Sports Food - Targets

Introduction

Active sports people need to have a carefully planned and balanced life. Physical and mental health and condition go hand in hand together with a balanced diet.

The role of diet in exercise and physical performance is essential: **Carbohydrates** are important for optimizing carbohydrate (glycogen) stores in muscles and as major energy source during prolonged exercise while **Proteins** are important nutrients for muscle protein synthesis, especially for atletes involved in strength and power events.

In development of sport foods an important question is which type of nutrients are most suited to support energy metabolism, fluid balance and muscle function.

The specific role of Protein, Dietary fibre and Fructose will be commented in this document.

Targets of sport foods[1] and suitable Cosucra ingredients

- Increased muscle / decreased fat mass (especially for strength and power exercise)
  Pisane® - pea protein isolate
- Hydration and rehydration - compensation for fluid losses by sweating
  Fructuline® - fructose
- Formation of muscle and liver glycogen stores - especially for endurance exercise
  Fructuline® - fructose
- Increased hormone release - thought to stimulate muscle growth and enhance recovery from exercise
  Pisane® - pea protein isolate: branched chain amino acids, arginine
- Bone health
  Pisane® - pea protein isolate: lysine
  Fibruline® / Fibrulose® - chicory inulin/oligofructose
- Enhanced performance - endurance / high intensity exercise
- Gastrointestinal tolerance - avoid disturbances during exercise
- Carbohydrate (or fat) oxidation - sparing of endogenous carbohydrate stores
- Nutritional status - avoid vitamins and minerals deficiencies
- Restoration of total adenine nucleotides - recovery after intensive exercise
- Restore muscle / tissue damage - caused by exercise-induced free radicals
- Prevent muscle cramps - especially for regular endurance exercise

Sports Food - The role of pea protein

1. Pisane, pea protein isolate

Vegetable protein has the advantage not being accompanied by fat or cholesterol compared to several animal proteins. In most cases a compromise will be found between vegetable and animal-based proteins based on protein quality, cost, flavour and texture profile.

Extracted from the yellow pea (*Pisum sativum*) by a physical process, the pea protein isolate Pisane® is a natural ingredient. Pisane® is well suited for protein enriched foods.

Pea protein isolate, containing 90% protein, is one of the few "clean label" vegetable proteins: Pisane® is GMO - free and gluten free and free from common allergies and intolerances concerning cereals, eggs, peanuts, soybeans and milk products.

On top of this, pea protein has a very high nutritional quality, which will be demonstrated below.

2. Well balanced amino acid profile of Pisane

Overall protein needs, as well as needs for specific amino acids, are increased for people who exercise regularly. Due to its excellent digestibility (98%) and well-balanced amino-acid profile, Pisane® is a very good protein source for foods or supplements adapted to these particular needs of intense endurance or strength exercise.

Proteins cannot be stored by the body like fat, thus regular intake is necessary. Of the 20 existing amino acids, 9 can not be produced in the body and must be supplied by the diet. These are essential amino acids. A good source of nutritional protein must contain a balanced quantity of these essential amino acids.

Some definitions[2]:

Reference amino acid pattern
essential amino acid requirements proposed in 1985 by FAO/WHO/UNU for children of 2-5 yrs old, to be used to evaluate dietary protein quality for all age groups, except infants (<12 months)

Amino acid score (AAS)
percentage of most limiting essential amino acid concentration in the food protein in comparison with the same amino acid concentration in the reference pattern

True digestibility
The proportion of food nitrogen that is absorbed, as determined by the rat balance method

Protein-digestibility corrected amino acid score (PDCAAS or DI-SCO)
amino acid score (children 2-5 yrs) x true digestibility / 100

The amino acid composition of Pisane is presented in Table 1. When compared to the FAO reference standard pattern of amino acids for a pre-school child[2], pea protein is a good source of essential amino acids.

