effects else than primary metabolism, in fact the biochemicals derived from their secondary metabolism have a variety of effects such as anti-asmatic, anti-bacterial, anti-cholesterol, anti-depressants, anti-diabetic, anaflogistic, astringent, cardiotonics, digestive, diuretics, lassative, sedatives, spasmolytic, virostatic and more. Thus, more

recently, research has expanded to functional components that influence organs and metabolism.
Functional foods can be fresh or processed, and they are rich in nutrients with overall beneficial effects on health that is extended to sport performances. The foods with such properties were initially studied in Japan in the 1980s because they were found to promote health or reduce the risk of disease (Katan and De Roos, 2003; Serafini *et Al.*, 2012).
Many functional foods are available on the market, although some have not clearly demonstrated efficacy and others are advertised with exaggerated claims that can confuse the customers. Their effects change according to the type of sport and level of activity, the person, and by environmental conditions of the place where the activities take place.
Although there is plenty of studies and full agreement on the generic positive effects of a specific diet on athletes performances, the different effects on individuals are less studied and understood (Beck *et Al.*, 2015). Diet is now recognized as an important component to be considered together with the training techniques. As an example, a programmed diet that includes electrolyte drinks, carbohydrates, sodium and caffeine has been compared to common diets and has increased the speed of marathon runners (Hanse *et Al.*, 2014) and cyclists (Hottenrott *et Al.*, 2012), another diet including just electrolytes and caffeine has reduced the racing time of cyclists of 32-84 seconds on a distance of 40 km (Jeukendrup and Martin, 2001).
A very important role for the athletes, especially during long-duration competitions (endurance sports) is played by rehydration, which at the same time also provides replenishment of the electrolytes lost through sweating. The available literature revealed wide variability in fluid intake and sweat losses across and within different events with varied strategies to allow fluid intake. While there is variable relationship between fluid intake and balance, and finishing times in competitions, some research has outlined how top athletes normally have well calibrated fluid intakes, whilst many common competitors risk disadvantages for drinking beyond requirements (Garth and Burke, 2013).
Other examples include the effect of vitamins, for example vitamin D has not only a role in maintaining bone structure, but also effects on muscle strength (Girqis *et Al.*, 2013) and consequently on athletic performance thanks to the influence of muscle contractility related to calcium balance.
A particular aspects, extremely important in sport, is the use of beverages. During competitions athletes increase their metabolism, produce more heat and consequently have to sweat to keep the normal temperature. Sweating causes loss of water and electrolytes, both must be refreshed (Buono and Wall, 2000). This loss of body fluid bring to a decline of athletic performance (Nose *et Al.*, 1994). Therefore, to maintain homeostasis and athletic performance, replenishment of water and electrolytes is essential before and after exercise, and also during it when the training goes on for over 90 minutes (Latzka and Montain, 1999). Replenishment of water alone is unlikely to maintain homeostasis of body fluid in prolonged training, and actually this practice brings to hyponatremia and a decrease in the osmotic pressure of body fluids and inhibit the release of antidiuretic hormone resulting in that water intake is suppressed and the urine output is increased, with a trend to spontaneous dehydration (Takamata *et Al.*, 1994). Latzka *et Al.*, (1999) suggested that during training longer than 90 minutes, fluid drink containing electrolytes and carbohydrate, not water alone, can sustain carbohydrate oxidation and endurance performance.
The losses of water and electrolytes have been investigated especially with reference to Sodium (Sawka *et Al.*, 2007). Nonetheless of differences related to the subject, the activity and the environment, during a training lasting two hours, a water loss of about 2-3% body mass and about 70 mEq (1.6 g) of sodium are common. These changes increase the plasma sodium concentration of on average 5-7 mEq/L. Consequently sodium ingestion plays an important role to minimize dehydration during long training.
On this base, athletes have a natural need of "tasty" water such as fruit juices, because into it they find also the electrolytes they need rapidly and the minerals and vitamins for longer term balance (Baker *et Al.*, 2005). The common use of beverages such as tea and fruit juices during competition can now be explained as contemporary sources of water, electrolytes and carbohydrates, a natural carbohydrate-electrolyte solution (CES).
Personalised diets for athletes are no longer limited to the simple balancing of carbohydrates, proteins and fats, but go into the detail of microelements, vitamins and particular biocompounds that are found in food or integrators (Travis *et Al.*, 2016) and must be diversified for each person.
In fact, food requirements are not the same for the practicant of a same sport and must be programmed for each individual. In addition there is variability of sports: sports of physical endurance in which dominate intense but above all prolonged efforts, other sports that require sudden but short energy peaks, others in which physical abilities are secondary to mental concentration, others in which the prevailing role is body coordination, or the

