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REVIEW / REVISIÓN

NUTRITIONAL ERGOGENICS ASPECTS AND DRUG-FOOD INTERACTIONS IN ALPINISM

ASPECTOS ERGONUTRICIONALES E INTERACCIONES FÁRMACO-ALIMENTARIAS EN EL ALPINISMO

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ABSTRACT

The main factors limiting climbing performance are as follows: muscle glycogen depletion, increased protein catabolism, fluid and electrolyte imbalance and acute mountain sickness (AMS). In this situation of high stress at high altitudes and with stays longer than 3 weeks, the diet is essential. In the case of AMS, the use of drugs is also essential, if it is not used in proper conditions, such supplementation could endanger the health of the mountaineer because of the possible interactions with the food and the nutritional ergogenic aids.

KEY WORDS: alpinism, nutrition, nutritional ergogenics sports, drugs, interactions.

RESUMEN

Entre los principales factores limitantes del rendimiento en el alpinismo destacan el agotamiento de los depósitos de glucógeno muscular y catabolismo proteico elevado, desequilibrio hidroelectrolítico y Mal Agudo de Montaña (MAM). Ante esta situación de gran estrés que se vive en las altitudes elevadas y en estancias superiores a las 3 semanas, se hace imprescindible una óptima alimentación. Aún así, en ocasiones el MAM en los alpinistas es inevitable y en estos casos se hace uso de fármacos para afrontar dicha situación, que si no se realiza bajo un control riguroso, la suplementación puede poner en peligro la salud del alpinista por las posibles interacciones que se dan con los alimentos o ayudas ergonutricionales ingeridas.

PALABRAS CLAVE: alpinismo, nutrición, ayudas ergonutricionales, fármacos, interacciones.

INTRODUCTION

More and more tourists are visiting high mountains like the Aconcagua (highest mountain in South America, Argentina) or make crossings at high altitudes. Many of them, without having previous experience in high mountains before going to high altitude (51% of the tourists who are visiting high altitudes, have not done trekking above 3000m) (Borm et al, 2011). These stays induce large physiological changes, such as increased heart rate, increased systemic and pulmonary blood pressure, hyperventilation, retention, and decreased haemoglobin saturation (SaO₂), among others (Napoli et al, 2009). Due to the difficulties of the situation of hypoxia, intense cold and exercise in low feeding situations in high altitudes usually leads to the use of ergo nutritional aid or drugs. Therefore, the updated information on the scientific evidence in reference to the ergo nutritional and pharmacological aids and the possible interactions between them is vital.

At high altitudes, especially above 4000m, and according to individual susceptibility to hypoxia, it is common for appetite to decrease and there is considerable weight loss (Shukla et al, 2005; Urdampilleta and Martinez-Sanz, 2012). It is common to suffer AMS (Acute Mountain Sickness) especially when you sleep over 4000m, which is characterized by symptoms such as headache, dizziness, nausea, insomnia, general fatigue and lack of appetite among others (Dumont et al, 2000). It appears in healthy mountain climbers who ascend high mountains. Typically these symptoms develop within the first 6-10 hours of ascension (Hackett and Roach, 2001), and showed a peak in the second or third day of stay. AMS incidence is variable but relatively high. At altitudes between 4000-5800m it affects 67% of subjects, with a range between 25 and 100% (Dumont et al, 2000, Pesce et al, 2001; Wagner et al, 2006). AMS, if not properly controlled, can lead to cerebral oedema and risk of death. In this situation, the climber is not aware and he is disoriented and is not properly coordinated, leading to failures that can cause a serious accident (Schommer et al, 2011).

The latest research suggests that preconditioning before ascension in intermittent hypoxia, with a minimum of 12 sessions (2-4 sessions / week) doing physical activity of an aerobic-anaerobic nature, above 4000m altitude, helps to prevent AMS (Hetzler et al, 2009; Urdampilleta et al, 2012). Likewise, it has proved to be effective as training in different sports in order to improve resilience (Millet et al, 2010; Urdampilleta et al, 2012).