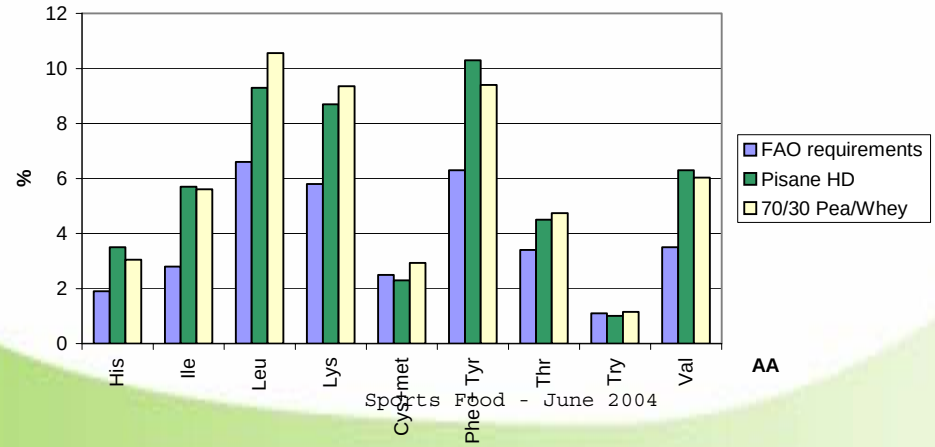
Pisane satisfies nearly all the needs of essential amino acids with a particularlly high content in lysine and arginine and a small deficiency in the sulphur-containing amino acids (cysteine, methionine) and tryptophane like in other leguminous plants.

Table 1 : Amino acid content of Pisane (g/100g protein) versus FAO requirement (Children 2-5 years). e=essential amino acid; AAS = amino acid score; True Digestibility measured by rat N balance method (Tomé et al, 2002, confidential report); PDCAAS = Protein digestibility corrected AA score (=AAS x Digestibility).

			Mean figures for PISANE	*Mean figures for PISANE*
		FAO Requirement	AA Score	g/100g protein
Aspartic acid				12,50
Arginine				9,50
Serine				5,90
Glutamic acid				20,60
Proline				5,20
Glycine				4,70
Alanine				5,60
Histidine	e	1,90	1,84	3,50
Lysine	e	5,80	1,50	8,70
Valine	e	3,50	1,80	6,30
Isoleucine	e	2,80	2.04	5,70
Threonine	e	3,40	1,32	4,50
Leucine	e	6,60	1,41	9,30
Phenylalanine	e			5,90
Tyrosine				4,40
phenylalanine+tyrosine		6,30	1,00	10,30
Methionine	e			1,20
Cysteine				1,10
methionine+cystein e		2,50	0,92	2,30
Tryptophan	e	1,10	0,91	1,00
			AAS	0,91
			Digestibility	98%
			PDCAAS	89%

The small lack in sulphur containing amino acids (methionine and cysteine) and tryptophane) can be overcome by combining Pisane® (70%) with whey proteins (30%), as shown in Figure 1.

Figure 1: Amino acid score of a pea and whey protein blend.



The obtained mix has an AAS of 1.