Product	Functionality
Sugar (beet or cane) *Beta vulgaris Saccharifera, Saccharum officinarum*	Occasional energetic in training and competitions.
Coffee, Tea *Coffea arabica, Camellia sinensis*	Nervous stimulant to increase attention and quick reactions in competition.
Sneaks of Ciocolate, honey, marmalades, fresh fruits (banana, apple, date) *Theobroma cacao, Musa spp., Malus domesticus, Phoenix dactylifera*	Energy maintenance with little effort of the digestive system, used daily in long training or during long competitions.
Drinks (oranges, pineapple, pomegranate) *Citrus sinensis, Ananas comosus, Punica granatum*	Thirst quenching, also with apports of salts and vitamins, low calories.
Stevia sweetener *Stevia rebaudiana*	Natural sweetener with extremely few calories, used daily or in competitions for body weight maintenance
Herbal tea of zingiber *Zingiber officinalis*	Adaptogen, used to warm in outdoor activities in cold season.
Herbal tea of Chinese ginseng *Panax ginseng*	Tonic-adaptogen, used in daily training before competitions.
Herbal tea of Maca *Lepidium meyenii*	Tonic-adaptogen for daily training and before competitions.
Herbal tea of minor ginseng *Codonopsis pilosula*	Tonic-adaptogen, for daily training and before competitions.
Chamomile *Matricaria chamomilla*	Soothing drink the nights before competitions.
Valeriana *Valeriana officinalis*	Soothing drink the night before competitions.
Cannabis *Cannabis sativa* var. *Sativa*	Soothing drink the night before competitions.

Table 1 – A list of herbs and functional foods used by sportives, outlined in a previous survey (modified from: Pardini et Al., 2019).

immediacy of instinct, or psychic dominance over the opponent. Of course, each type requires a specific diet.

A personalized diet can strongly affect the performance of the athlete (Guest *et Al.*, 2019) aiming at maximizing performances on the base of individual characteristics, in fact referring to the genetic type. Genetic differences influence the absorption of nutrients, their metabolism and their excretion and, as a whole, influence metabolic pathways, although this fact is well known and widely used in important sports and at high levels, in secondary sports or at amateur levels the use is still to general recommendations.

For all these reasons, our aim in this article is not to propose ourselves as specialists in an area that is too large and at the same time too individual, but to present some actual uses of sportive people and to verify their correspondence with science. First of all we wanted to listen to athletes, both of a high level including international, and amateur practicants who in fact do not benefit from any specialist support except at their own expense. We managed to include former high-level agonists after the end of their competitive careers, people who often face the after-effects of previous traumas without much support from the federations and without the due consideration by the health care system.

In fact, the largest number of practicants manages diets by themselves, with an obvious risk of mistakes. In order to verify the response between actual uses and modern science, we take a start from our previous survey (Pardini *et Al.*, 2019), which had already highlighted what the actual practitioners use. In this article we limit our considerations on some functional foods derived from plants. Plants provide us with most primary nutrients and contain many bioactive phytochemicals which provide health benefits such as carotenoids and polyphenols, including phenolic acids, alkaloids, flavonoids, glycosides, saponins, and lignans (Sellami *et Al.*, 2018). Herbal dietary supplements and integrators are used by sportives for increasing energy, stimulate fat-burning metabolism inducing weight loss, promoting muscle growth, increase attention (Williams, 2006).