A situation of intense cold, hypoxia and aerobic-anaerobic physical activity (climbing), makes nutritional needs of 4500-6000 kcal / day necessary in ascents (Koehler et al, 2011; Westerterp et al, 1994). Studies that claim an expenditure of 3000 kcal / day (Mariscal-Arcas et al, 2010) have also been found, but these have been made in base camp (4000-4500m above sea level), where climbers usually are resting most of the time, with the intention to acclimate to the altitude. Recent research estimated an expenditure of 4944 kcal / day, with the disadvantage that losses of approximately 10kg occur during a 3 week expedition because mountain climbers don't have energy intakes

greater than 2250 kcal / day (Koehle et al, 2011), which can lead to some degree of malnutrition (Urdampilleta and Martinez-Sanz, 2012).

The main performance limiting factors in alpinism are the depletion of muscle glycogen stores and increased protein catabolism, electrolyte imbalance (Westerterp et al, 1994) and AMS.

The objectives of this review are: 1) to analyse the nutritional and health situations that occur at altitude, 2) seek ergo nutritional and pharmacological aids commonly used, 3) to evaluate drug-nutrient interactions that may occur, and 4) assess the risks of these interactions on the health of the climbers.

METHODOLOGY

Design: Cross-sectional study of retrieved works from biomedical literature reviews regarding the scientific basis of nutritional needs, ergo nutritional assistance and drugs used in alpinism.

Source of data collection: The databases used were Medlars Online International Literature (MEDLINE) via PubMed, EMBASE, Web of Knowledge, Institute for Scientific Information (ISI), The Cochrane Library, International Pharmaceutical Abstracts (IPA) and SportDiscus.

Information processing: We studied the articles published in English and Spanish. We selected and reviewed articles published from January 2002 to February 2013 (time of last update). We used the following key words in Spanish and English according to the study's Thesaurus, Medical Subject Headings (MeSH) developed by the U.S. National Library of Medicine: "alpinism", "alpinism AND nutrition", "nutritional ergogenics AND sports" "drug" "interactions". Unable to find many articles about drug-food interactions with the keywords used, we used the snowball strategy to increase the amount of information.

Selection of items: In total 305 articles were found by in the end analysing investigations performed on humans (101).

BODY WEIGHT LOSS AND BODY COMPOSITION CHANGES IN HIGH MOUNTAIN CLIMBING

At high altitudes, there is loss of appetite, and the perception of flavours is partly suppressed. The effect of this anorexia is loss of body weight from 4000 meters above sea level, although there is variability in this respect (Westerterp et al, 2001). Anorexia is believed to be induced by changes in hormone levels that are experienced at altitude, particularly decrease in plasma leptin levels (Zaccaria et al, 2004), and increased plasma cholecystokinin (Bailey et al, 2000).

Another fact that seems to be involved is an increase of insulin during the first week, returning to normal levels after 15 days of stay. Likewise these subjects develop hyperglycemia (Shavney et al, 1991), thus demonstrating a degree of transient insulin resistance which may be due to increased catecholamine and cortisol (Larsen et al, 1997). This may decrease the utilization of glucose and lipids as an energy source, resulting in a large protein catabolism (Urdampilleta and Martinez-Sanz, 2012). But Larsen and colleagues (2004) found that two days at high altitude were sufficient for the body to reverse the initial hyperinsulinemia.

Moreover, along with loss of appetite, low energy intake in relation to the high energetic cost appears to be another key point in weight loss (Koehler et al, 2011) as well as with other conditions such as extreme cold, intense physical activity and hypoxia, they increase caloric expenditure at rest and during the physical activity (Kechijan, 2011).