3. Amino acids in Pisane of particular interest in sport foods (Table2)

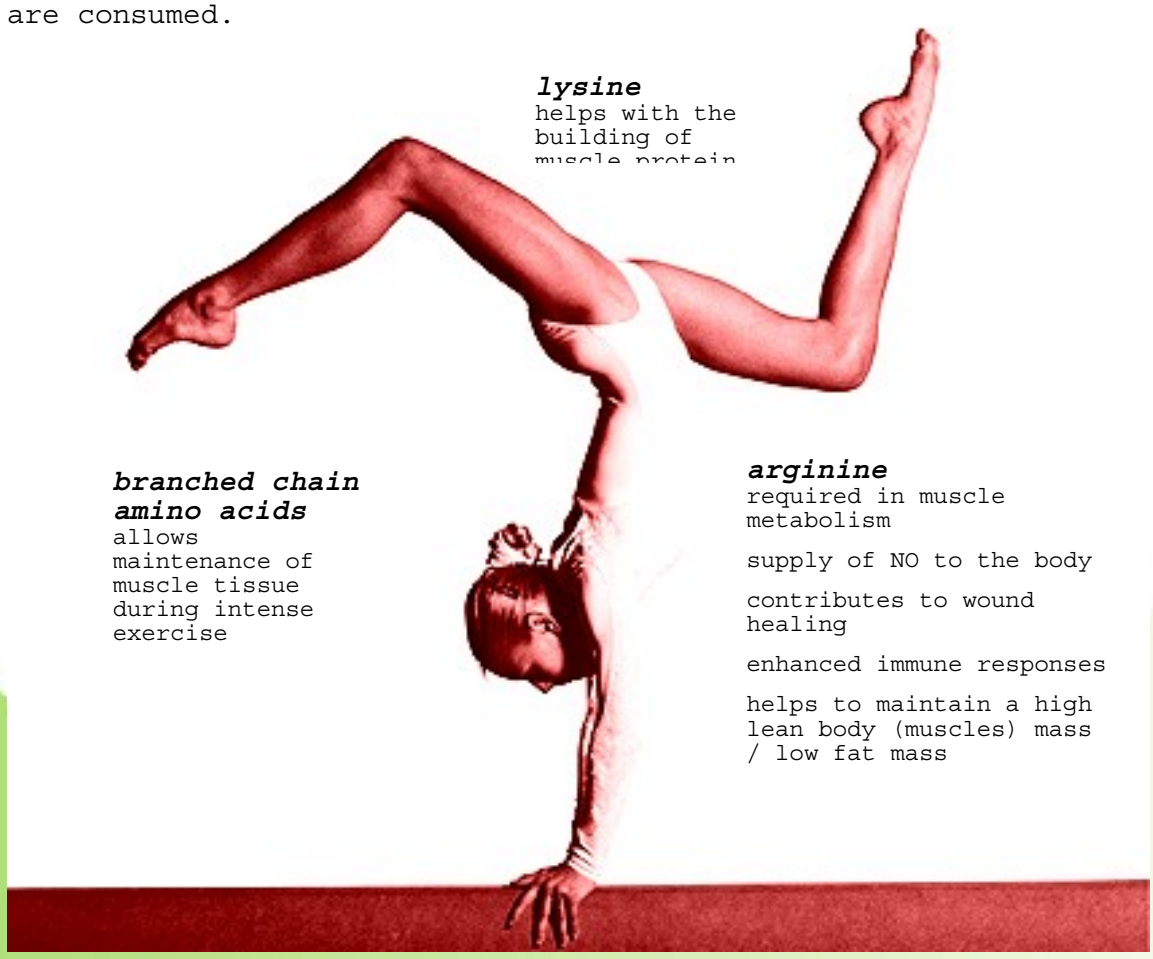
The level of branched chain amino acids (leucine, isoleucine, valine) in Pisane is higher than in other vegetable proteins and is comparable to those in milk and egg protein. These branched chain amino acids are of interest in sport foods because they allow maintenance of muscle tissue during intense exercise.

Strenuous exercise may be associated with immune suppression and thus increased risk of infections. Glutamine appears to be an important amino acid involved in the functioning of the immune system cells. Glutamine can be produced in muscles starting from glutamic acid or branched chain amino acids. Compared to other vegetable proteins and milk proteins, Pisane is a good source of glutamic acid.

The arginine content of Pisane is very high as compared to other proteins. The richness in arginine participates to the supply of NO to the body (improved vasodilatation).[3,4,5] Arginine also contributes to wound healing[6,7,8,9,10] and enhanced immune responses.[11,12] It is required in muscle metabolism - maintaining the nitrogen balance, and helping with weight control since it facilitates the increase of muscle mass, while reducing body fat. Especially strength and power athletes will benefit from having a high lean body (muscles) mass / low fat mass.