The reasons for the use of plant foods in sport can be grouped in three kinds: enhance endurance (eg, running, cycling, rowing, swimming, walking, dancing, aerobics); induce muscular hypertrophy and strength (eg, bodybuilding, weight lifting, wrestling); enhance performance in competitions (Bucci, 2000).

Although the use of plants is still not common among athletes, their use as integrators has much increased in recent years. The sale and use of some of the more powerful extracts are not allowed in some national legislations and they are being used as doping (ex. *Pausinystalia yohimbe). Y*ohimbine is a component of several food supplements recommended for sexual and physical enhancement, however these can be a significant risk for consumers. Yohimbine is a potent α-2 antagonist and a weaker α-1 antagonist, with effects on both peripheral and central nervous system (Coates *et Al.*, 2010). Adverse effects including headache, hyper-tension, panic attacks and increased frequency of urination have been reported after its use (Tam et al, 2001; Aguilar *et Al.*, 2013). Yohimbine effects on arterial pressure are due to interactions with α-1 and α-2 receptors. Yohimbine is a weak α-1 blocker, thus it can reduce blood pressure with a slight relaxation of smooth vascular muscles but, at the same time, it can rise the blood pressure increasing the heart output, its frequency and liquid retention. Instead it is a strong α-2 blocker thus it increases the release of norepinephrine (NA), the activation of α-1 and β-1 receptors, and consequent rise of pressure.

A recall from our past survey

The scientific articles available expose the point of view of medicine, but not the actual uses of sportsmen. The results we published previously were the first to be obtained directly from interviews with athletes, it was carried out in 2018 through interviews and questionnaires distributed to 150 athletes aged between 11 and 55 years and practicing various types of sports with varying intensity of training from high-level competition to mere occasional practice. The survey produced a list (table 1) of herbal remedies and foods used as a matter of fact in relation to training.

This survey showed that the interviewed athletes seek in their diet a few functions that can be grouped in: adaptogen, calming-relaxing, quenching and reintegrative of micronutrients, energizing, low-calory, stimulating, tonic.

Categories pf herbs functional to sports

Adaptogens: (examples are *Zingiber officinalis*, and the whole Ginseng group including *Panax ginseng* (Chinese or Korean ginseng), *Panax notoginseng* (South-China ginseng), *Eleutherococcus senticosus* (Siberian Ginseng), *Panax quinquefolius* (North American Ginseng). The term was introduced by Soviet scientists who were studying on ginseng. Refers to plant components that can be used even in rather large quantities with minimal side effects, able to increase the adaptation of body to environmental stresses like cold or hot weather, strong emotions, muscular or nervous fatigue. Adaptogens improve the adaptation to adverse environmental conditions. Often confused with tonics or stimulants, adaptogens bring the metabolic system to a higher level in a sustainable way. Stimulants on the contrary give a rapid boost always followed by need of a recovery period. This category can also include foods that can contribute to environmental adaptation thanks to antioxidant power, such as pomegranate (*Punica granatum*).

Calming-relaxing

Herbs that influence the central nervous system (such as valerian, hyperic, chamomile, lobelia, passiflora, lollypop, hemp), they are used by apprehensive or sensible subjects, to sleep calm especially the few nights before a competition, they are common also among students that have exams. Instead, stimulants and tonics are preferred to increase performance during the day in training periods and during the competition.

Refreshing and reintegrative

We refer here to beverages that in addition to providing water, contain also minerals and vitamins for reintegration. Commonly they are drinks obtained by direct squeezing of fruits such as oranges, lemon, lime, pineapple, papaya; or similar green tea and herbal teas. Such drinks bring also a variety of substances that as a whole give the drink a taste that is at least temporarily more appreciated than that of the common water.