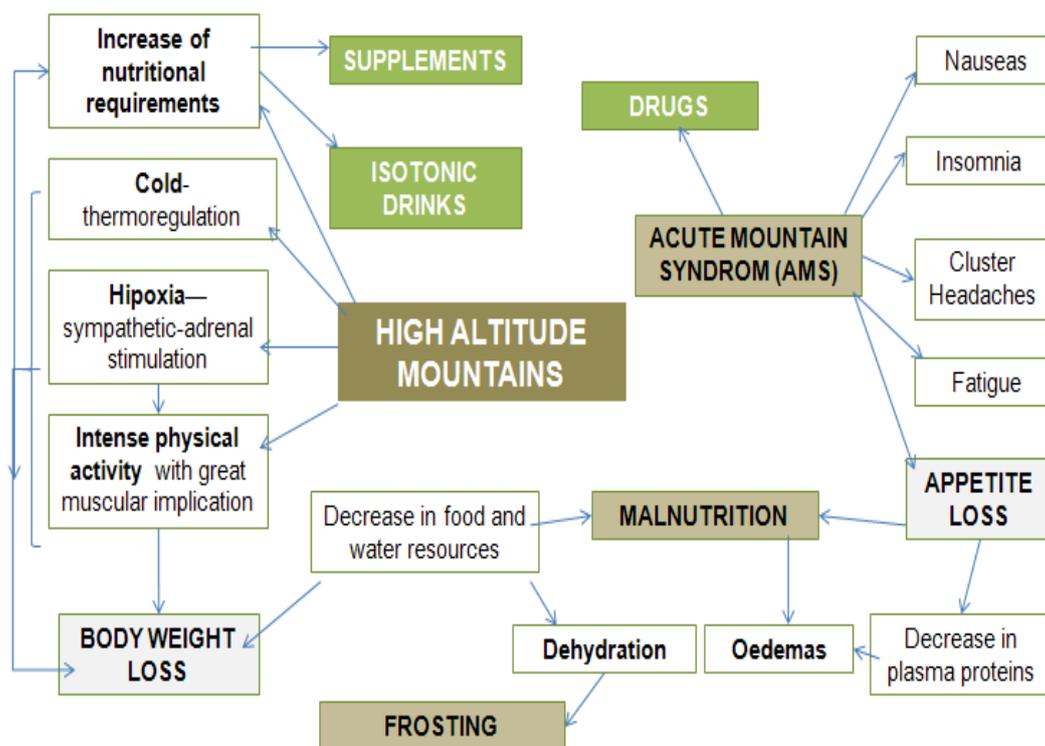


Figure 2: Causes justifying medical-nutritional risks on high mountains ascents in alpinism (own calculations)

FEEDING IN GREAT MOUNTAIN CLIMBS

In hard climbs, like an 8000m, and an average stay of four weeks, an energy deficit takes place which leads to protein malnutrition and decreased plasma protein in the mountain climber. This makes the climbers more susceptible to oedema, decreasing oncotic pressure, maintained by plasma proteins (Bourrilhon et al, 2010). It is for this reason that during this type of stays, there

are cases of oedema of the face, hands or worse, cerebral or pulmonary oedema (Bourrilhon et al, 2010).

This is the reason for the importance of protein intake, an intake of 1.2-1.4 g of protein per kg of body weight is recommended for endurance athletes and 1.7 g in strength sports (Urdampilleta et al, 2012). However, in these situations, it may be more interesting to take more carbohydrates (CH), so as to not activate the glucose-alanine cycle and bring the body to protein catabolism, a situation that usually occurs at high altitudes. In this sense, whey protein may be ideal for the absorption to be as quick as possible and to stop the large protein catabolism that occurs during the activity at high altitudes as soon as possible. Regarding the form of ingestion, protein hydrolysates are best suited to be even better than the amino acids themselves on an individual basis (Urdampilleta et al, 2012).

We must take into account the quality of fatty acids which are ingested in the diet, because they have great importance in the health and nutritional status. Taking saturated fatty acids (SFA) and polyunsaturated (PFA) can be harmful, if they exceed 20% of the total caloric intake in the diet. SFA causes increased levels of total cholesterol and PFA (except omega-3), and are more susceptible to suffer lipid peroxidation which can lead to increased oxidative stress in the body, and in the case of alpinism, they increase these processes (Fisher-Wellman et al, 2009). Thus, monounsaturated fatty acids (MFA) are the most recommended both for collective sports as for mountain climbing, not to mention omega-3 as will be discussed later (De Rosa and Luluaga, 2011). That is why it could be recommended as a staple to carry mountain olive oil or other nuts like almonds, rich in MFA.

The **deficit of sodium** in the body can trigger hyponatremia. The high water intakes required in this activity means that if enough salts are drunk along with drink (recommended taking isotonic drink with proper proportions of salts and CH) (Palacios et al, 2008), they can trigger hyponatremia .