The particularly high level of lysine in Pisane is complementary to the low level of this amino acid in cereals. Lysine also helps with the building of muscle protein.

Remark that it is the combination of sufficient calories from carbohydrate, protein and fat that contribute to protein synthesis: muscle growth is limited if insufficient calories are consumed.



4. PROTEIN "SCORE" OF PISANE

Five different composition parameters important in the choice of protein for sport foods are compared for different commercial proteins and the relative score for each parameter, as well as the mean relative score are calculated.

	BCAA(1)	*relative score*	**Glutamic acid**	*relative score*	**Arginine**	*relative score*	**Lysine**	*relative score*	**AAS**(2)	*relative score*	**Mean relative score**(3)
Pisane®	**21.3**	***88***	**20.6**	***57***	**9.5**	***93***	**8.7**	*80*	**0.91**	***81***	**80**
Rice protein	19.9	*82*	20.9	*58*	9.1	*89*	3.4	*31*	0.79	*71*	**66**
Soy protein isolate	18.1	*74*	19.1	*53*	7.6	*75*	6.3	*58*	1.04	*93*	**71**
Egg white	23.2	*95*	14.5	*40*	6.06	*59*	6.5	*60*	1.06	*95*	**70**
Caseinate	19.4	*80*	20.9	*58*	3.7	*36*	8.1	*74*	1.09	*97*	**69**
Lupin flour	14.9	*61*	19.3	*53*	10.2	***100***	4.4	*40*	0.64	*57*	**62**
Whey protein isolate	24.3	***100***	17.7	*49*	3	*29*	10.9	***100***	1.05	*94*	**74**
Egg	20.5	*84*	13.3	*37*	5.4	*53*	7	*64*	1.12	***100***	**68**
Wheat gluten	13.8	*57*	36.1	***100***	3.3	*32*	2	*18*	0.28	*25*	**46**

Table 2
(1) Branched chain amino acids (valine + leucine + isoleucine)
(2) Amino acid score, as compared to the FAO/WHO reference protein (amino acid needs for children of 2-5 years)[2]
(3) Based on relative scores for BCAA, Glutamic acid, Arginine,Lysine, and AAS (with same weight for each parameter)

From this comparison we can conclude that, for each parameter separately, Pisane® scores very well, without being the top choice. Moreover, it appears that overall, taking into account all 5 parameters, Pisane is a very good choice (highest mean relative score!) for sports food within the given range of milk, egg and vegetable proteins.

5. BIOLOGICAL VALUE OF PISANE

As explained above, the amino acid composition and the digestibility are important parameters for determining the nutritional quality of a protein source. Another important characterisic, especially in sports foods, is the percentage of the protein that can actually be utilized by the body for maintenance, growth and muscle building purposes. This is reflected in the biological value (BV: the proportion of absorbed nitrogen that is retained in the body) or the net protein utilization (NPU: the nitrogen retention or the proportion of nitrogen intake that is retained in the body).

Gausserès et al (1997)[13] found a biological value of 78% for pea proteins in healthy humans. This high biological value was confirmed by Mariotti et al (2001)[14] who reported a BV of 78.7% and a NPU of 70.9% for a pea protein isolate. This means that the nutritional quality of pea protein isolate is very similar to that of soy protein isolate, for which a BV of 80.1% and a NPU of 73.3% were reported[14]. For comparison, the BV of casein is 80% and that of whey protein is 100%.

6. PISANE, AN EASILY ACCEPTED PROTEIN SOURCE

Peas have low content in antinutritional factors compared to other legumes. The remaining antinutritional factors are inactivated by light heat treatment and water solubilisation.

The low level of flatulent sugars allows high incorporation levels, as is often the case in sports foods. As vegetable protein, Pisane® is lactose-free, which is of importance since a number of sportspeople are lactose intolerant.