Energizing

It has actually a broad meaning that can refer to various types of plants. Energizers are plants with various beneficial effects on the body, for example anti-inflammatory, stimulant of the NCS, or va-

sodilatory or with effects on heart and circulation, or because they promote digestion. As a result of these effects, the person has a feeling of more energy. For example tea and coffee, or yerba mate (*Ilex paraguariensis*) a drink of Latin American origin recently spread in Italy and other European Countries for its ability to accentuate attention probably due to its caffeine content. The concept of energizing, however, is also related to the environment and the particular case, for example a ginger drink on a cold day can give a temporary feeling of energy.

Refined sugar from sugar beet or cane are sometimes added to beverages in the belief that they release immediate energy. The sucrose extracted from the two plants is the same and the difference in colour is due only to refinement: white if completely refined, brown if still containing molasses. Both have the same effects and contain about 400 Kcal per 100 grams. Integral sugars, not refined, contain also useful micro-elements.

Hypo-calorie sweetener

Stevia has been used for centuries in Latin America (Meli *et Al.*, 2014b) but only recently available on European markets. This product is obtained from the leaves of the plant and has not any negative side effects that are instead indicated for artificial sweeteners. Stevia has a sweet taste greater than that of sugar but at calories close to zero (Meli *et Al.*, 2014a). Low-calory drinks provide also nutrients and vitamins, they are done from several fruits such as oranges, pineapple, lemon, pomegranate; the squeezed prickly pear (*Opuntia ficus-indica*) is known in the Countries around the Mediterranean Basin and tropics (Pardini *et Al.*, 2017). The juice from these fruits is often diluted in water to make them more refreshing.

Stimulants

Biochemicals like caffeine, theine or nicotine, increase rapidly and just temporarily attention, concentration, ability to work, and give a feeling of more energy available. Their effect is after all similar to that of amphetamines and it is similar to that of plants not everywhere allowed like Yohimbe. The quick result is achieved by stimulating the release of stress hormones especially adrenaline and cortisol. Their use is normally followed by a state of fatigue due to overuse of your possibilities. The stimulants of the nervous system can cause insomnia, nervousness, anxiety and overall exhaustion.

Tonics

Plants like the group of Ginseng and Maca, have no negative side effects if taken in the right doses. They strengthen and invigorate several organs or systems of the body. Repeated doses tend to further improve the organic condition without tolerance or addiction or other negative effects. A residual effect of their ingestion tends to remain even when intake is interrupted. For example in oriental food traditions food and tonic drinks are taken daily to maintain balance and well-being.

Some species in detail

The list of plants with functional effects is large, we focus on the details of just some more specifically used by athletes for sport training.

Ananas comosus* = *Pineapple

Native of Latin America, probably Brazil and around. A tropical and perennial plant cropped as annual or biannual, new plantations are done using ground or side suckers, and the leafy tops. As a home ornamental, the plant can be multiplied by the tops of the fruits available in markets, but shall not make fruits in temperate Countries. As a food or drink it is appreciated to replenish liquid and electrolytes also with anti-inflammatory-anti-oedemigen efficacy. Raw pineapple pulp contains around 50 calories per 100 grams and has 86% water, 13% carbohydrates, 0.5% protein, and contains very few fats; it is rich in Vitamin C and Potassium, Calcium, Magnesium, Phosphorus. Bromelain has proteolytic properties useful to reduce oedemas after contusions or surgery, for antithrombotic and anti-inflammatory effects, to recover burn wounds (Pavan *et Al.*, 2012) and for reduction of symptom severity in osteoarthritis (Brian *et Al.*, 2006). Bromelain is known to increase the production of the anti-inflammatory prostaglandins avoiding the negative effect that FANS have on gastro-intestinal system and the risk of cardiovascular and renal complications such as hypertension, edema, myocardial infarction. Bromelain is commonly extracted from the stem of the pineapple plant that is a waste of canned foods industry, the substance is unstable to high temperatures (Poh and Majid, 2011) such as those used by industry to increase the preservation of drink or foods, thus positive effects can be got only from fresh fruits or in food integrators.