In hypoxic conditions, erythropoietin (EPO) increases, especially in the first 3-7 days of acclimatization. If it provides enough dietary iron, this may intervene directly in the synthesis of new red blood cells (Smith et al, 2011). An increase of iron in the diet (or drug in case it is required) does not improve athletic performance of athletes without iron deficiency. However climbers on expeditions over the three weeks are a collective shortfall risk (Beard and Tobin, 2000). In addition, a study showed that its supplementation in non-deficitary athletes was not associated with improved muscle fatigue (Brutsaert et al, 2003). It is important to go to the expeditions with high iron reserves as well as for stays longer than 2 weeks to follow dietary and nutritional strategies and / or an Iron supplements therapy. This is due to the higher needs that the body has when exposed to high altitude (hypoxia) and to have higher energy and nutrient needs for the physiological effort involved an expedition.

Fat-soluble vitamins are another problem for the mountain climber, especially vitamin E, due again to the energy deficit and few fatty foods. To solve this

problem, it is recommended to load up with fat soluble vitamins before going to the mountain. Being fat soluble, they can be stored in fatty tissue, unlike the water soluble that should be taken daily (Kechijan, 2011). Recent studies suggest that height may cause a deficiency in the antioxidant adaptive response (Mariggio et al, 2010), advising taking vitamin E for 3-4 weeks (200-400 IU / day). The water-soluble vitamin C should be taken daily at the mountain itself, and is useful to help the absorption of non heme iron (Urdampilleta et al, 2010).

ERGO NUTRITIONAL AIDS SCIENTIFICALLY JUSTIFIED FOR ENDURANCE SPORTS

Among the objectives of ergo nutritional mountain climbing aids, some physically quality enhancing ones stand out, especially aerobic endurance, decreased fatigue, weight control, acceleration of the recovery of the body and enhanced athletic performance in short (Garnes and Mas, 2005).

The only thing that is clearly evident is that adequate hydration with **isotonic drinks** at endurance sports is the best aid ergo nutritional (Clarke et al, 2011, Kreider et al, 2010), it is therefore a crucial aspect for the increase performance in alpinism, and not only this, but a key to maintaining health. Sports drinks, according to several research, should follow a number of features which are agreed upon (Palacios et al, 2008):

Table 1. Characteristics of isotonic drinks on long endurance sports (own calculations).

	Minimum quantity	Maximum quantity
Volume (ml)	500	1000
Sugars (%)	4	8
Type of sugars	The best is the mixture of sugars: glucose, fructose and maltodextrin	Fructose should not exceed 40% of total sugars
Salts	Na ⁺ (0,5g/l)	Na ⁺ (1g/l)
Temperature(°C)	15	20
Intake frequency (minutes)	15	30
Observations	- When you work out at temperatures above 30 ° C, it is recommended to add ice cubes to keep the drink fresh and more appealing for their intake. -That the drink is palatable is crucial so that the mountain climber can continue drinking enough. -The higher the need to rehydrate, the more it is advisable to lower the concentration of sugar to 4%, and increase salts (0.7-1 g / l) to avoid hyponatremia.	

The glycerol-induced hyperhydration has been shown to increase endurance performance on extreme conditions (altitude, heat and high humidity) as it can maintain a weight loss of less than 2% (Goulet, 2010). This is due to the induction of renal water reabsorption, which is interesting especially in long endurance sports. Moreover, in alpinism water availability is limited and the requirements are higher due to hypoxia. However, there is no evidence that it

increases performance in endurance sports, although it helps to lengthen the possible processes of dehydration and increased body temperature, which is why it could be taken as an ergo nutritional help in alpinism.

Of all the supplements found in the scientific literature, these have supported the ergo nutritional effectiveness of: **caffeine** (aerobic and anaerobic sports), **sodium bicarbonate** (anaerobic sports competing one-8'de duration to VO₂max), **creatine** (explosive sports and intermittent as equipment), and without a doubt, the most effective as previously mentioned, in endurance sports, are sports drinks (Bishop, 2010; Kreider et al, 2010; Ranchordas et al, 2012) . In alpinism, sports drinks have the highest efficiency.

The evidence is still not so clear on the intake of L-alanine and colostrum. Nor is the intake of ribose, β -hydroxy- β -methylbutyrate or **branched chain amino acids (Baa)**, but regarding Baa, we should mention its efficacy in muscle recovery is being tested (Urdampilleta et al, 2012). These last three ergo nutritional aids have only been tested in well-trained athletes (Ranchordas et al, 2012; Rodriguez et al, 2009), so we should be cautious about untrained subjects.

