

Nutritional Supplements in Brazil: Use, Regulation and Health Risks

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Abstract

The use of nutritional supplements (NS) in Brazil has become fashionable in recent years, gaining considerable "momentum" in the fitness market. However, the possible complications arising from their use are not entirely clear and the information available for consumers to decide is contradictory and insufficient, jeopardizing health, since there are cases of death associated with the use of NS. Thus, the regulation SN has become a matter of public health. The purpose of this article is to discuss the widespread use of SN, the scientific arguments supporting or condemning its use, the existing regulation and the possible health risks. The method consisted in reviewing the existent scientific output in Brazil. It concludes for the need for adequate mapping of SN users in Brazil, an extensive and rigorous scientific literature on the effects and risks of SN and effective regulation. The article points out ways to rethink the use of SN and contribute to conscious decisions by the consumer.

Keywords: Food supplements; Dietary supplements; Substances to improve performance; Fitness

Introduction

In search of improved physical conditioning many people resort to different forms of physical exercise in gyms and quicker means to achieve their goals. One of them is through the use of ergogenic^a resources, defined as "treatments or substances formulated to enhance athletic performance or the ability to perform physical activity" [1], whose nature could be nutritional, physical, mechanical, psychological or pharmacological [1].

Ergogenic nutritional resources [2], in the forms of nutritional supplements^b (NS) are the most widely used by gym-goers and are often administered without proper guidance [3]. This usage is rooted in ritualistic behaviors that hark back to Antiquity, when athletes and soldiers

associated performance to certain specific food components- in preparation for competition and battles it was common to consume specific parts of animal flesh in order to acquire agility, speed and strength associated to the animal [4]. Thus the popularity and usage of NS precede and overlap its scientific foundation. In addition to this historical factor, it is likely that the increasing media exposition, although contradictory, of different supplements and their effects [5,6], has influenced the demand of these products, specially because it is prescribed by doctors and nutritionists (Revista Suplementação n.d.), and also encouraged by gyms [7] and physical educations professionals [8-12].

Based on the scientific comprehension of chemical and physiological nature of muscular activity in the beginning

of the twentieth century, the administration of ergogenic resources was rationalized by the argument that some NS can minimize the wear caused by intense exercise and improves performance [13]. Although these studies are not conclusive and beyond doubt, ergogenic substances such as caffeine, carbohydrates and proteins, have been used by athletes with varied degrees of success. However, there have been few studies on the use and effect of NS on individuals that are physically active or even sedentary, and there are cases of death linked to athletes [14] and physically active people that ingested NS [15].

The use of NS is being diffused indiscriminately and trivialized [16]. In 2012, in Brazil, the commercialization of NS amounted to 450 million Brazilian Reais according to the Association of Nutritional Products Companies (ABENUTRI), a figure that is still below the size of the US market, Worth 32 billion USD [17]. The commercial level of this product allows us to classify this technology in the momentum stage, as put by Hughes [18]. Momentum is a concept established by Hughes (2016) and refers to the stage in which a technology emerges before becoming acknowledged and established, no longer being questioned. This stage is achieved with the assistance of stakeholders (investors, makers, research agencies, consumers, among others), although its durability is uncertain. In other words, supplements today in vogue, can disappear as new research arises either corroborating or condoning usage.

The regulation of NS in Brazil – an aspect that takes into account the oversight and labeling of these items – relies on a fragmented legislation, with loose control of products that are in the market, in addition to overlapping jurisdictions that is not always coordinated between agencies such as the National Sanitary Vigilance Agency (ANVISA) and the National Institute of Metrology, Quality and Technology (INMETRO). There are repeated and, for those who look carefully, constant reports on the research and vetoes enforced by the ANVISA in relation to certain NS [19-22] and there is also an evaluation study by the INMETRO on the usage of NS, but who applies the notification is ANVISA [23].

Considering these aspects the objective of this theoretical essay is to systematize the current knowledge of NS in Brazil regarding its use, regulation, efficacy and risks to health, based on a dialogue with the Brazilian scientific literature, framing these issues through the lenses of the impact of science and technology in society [18,24-27].

In order to sustain this proposition, this essay is structured into four sections, bibliographical, theoretical and conceptual in scope. In the first section, we seek to map the use of NS in Brazil and to this end we analyzed all articles that investigated the use of supplements in different regions of the country. In the second section, we approached the findings of the literature relative to the consumer profile and their knowledge of NS, the opinion of experts and what science has to say of the effects of NS and whether athletes have been using. In the third section we discuss NS regulation. In the fourth section we expose some of the risks faced by NS consumers due to inadequate guidance, regulation, oversight and labeling. Lastly, in the conclusion, we present the relevant data in this study and our conclusions taking into consideration the dialogue with the critical theories of science [24], and also considering the social construction of science [18,27] in order to problematize the indiscriminate use of NS in Brazil.