Beta vulgaris* = *Beetroot

Domesticated in Middle East and already grown by the Ancient Egyptians, Greeks and Romans. It is a herb of the temperate areas, with a long edible taproot. Can be cropped home for fun into deep pots.

Although not yet much known among sport people, beetroot is recently getting some relevance. It is a low calory food that can also improve a variety of symptoms related to digestion and blood circulation, that is now acquiring interest also for sportsman diet. Beetroot contains over 250 mg (>4 mmol) nitrate per 100 g fresh weight (Bryan, 2006; Lundberg *et Al.*, 2009; Hord *et Al.*, 2009) and contributes to the release of nitrogen oxide that in turn contributes to blood pression reduction. In addition to nitrate, Moreover, beetroot contains other

bioactive compounds that are synergistic with nitrate, including antioxidants (betaine and vitamins) and the polyphenols resveratrol and quercetin (Wootton-Beard and Ryan, 2012). A research has tested a nitrate-depleted beetroot juice placebo (Lansley *et Al.*, 2011) and compared nine healthy subjects drinking 0.5 litres of beetroot juice/day (6.2 mmol of nitrate) or the same volume of placebo (<0.005 mmol of nitrate) for 6 days and completed treadmill and knee-extension exercise tests on days 4–6. The oxygen cost of walking and moderate-intensity running on treadmill were significantly reduced. During fast running, beetroot juice supplementation resulted in increased exercise tolerance of 15%.

Two studies have reported positive effects of nitrate supplementation on exercise performance: Murphy *et Al.*, (2012) reported that 'recreationally fit' adults completed a 5-km treadmill time trial faster (p= 0.06) following the consumption of 200 g baked beetroot 75 minutes before training (≥500 mg or ≥8 mmol nitrate) compared with consumption of a placebo. Bond *et Al.*, (2012) found that at 1.8 km into the 5-km run, the rating of perceived exertion was significantly lower and running speed over the last 1.8 km of the 5-km distance was 5% faster consuming beetroot; they also tested the effect of 6 days of 0.5 litres of beetroot juice or placebo on six 50 m rowing ergometer performances in 14 well trained rowers. The authors concluded that beetroot juice supplementation improved the average repetition time compared with placebo (0.4%, 95% confidence limits ±1.0%) and probably improved repetitions 4–6 (1.7%, 95% confidence limits ±1.0%).

Coffea arabica (= Arabica coffee, mountain coffee) and Coffea canephora (= Robusta coffee)

Coffea arabica is believed to be the first species of coffee to be cultivated, and is the dominant type, representing some 60% of global production. The Robusta coffee (*C. canephora*) makes up most of the remaining coffee production. Both are shadow tolerant species, that can be grown as ornamental also in houses with scattered light. The stimulant drink is got from the seed after fruit and peel removal and after toasting. The two species and their provenience are mixed to get different flavours in the drink.

Coffees effects are due to the caffeine content. Caffeine is actually found also in tea, cocoa and guarana, and its content in *Coffea* species is variable, being *C. arabica* more acidic, less bitter and less highly caffeinated than *C. canephora*. Coffee is widely used in sport as a performance enhancer or ergogenic aid.

Numerous studies have investigated the effect of supplemental caffeine on exercise performance, but there is considerable inter-individual variability of effects probably due to variation in genes such as *CYP1A2* and possibly *ADORA2*, which are associated with caffeine metabolism.

One study found that the consumption of at least three cups of coffee per day stimulated CYP1A2 activity (Djordjevic *et Al.*, 2008).