Food allergy is due to a reaction antibody/antigen after a protein ingestion. Even very small amounts of allergen can cause allergic reaction. The problem is of particular importance for neonatal humans. It declines with age.

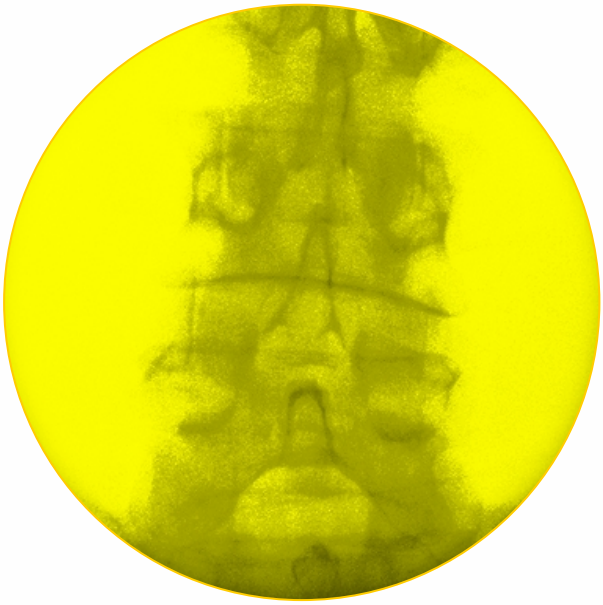
A recent study in the UK demonstrated that in a representative group of the adult population true incidence of food allergy was less than 2%. About 5% of infants and young children suffer from some form of food allergy in the first 2 years of life. More than 90% of food allergy reactions can be attributed to hypersensitivity to egg, milk, peanut, other nuts, wheat and soy proteins[15].
In a review on legume allergens[16] peanuts and soybeans were identified as the major legumes involved in human food allergy, although some data exist on adverse reactions to other legumes like pea, green bean, sweet lupin and lentil. The leguminosae in general, peanut excluded, account for < 3% of all food allergies, both for children and adults[17].

Based on the reviewed literature, we can conclude that allergy to pea proteins must be regarded as a less significant allergy problem, belonging to the range of other known food allergens, such as egg, milk and wheat.
In general, within the leguminosae family, pea allergy is less frequent than allergy to soy and peanut.
Declaration of pea protein (or pea starch / pea fibre) ought to constitute sufficient protection for pea allergics.

Since Pisane contains no gluten, it is suitable for coeliac patients. Pisane® is suitable for vegetarians, vegans and diabetics. It is Kosher and Halal approved.

7. Relevance of Pisane for bone health in endurance athletes

High consumption of proteins, especially animal proteins is known to increase urinary calcium excretion, and as a result increase the risk of bone loss and osteoporosis. However, the amounts of calcium excreted in urine for subjects on a vegetable protein diet were found to be lower than for subjects on an animal protein diet.[18] Within a group of 742 postmenopausal women it was shown that women with a high ratio of vegetable to animal protein intake had a significantly lower rate of bone loss than did women with a low ratio.[19] This protective effect towards bone health observed with vegetable proteins might be linked to lower amounts of sulphur-containing amino acids or lower acid loads in vegetable proteins.[20]



Female athletes are often confronted with bone health problems. Therefore vegetable proteins, like Pisane®, may be a better choice than animal proteins for this specific population. Moreover, Pisane® is particularly rich in lysine, an essential amino acid that is required for growth and bone development, especially in children, and that assists in calcium absorption[21].

Sports Food - The role of inulin & oligofructose

1. Fibruline / Fibrulose and Energy

Fibruline and Fibrulose, chicory inulin and oligofructose are low calorie bulking agents. Energy from inulin and oligofructose (1 kcal/g) is only provided through fermentation in the large intestine. Therefore inulin and oligofructose could serve as long term energy source and a combination of sugar, maltodextrins and inulin could be used in beverages for endurance sports in order to provide energy for the short, medium and long term.