Supplementation with L-arginine is being thoroughly investigated (Alvares et al, 2011; Kern and Robinson, 2011) and **omega-3** (Filaire et al, 2011) for its immunomodulatory and vasodilator effects, which may be of interest to the performance and health of the mountain climber. The vasodilatory effects and possible performance improvements are also investigated with the precursors of **nitric oxide (NO)** (L-alanine and nitrate) (Bescos et al, 2011). Systemic vasodilation, increases tissue oxygenation and carries to them more nutrients. However it is noteworthy that hypoxia itself stimulates the synthesis of nitric oxide.

Supplements of **omega-3** fatty acids are increasingly popular in sports, they reduce swelling (Machado and Tavares, 2004), cause vasodilation (Simopoulos, 2007) and reduce competitive anxiety (Ferraz et al, 2011), among other effects. This supplement could be an ergo nutritional aid in alpinism, to cover the minimum nutritional needs as well as for their vasodilatory effects.

Some authors recommend ergo nutritional supplements to tackle AMS, like **ginkgo biloba** (ginkgo). A clinical trial on 26 individuals found that use of ginkgo starting the day before rapid ascent significantly reduced the symptoms of AMS (Gertsch et al, 2002). However, its use is not internationally agreed upon.

Glutamine has been widely studied in the field of sports as the levels decrease in states of overtraining, which is associated with a rise in cortisol levels and reduced defences. However, it has not been demonstrated well enough whether the increase in this amino acid can enhance the immune system (Phillips, 2007). For prevention issues, their supplementation in stays longer than three weeks could be justified, since a decrease will make performance drop.

A double-blind trial with 18 mountain climbers who climbed the Mount Everest base camp, it was observed that the use of an antioxidant supplement (providing **1000 mg of vitamin C, 400 IU of vitamin E and lipoic acid 600 mg** daily) improved AMS (Bailey and Davies, 2001). Treatment started three weeks before ascent and continued for 10 days of climbing. However, recent investigations have not agreed that antioxidants improve AMS (Bailie et al, 2009).

Regarding ergo nutritional aids, a meta-analysis on the placebo effect of these aids in sport, argues that the placebo effect may be responsible for the improved performance in most cases and that ergo nutritional studies should be double-blind tests based on real competitive situations in which psychobiological factors that influence final performance are mixed (Beedie and Foad, 2009).

DRUGS FOR ALPINISM

To cope with AMS many climbers use drugs (**acetazolamide**, and especially acetylsalicylic acid ibuprofen to avoid the headache induced by AMS) with the intention of avoiding or masking the body's natural response and thus to continue the ascent. This is the risk with the use of drugs. We must understand that in alpinism, both by altitude, malnutrition, or situation of extreme cold the effectiveness of nutritional ergo aid or drugs may vary considerably, it should not be used if such aid is not scientifically proven to be effective and still they must be used cautiously, because the environment on high altitude mountains changes considerably.

Ephedrine stimulates the sympathetic nervous system causing vasoconstriction in the nasal mucosa. Ephedrine and pseudoephedrine have the ability to dilate the bronchial tubes and are therefore used when there are problems on the upper respiratory track. In turn they can stimulate the heart, improve muscle development in athletes, promoting the disappearance of fat. Ephedra adrenergic receptors increase the metabolic rate and increase caloric intake. The net result is the release of fatty acids from adipocytes and faster consumption of triglycerides for energy. It has been banned for its effects in improving sports performance, although studies on its efficacy are contradictory (Chu et al, 2002; Gillies et al, 1996). The minimal effect ephedrine can offer could be provided by caffeine (Hodges et al, 2006) and with fewer side effects, so its use is not to be justified in alpinism.

The **glycophosphopeptical or AM3** (Immunoferon®) is an immunomodulatory polysaccharide nature, with a significant impact on the immunoinflammatory response. It is capable of increasing the response of effector cells involved in the anti-infectious response (source Pradas, 2009). This immunomodulation is interesting for long endurance sports and mountain climbing as hypoxia, negative energy balance, cold and intense physical activity increase cortisol levels worsening the immune system (Cordova, 2010).

Administering **glucocorticoids** (for its anti-inflammatory and increased lipolytic) is prohibited by WADA in competition. Growing evidence has shown that there is short-term athletic performance improvement. However it is associated with numerous health risks (Duclos, 2010), preferentially has a suppressant effect on the immune system (source Pradas, 2009). Within the corticoids, **dexamethasone** is the most widely used for the treatment of AMS.