Some interactions have been found on caffeine consumption with other foods: grapefruit juice decreased caffeine clearance by 23% and prolonged caffeine half-life by 31% (Fuhr *et Al.*, 1993, 1995). Broccoli and brassica vegetables (Lampe *et Al.*, 2000), and high quantities of vitamin C increased caffeine clearance (Blanchard and Hochman, 1984). Caffeine is primarily metabolized in liver where it undergoes successive demethylations and a C8 oxidation. CYP1A2 is found only in liver and represents 15% of all cytochrome P450 in human liver and accounts for more than 90% of caffeine metabolism (Arnaud, 2011). Caffeine biotransformation by CYP1A2 accounts for an average value of 84% for paraxanthine, 12% for theophylline, and 4% for theobromine. (Gu *et Al.*, 1992). Caffeine metabolism is affected by many exogenous and endogenous factors such as genetic, age, sex, pregnancy, diet, lifestyle, smoking, environmental factors, medications, and diseases. (Nehlig, 2018).

N-Acetyltransferase-2 (NAT2) is also involved in caffeine metabolism and catalyses the conversion of paraxanthine to 5-acetylamino-6-formylamino-3-methyluracil. Once the genotype has been taken into account, acetylation activity is not influenced by sex, race, age, education, physical activity, weight, and consumption of coffee, alcohol, red and processed meat, cruciferous vegetables, smoking, use of oestrogens (Le Marchand *et Al.*, 1996).

The primary metabolites of caffeine, paraxanthine, theobromine, and theophylline are biologically active. Theophylline is considered a bronchodilator in asthma, it influences inflammatory pathways (production of interleukin-6, tumour necrosis factor-α) and antagonizes A1, A2A, and A2B adenosine receptors (Haskó and Cronstein, 2011). In addition, theophylline influences histone acetylation pathways favouring deacetylation, and hence reducing the expression of inflammatory genes and proteins (Ito *et Al.*, 2002). Paraxanthine has proved to be as effective as caffeine to inhibit adenosine receptors (Fredholm *et Al.*, 1999). Instead, theobromine bioeffects are rather minor. Most of the research available is concentrated on caffeine and no paper has considered the potential role of caffeine metabolites together with caffeine in the biologic effects of the trimethylxanthine (Nehlig, 2018).

Eleutherococcus senticosus* = *Siberian Ginseng

A deciduous shrub native of Siberia, Mongolia, Northern China, where lives in the underlayer of forests. It is broadly tolerant of soils, sandy to clayey and slightly acidic to alkaline. Can be grown as ornamental in large pots or soil. The herbal tea is done from the roots and has tonic and adaptogen properties and hormone stimulating effects that help the body to recover from overwork, it is also studied for its ability to increase immunological defences increasing the T lymphocytes number and stimulating white cells activity. It is studied as antimicrobial and anti-stress agent (Zhai *et Al.*, 2017). It is considered useful to increase mental attention thus used also by students. In sport it is used to enhance endurance and strength. High doses and long time use may cause irritability, confusion, insomnia and anxiety.
The major constituents of root extract include lignans, sesamine (Eleutheroside B4), Syringaresinol, phenylpropanes, coumarines, beta-sitosterol, daucosterol. The berries contain polyphenols, including caffeic acid, vanillic acid, ferulic acid, p-coumaric acid, benzoic acid. The leaves contain essential oils including α-bisabolol, β-caryphyllene, germacrene D, β-bisabolene, and α-humulene. The whole plant has also significant content of calcium, magnesium, potassium.