What is the Glycemic Index of a food?
The **Glycemic Index** (GI) provides a measure, on a scale from 0 to 100, of how quickly a carbohydrate containing food is digested and absorbed, as compared to a standard food. The standard food is glucose or white bread (GI=100). It thus gives an indication of the rate at which the food affects blood glucose levels after ingestion of the carbohydrate containing food.
Individual foods with a *high* glycemic index release glucose into the bloodstream quickly. This causes blood sugar levels to rise rapidly. Individual foods with a low glycemic index release glucose more steadily over several hours. This helps to keep blood sugar levels relatively stable.

How a foodstuff affects the blood sugar level is very important for sports people, especcially for endurance athletes. Just before, during and right after the performance the food needs to quickly supply glucose to the body (= "high GI food"). The period before and the period after the intense exercise the body needs to "recuperate" by means of food which releases glucose into the bloodstream more slowly (= "low GI food").

high GI food	v	v	v	v	v	
low GI food						v
time (min)	-120 BEFORE	-30 BEFORE	0 (start) DURING	60-180 DURING	end + 240 AFTER	RECUPERATION PERIOD
function	maximise glycogen stores delay time to exhaustion	maximise glycogen stores	extend the time to exhaustion	extend the time to exhaustion	reload the glycogen stores	low GI food to restore the body

Fibruline and Fibrulose, low glycemic ingredients, can easily be incorporated in sports food to help to design "low GI sports food for recuperation".

2. Fibruline / Fibrulose and bone health in Female athletes

Fibruline and Fibrulose may be of interest for female athletes, due to the improved calcium absorption as a result of ingestion of inulin or oligofructose.

Female athletes like long-distance runners, gymnasts, body-builders, cyclists have a very low oestrogen content (comparable to that of postmenopausal women) and a lot of female athletes of 30 years old have bone skeletons resembling those of 60 year old women. Their calcium need is therefore much higher than other women of their age and is close to 1500 mg/day. Improving calcium absorption by inulin intake by these women can therefore be very beneficial to them. It is recommended for athletes to consume inulin in the evening, not just before or during exercise, in order to avoid all possible side effects like flatulence.

Of course there are a large number of other dietary factors that will influence bone health, like dietary content of calcium, phosporus, fibres, vitamin D, …

3. Fibruline / Fibrulose and Fibre benefits

Inulin and oligofructose, being soluble fibres from chicory, have other interesting health benefits, like an improved intestinal transit. This results in a relief of constipation, a problem sports people often experience.

4. Fibruline / Fibrulose and Prebiotic - Bifidogenic benefits

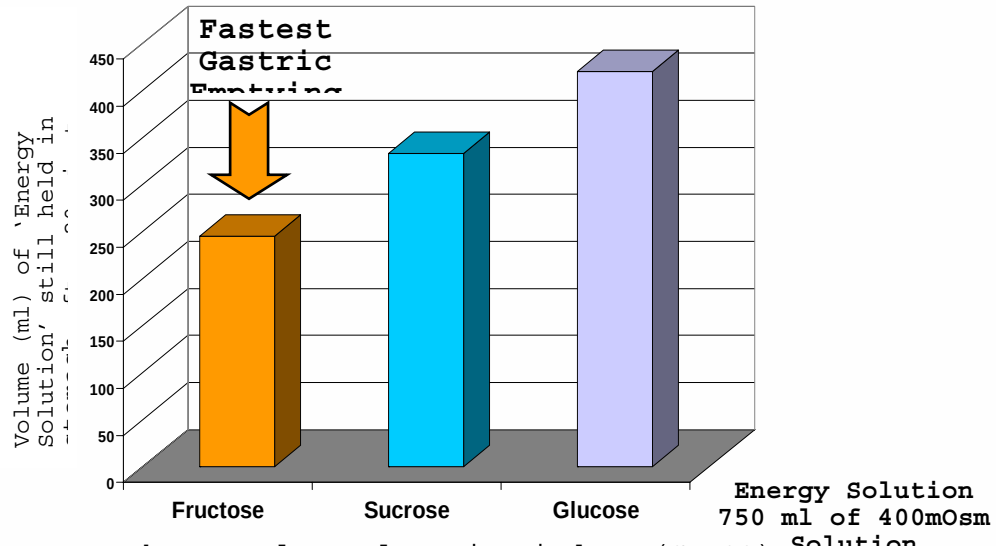
Another health benefit is the stimulation of bifidobacteria in the large intestine (bifidogenic or prebiotic effect). A lot of female athletes like runners and gymnasts follow a very strict low calorie and thus also low fibre diet. The incorporation of inulin or oligofructose in their diet would provide them a high quality fermentable source of dietary fibre beneficially affects the gut microflora.