It appears that the most effective drug to deal with AMS is acetazolamide (Edemox) (Luks et al, 2010). Ibuprofen and acetylsalicylic acid, are used for headache generated by AMS. The acetazolamide can improve cerebral oxygenation at high altitude stays and consequently improve psychomotor skills and decision making moments (Vuyk et al, 2006). However, its use is limited to pre-acclimatization (especially in fast ascents such as the Andes Mountains, not the 8000m), since once acclimated to the altitude it is not effective.

The **nipedefine** or **sildenafil** (viagra), **salmeterol**, or **phosphodiesterase** inhibitors (Luks et al, 2010) have been effective in the treatment of pulmonary oedema and inhaled nitric oxide (Bailey et al, 2010; Duplain et al, 2000). Moreover, recent research has also shown that ibuprofen can be very effective for cluster headaches (Gertsch et al, 2010).

Table 2. Nutrients, ergo nutritional aids and drugs used in alpinism (own calculations).

Basic nutrients	Ergo nutritional aids	Drugs
Carbohydrates	Isotonic drink	Acetazolamide
Proteins: -Serum	Caffeine	Acetylsalicylic acid
Lipids -AGM	Glicerol	Paracetamol
Iron hemo/ non hemos	aaR	Ibuprofen
Vitamin C	NO precursors	Iron
Vitamin E	<i>Ginkgo Biloba</i>	Vitamins C and E
Omega 3	<i>Guaraná</i>	Dexametasone
Lipic acid	<i>Panax Ginseng</i>	Sildenafil
Magnesium	<i>Ephedra</i>	Salmeterol
References		
Beard et al, 2000; Bourrilhon et al, 2010; De Rosa, 2011; Fisher-Wellman et al, 2009; Kechijan, 2011; Mariggio et al, 2010; Smith et al, 2011	Baillie, 2009; Bescós, 2011; Birshop et al, 2010; Clarke et al, 2011; Garnés et al, 2005; Getsh et al, 2002; Goulet et al, 2010; Kreider et al, 2010; Palacios et al, 2008; Ranchordas et al, 2012; Rodriguez et al, 2009.	Bailei et al, 2010; Chu et al, 2002; Cordova et al, 2010; Diclos, 2010; Getsch et al, 2010; Hodger et al, 2006; Luks et al, 2010; Vuyk et al, 2006

INTERACTIONS OF ERGO NUTRITIONAL AIDS AND NUTRIENTS WITH DRUGS USED IN ALPINISM

It is interesting to investigate the interactions of different nutritional ergo aids or drugs in this area (Kreider et al, 2010). Nonetheless, there are few interaction studies in sport despite the numerous ergo nutritional aids that are being used. Anecdotal reports suggest that in different sports, athletes often take more than one dietary supplement and very little is known about the potential adverse effects of the concomitant intake of multiple supplements (Bishop, 2010).

Some effective ergo nutritional supports such as caffeine, due to its diuretic effect and its effect on the central nervous system, may be detrimental in high doses (above 500 mg), as in hot or high relative humidity (Roelands et al, 2011). Thus we should know that the use of caffeine along with other diuretics (e.g. typically taken acetazolamide high altitude) can be detrimental to athletic performance, dehydration being a limiting factor for the increase in body temperature and the increased cardiovascular level work involved.

Regarding caffeine, its taking with grapefruit juice or alcohol increases its bioavailability (Pardo et al, 2007). So caffeine can also interact with eleutherococcus, giving an additive effect, and ephedra (Bulletin amarilladle card pharmacies). On the other hand, carbonized meat and some cruciferous, decrease plasma concentrations. In turn, they increase the absorption and bioavailability of drugs such as paracetamol, aspirin and ergotamine and thus its analgesic effect (Pardo et al, 2007). Additionally, guarana-caffeine interferes with 30-50% renal clearance decrease (Brinker, 2001).

Of all these substances that can interact with caffeine, the most widely used drug in the mountain is acetylsalicylic acid (interestingly this is also sold with moderate doses of caffeine, 50mg). While acetaminophen is also used for headaches caused by AMS, which is why when you eat at the same time, it should take less amount of caffeine because they increase their bioavailability.