Lepidium meyenii* = *Maca, Peruvian ginseng

Is a little biannual plant native to the Peruvian Andes. It can be grown in mountain climates of temperate Countries although at the moment is not. Although it can be eaten as a green vegetable, the common product is got from the taproot which is typically dried and processed to a baking flour or sold as a functional food.
Maca is considered to promote libido and fertility, and it is a recognized energetic and adaptogen food, supporting physical and mental performance.
A randomized, double-blind, placebo-controlled study (Jiannine and Antonio, 2019) has examined the effects of maca on body grip strength, mood, and sexual functioning: 47 subjects consumed 2.1 g of maca for 28 days, examining also the differences between the groups of men and women separately. The females group had not significant differences when compared to the placebo group, instead males showed significant improvements over the placebo group in fatigue (mean±SD: -3.3 ± 3.9 vs. 1.3 ± 6.2), handgrip (4.6 ± 7.5 vs. -0.4 ± 5.4), and sexual behaviour (3.83 ± 4.3 vs. 0.7 ± 2.1). The authors concluded that Maca supplementation may lessen fatigue, improve strength, and enhance sexual functioning in otherwise healthy men.
Among the active components of Maca roots, the phytosterole β-ecdysone has anabolizing properties. Recent studies suggest that the anabolizing effect is mediated by binding with estrogens receptor ER, in fact a study was conducted on 46 young sportive males that ate various doses of ecdysterone integrators for ten weeks, the results showed a significative rise of muscular mass and the same ipertrophic effects emerged from the in vitro analisys of C_2C_{12} miotubes. No increase in biomarkers for liver or kidney toxicity was detected. The research therefore suggests to include the ecdysterone in the list of substances and methods forbitten in sport in class S1.2 "other anabolysing agents" (Isenmann et Al, 2019).

Panax ginseng* – *Chinese Ginseng, Korean Ginseng

An herbaceous plant native of China, mentioned in the *Shen-Nung Pharmacopoeia*, written in China in 196 a.D. and traditionally known as a tonic herb. The wild Ginsengs grow naturally on mountains, it is traditionally hand picked and now almost extinct in China and endangered globally. All the Ginseng commonly availabe for trade is cultivated. The plant takes some years to reach maturity with roots large enough to be harvested, as the useful product is the root, once harvested the plant dies, however recently has been found that the leaves and stems contain larger quantities of the phytochemicals than the roots, and their use instead of the root allows the plant to persist after harvesting (Wang *et Al.*, 2009).
Ginseng gives energy drinks and herbal teas, or it is sold as a dietary supplement. It is being studied for the useful effects of Ginsenosides (steroid saponins) on memory, fatigue, and cure of mild diabetes symptoms (Kim *et Al.*, 2015). A persistent use in large quantities is thought to give side effects like insomnia, excitability, irritability (Shergis *et Al.*, 2013).
A double blind, randomized, crossover study has been conducted at the Institute of Medical Pathophysiology of the University of Chieti (Italy) on 50 healthy male sport teachers aged 21 to 47 years. The research considered the effects of a standardized ginseng extract combined with dimethylaminoethanol bitartrate, vitamins, minerals, and trace elements on physical performance during exercise. Every day for six weeks each subject received two capsules containing ginseng extract, dimethylaminoethanol bitartrate, vitamins, minerals, and trace elements, or two capsules of placebo. The subjects then performed an exercise test on a running machine at increasing work loads. The effects of ginseng were more pronounced in the subjects with maximal oxygen consumption below 60 ml/kg/min during exercise than in the subjects with levels of 60 ml/kg/min or above. The results indicate that the gin-

seng increased the work capacity by improving muscular oxygen utilization (Pieralisi *et Al.*, 1991).
In a randomized placebo-controlled clinical trial study lasted 12 weeks, Lee *et Al.* (2018), evaluated the effect of high-dose ginsenoside complex (UG0712) supplementation, that is a standardized ginsenoside complex with 10% protopanaxadiol ginsenosides Rg3, Rg5, and Rk1, which is higher than the content in Korean white ginseng root (0.35%). Due to the high concentration of ginsenosides, UG0712 is thought to have a better ergogenic effect than common ginseng products. This trial evaluated the efficacy and safety of daily UG0712 intake (100 mg or 500 mg), as an integrator for aerobic and muscular exercise training of healthy but sedentary adults; the results showed that high doses of ginseng supplementation could improve aerobic capacity during training.