Sports Food - The role of fructose

Fructuline®, fructose from chicory, is a natural sugar with a high sweetening power (up to 60-80% more sweet than sucrose).

Sports people have to replace lost fluids and to re-energize. Fructose is the carbohydrate with the fastest gastric emptying[22], so that water, salts and energy reach the tissues quickly allowing rapid rehydration.

Following rehydration, fructose provides a sustained energy source, particularly suitable for endurance sports.



Fructose has a low glycemic index (GI=23) as compared to glucose (GI=100) and sucrose (GI=65). Fructose provides thus a sustained energy source, particularly suitable for endurance sports. Fructose also restores hepatic glycogen stores more readily than glucose[23].

Fructuline® is available in liquid form, but also in crystalline form:

Fructuline® L95
fructose syrup (70% dry matter)
Fructuline®CR
crystalline fructose

Sports Food - Applications

Pea protein isolate - Pisane® and Chicory fibre - Fibruline® & Fibrulose® are very easy to incorporate:

Pisane® is neutral in taste and colour compared to other vegetable protein, which make it suitable for several foodstuffs, including sports food.

Fibruline® & Fibrulose® are neutral in taste and colour and are soluble, which make them suitable for a variety of foodstuffs, including sports food.

Sport foods Applications and relevance

- Energy and performance drinks (845 refs):
  boost during exercise and replenish lost fluids (rehydration)

  Sports & Energy drinks are the most active & innovative segment within beverages. Competition from the bottled water segment leads the sport drinks segment to increase product launch activity (GNPD 2004)
  The Sports Drinks category can be segmented into isotonic drinks which have the same osmolality as occurs naturally in the body, and are designed to aid rehydration as they are readily absorbed; and hypotonic drinks, with a lower osmolality than body fluid, designed to be taken after exercise to replace electrolytes, aid recovery and provide an energy boost.

- Energy bars (67 refs):
  healthy alternative to chocolate bars and provide good quality source of protein

  Sports & Energy bars are either positioned as sports products (pre or post-exercise or as body-building aid) or as mainstream "energy-giving" (quick "on the go" energy boost) Protein content varies between a few% up to 35%
  Energy and sports bars promote recovery by replenishing lost vitamins, and also claim to provide an extra boost of energy during strenuous activity by including ingredients such as guarana and taurine.
  There are limited functional health claims within the snack bars segment, leaving room for expansion and continued development. Many functional claims focus on aiding digestion (prebiotics), lowering and improving heart health. In addition, a few varieties offer unique benefits such as memory enhancement or immune system support.