Regarding pharmacological iron supplementation (non-heme iron), we should say that it interacts negatively with calcium, zinc, insoluble fiber (bran cereals), phytate (whole grains, nuts and legumes), thanatos (coffee or tea) polyphenols (vegetables, legumes, fruits, nuts and beverages such as tea, red wine, plum, beer, cocoa, coffee) and certain milk proteins such as casein. In the same way absorption promoters is vitamin C, vitamin A, fructooligosaccharides (FOS) or certain amino acids of meat origin (Urdampilleta et al, 2010).

Ginkgo Biloba can interact with garlic (widely used in expeditions) and vitamin E (sunflower oil) in the same sense. However, no scientific evidence has been found that garlic interacts with nonsteroidal antiinflammatory drugs (NSAIDs). The chronic taking of acetylsalicylic acid at high doses, should bring an increased intake of vitamin C and folic acid (vegetables, legumes) and limit, just in case, consumption of garlic, ginger, ginkgo biloba, chestnuts and foods high in caffeine and to avoid alcohol intake (MIMS).

Pearls of **omega 3** can lead to such negative interactions with anticoagulants and antiplatelet agents such as aspirin, garlic, ginger, *ginkgo biloba* and ginseng among others, so care must be taken. They may also reduce the levels of vitamin E, although the cause is unknown. However we have not found any other interaction with food (Medlineplus). In alpinism it is customary the taking of vasodilators such as pearls of garlic, omega 3 and other antiplatelet drugs such as aspirin, and this could lead to problems in cases of injury or cause internal bleeding.

Ibuprofen as **acetylsalicylic** acid should be taken with food as they decrease gastric irritation and as food limiting recommendations that are similar to aspirin (Anderson et al, 2008). Likewise, it has been shown that vitamin E, can increase the antiplatelet effect of aspirin.

Corticosteroids induce liver enzymes and therefore when taken with acetaminophen (paracetamol increases hepatotoxic metabolite formation. Concomitant use with NSAIDs increases the risk of ulcers and bleeding. Furthermore steroid use or sodium-rich foods increases the risk of hypertension and oedemas. Also antacids decrease the absorption of prednisone and dexamethasone, two glucocorticoid widely used in alpinism which therefore should not be mixed with antacids (USPDI, 2003). The use of diuretics decreases the effect of both drugs, which are not recommended to mix on the mountain are dexamethasone and acetazolamide. Finally, say that their use increases folate requirements (USPDI, 2003).

Table 3. Some interactions between nutrients, ergo nutritional aids, and drugs used in alpinism (own calculations)

Basic nutrients	Ergo nutritional aids	Drugs	References*
AG Omega-3	Ginkgo Biloba	Acetylsalicylic acid (-)	Bisshop, 2010; Kreider et al, 2010; vademecum
Grapefruit juice	Caffeine	Acetylsalicylic acid (-) Paracetamol (-) Ibuprofene	Anderson, 2008; Brinker, 2001; Pardo, 2007; Roelands et al, 2011
Iron		Vitamin C (+)	Urdampilleta et al, 2010
	Efedra	Acetozalamide (-)	
Fruit salts	Sodium bicarbonates	Antacids-corticoids (-) Diuretics-corticoids	USPDI, 2003

CONCLUSIONS

- At high altitudes the severity of AMS affects appetite and food intake in mountain climbers.
- We should pay special attention to using drugs for AMS because they can hide the usual symptoms of AMS and therefore can continue present up to the time when the body cannot adjust to the altitude.
- Nutritional supplementation with vitamin E prior to the stay and taking iron and vitamin C for alpinism activity is crucial.
- Ergo nutritional supplements, isotonic drinks, glycerol, caffeine, Baa, the AG Omega 3 and *Ginkgo Biloba* can be effective.
- They use supplements (*Ginkgo Biloba*), diuretics, analgesics and corticoids ultimately to address AMS and immunomodulators. The acetozalamide has proven to be the most effective drug to prevent AMS.
- In states of malnutrition, nutrient interactions of ergo nutritional aids and drugs may be higher, the most dangerous of those between supplements are vasodilators (omega3, ginkgo biloba, garlic pearls, NO precursors and aspirin).
- It is recommended to mix diuretics (acetozalamide) and corticosteroids (prednisone or dexamethasone).

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