Zingiber officinalis* = *Ginger

Ginger is native of Southern Asia where is an herb of the forest underlayer. Ginger has thick and branchy rhizomes from which depart stems and leaves. The useful part is the rhizome used as a spice on foods and a warming and disinfectant herbal tea. It is a short herb that can be grown home in pots but needs repair in cold season. It has been used in medicine for decades and has anti-inflammatory effects due to Gingerols, Paradols, Shogaols and related compounds (Senchina *et Al.*, 2014). Apart of the uses done by common people, studies on athletes have proved analgesic effects and increase in fatigue resistance, whilst other effects were not demonstrated (Wilson, 2015). It has anti-nausea, anti-emetic, anti-inflammatory properties and it is useful to reduce fever (Vohora and Dandiya, 1992).
The anti-inflammatory properties of ginger root are due to the presence of cyclooxygenase-2 inhibitors (COX2): there are two types of COX involved in the regulation of the inflammatory process, (COX)-1 and COX-2 which are the targets of widely used non-steroidal anti-inflammatory drugs (NSAIDs). COX-1 is expressed constitutively in all tissues and stimulates the production of prostaglandins involved in physiological processes; COX-2 is induced specifically during inflammatory, degenerative, and neoplastic processes (Yokoyama *et Al.*, 1989).
COX-1 and COX-2 catalyse the conversion of arachidonic acid to the endoperoxide prostaglandin H2 (PGH2) which can form a va-

riety of prostaglandins, thromboxanes and prostacyclin through catalysis by non-rate limiting enzymes (Chandrasekharan *et Al.*, 2004) or by non-enzymatic rearrangement. By inhibiting COX-1 and/or COX-2, NSAIDs prevent the enzymatic conversion of arachidonic acid to pro-inflammatory cyclic endoperoxides. Based on the assumption that inhibition of COX-2 but not COX-1 might reduce the side effects observed in older NSAIDs, the discovery of COX-2 selective inhibitors has become an important area of pharmaceutical research.

In vitro trials on ginger preparations have shown anti-inflammatory effects including inhibition of COX (Tjendraputra *et Al.*, 2001), inhibition of nuclear factor κB (Grzanna R *et Al.*, 2005) and inhibition of 5-lipoxygenase (Kiuchi et al, 1992). Other *in vivo* and clinical trials have confirmed the anti-inflammatory activities of ginger preparations, for example, ginger extracts have been shown to reduce knee pain in human subjects suffering from osteoarthritis (Altman and Marcussen, 2001).

Van Breemen *et Al.* (2010), used ultrafiltration liquid chromatography mass spectrometry to screen a chloroform partition of a methanol extract of ginger roots for COX-2 ligands, and 10-gingerol, 12-gingerol, 8-shogaol, 10-shogaol, 6-gingerdione, 8-gingerdione, 10-gingerdione, 6-dehydro-10-gingerol, 6-paradol, and 8-paradol bound to the enzyme active site. Purified 10-gingerol, 8-shogaol and 10-shogaol inhibited COX-2 with IC50 values of 32μM, 17.5μM and 7.5μM, respectively. No inhibition of COX-1 was detected. Therefore, 10-gingerol, 8-shogaol and 10-shogaol inhibit COX-2 but not COX-1, this can explain, at least in part, the anti-inflammatory properties of ginger.

Conclusions

Some of the food components described in this article should be studied further because of differing views with regard to their efficacy in different reports. In fact each plant contains many components whose effects on the body can be synergic but also antagonistic according to the case.

Furthermore, the efficacy of the components may differ according to gender, age, individual, lifestyle. Also the modality of ingestion can influence the results, so that the optimum method of intake the quantity and quality to be ingested, and the timing of their intake has still to be established.

In the next years, guidelines for the use and evaluation system of sports functional foods should be established with backing by clear scientific evidence related to the individual foods.

At the moment the use of functional foods by common athletes is based on a mixture of scientific and traditional knowledge that not always corresponds to the best use possible.

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