Other Applications

- Sports waters (161 refs) and juices (80)
  waters and juices remain a favorite food for sports people, being essential to restore the body's fluids (often presented with the typical "sports cap")
- Meal replacement (26 refs) (shake, powder or bar):
  for fitness, performance and weight management
- Supplements (93 refs)
  (tablets, capsules to supplement vitamins / minerals)
- Protein powders: specific weight gain by bodybuilders and hardcore athletes
- High protein products: bars, shakes, soup, pasta

In most applications Pisane® - Fibruline® & Fibrulose® - Fructuline® or a combination of these ingredients can be used:

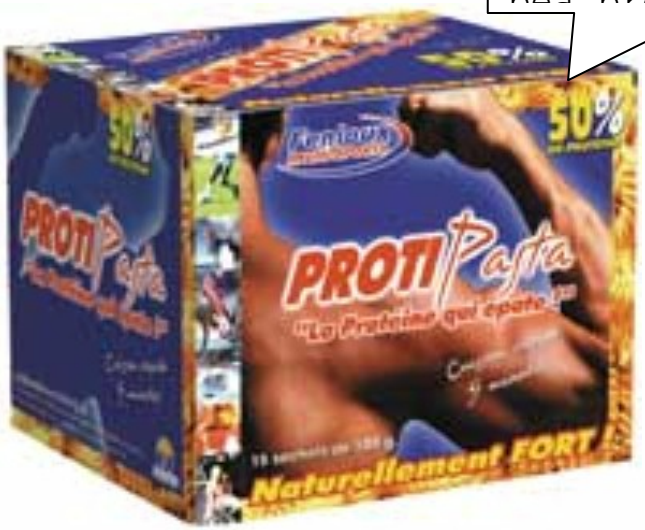
- For most sport foods pea protein isolate, Pisane®, can be used due to its unique nutritional & health benefits.
- For fast energy intake fructose, Fructuline®, can be incorporated.
- For recovery (low glycemic products during recuperation period) inulin or oligofructose, Fibruline® & Fibrulose®, can be incorporated and their low calorie, low GI and dietary fibre benefits as well as their health benefits can be communicated to sports people and active consumers.

Sport foods References with Pea Protein Isolate

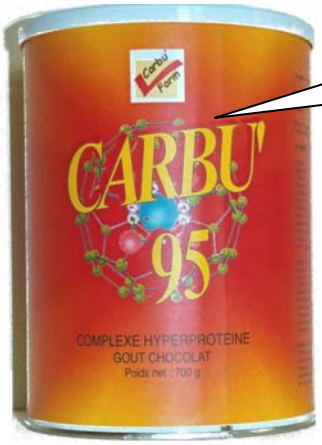
Energy bar for active people

Supplement For the Active indivual
and Athlete who is interested
in boosting their protein intake
while avoiding dairy and

Pasta for sports people with more than 50% protein (mainly pea protein isolate)



Supplement for sports people
Hyperprotein,
Maintenance of muscle tissue



Energy Bar,
supplies instant energy

Protein Shake

ideal for athletes who want to increase strength / muscle definition, with out putting on fat.

NUTRISPORT 90+ combines whey with pea protein peptides to give the best of both worlds

- Higher in protein than whey protein concentrate alone.
- Low glycaemic index ideal for pre-contest preparation
- Excellent flavourings without spoiling nutritional properties.
- 98% FAT and SUGAR/LACTOSE free lower in calories than pure whey
- Higher protein than pure whey, higher biological values than milk, Soya or caseinate.

Easily absorbed and high in essential amino acids and branched chain amino acids for rapid conversion into muscle tissue.

Free from Genetically Modified Materials.

Protein Mix Formula

a mix of 5 high quality protein sources, developed by a team of nutrition specialists in cooperation with high level sports people.

whey protein, egg white protein, calcium caseinate,
pea protein, wheat protein

pea protein: an amino acid profile which perfectly balances the profile of animal proteins and which increases the total

Sports Food - Regulatory Aspects

On European level sports foods are considered as Foods for Particular Nutritional Use but there is not (yet) a specific legislation with regard to the composition of these sports foods. Also no Codex Alimentarius guidelines exist on this subject, the Codex Committee even concluded that no further consideration was required in this area.

Specific legislation on the composition of sports foods exist in Belgium, France, and Italy.

Sports Food - Notes

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