Methods

Even though this article is based on bibliographical research, it does not intend to be exhaustive or simply a review. This article is rather defined as a theoretical essay. The theoretical essay format of this article aims to contribute towards research through innovative reflections in the field, by means of a consistent debate with the scientific community. Its traits are: being in the vanguard of the theoretical understanding of the field; provoking innovative reflection; pointing towards futures research; being inter-disciplinary [28].

In our searches of the scientific literature we inputted the terms: food supplements, diet supplements, nutritional supplements and regulation. A careful selection of the articles referring to the use of NS, its common and scientific understanding, was carried out.

The Use of Nutritional Supplements in Brazil

In general the studies on the use of NS researched gym-going samples of the population. We found 17 studies findings in 25 cities, distributed in nine states and four regions of Brazil: the Northeast (1), the Center-West (1), the Southeast (10) and the South. The findings are summarized in Table 1.

Region	State	City	Year of Publication	N	Use of NS
Northeast	PI	Teresina	2008 [29]	164	96.90%
Midwest	GO	Goiânia	2002 [8]	183	34.00%
Southeast	MG	Belo Horizonte	2007 [30]	159	81.20%
	ES	Vitória	2002 [31]	100	70.00%
	ES	Linhares	2008 [32]	158	28.00%
	SP	Ribeirão Preto	2008 [33]	102	52.00%
	SP	São Paulo	2009 [34]	126	69.00%
	SP	São Paulo e Região	2009 [10]	59	34.00%
	RJ	Rio de Janeiro	2011 [3]	30	36.70%
	RJ	Niterói e São Gonçalo	1998 [35]	160	32.00%
	RJ	Goytacazes	2006 [36]	334	35.00%
	MG e SP	Poços de Caldas/MG, Águas de Lindóia/SP, Monte Sião/MG e Espírito Santo do Pinhal/SP	2008 [37]	64	71.42%
South	SC	Balneário Camboriú	2008 [38]	200 (34% ♂ and 66% ♀)	75.7% ♂ e 24.3% ♀
	PR	Guarapuava	2010 [39]	102	40%
	RS	Porto Alegre	2013 [40]	316	28.80%
	RS	Passo Fundo	2009 [41]	61	59.00%
	RS	Arroio do Meio, Cruzeiro do Sul, Lajeado, Mato Leitão e Santa Clara do Sul	2010 [42]	61	40.98%

Table 1: Mapping of the scientific literature on the use of NS in Brazil.

No studies were found regarding the North and the majority of the studies are on the Southeast. In fact, the two studies found focusing on specific studies, as the case of physical educational teachers [11] and university students [43], also originate in the Southeast (São Paulo state). Among the 76 physical educational professionals [11] analyzed 54.4% used some kind of NS for work-related reasons, while among the 894 university students [43] researched, 30.4% had used vitamin supplements in the three months preceding the survey. Such studies are especially relevant, given that the physical education professional is held as knowledgeable of NS, and the students that use vitamins are doing so to enhance their studying performance.

Although this survey does not encompass the entirety of the Brazilian territory, of the 17 studies found, covering approximately 25 cities, more than half (9) indicate percentages of usage higher than 50% and all remaining studies report rates above 25%, evidence of the considerable use of this substance.

What Consumers Know and What Science Knows about Food Supplements

As consumption of NS is so widespread, it is fundamental to consider the current level of knowledge on the subject, both what consumers, nutritionists and other specialists know, as well as scientific understanding of the efficacy of these substances, in addition to examining whether athletes use NS. Unfortunately, studies investigating the use of NS not always investigate what consumers know.

The profile and knowledge of consumers regarding NS

Unfortunately few researches determine the profile of NS consumers, and usually simply establish the age and gender of consumers, and in cases, specify the level of schooling. In general consumers are young males with higher learning diplomas [29,31,34,40].

One research evaluated the basic understanding of the nutrition of 141 gym-goers in Recife (Pernambuco state), identifying a certain amount of knowledge concerning the food sources of macronutrients and of fasting not being the most efficient forms of reducing body weight.

However, the investigated subjects presented low knowledge in terms of the usage and types of supplements [44].

In gyms in the central of Teresina (state of Piauí) of the 164 subjects, 54 were NS consumers, all of the make gender, aged between 18 and 23, with either complete or incomplete higher education diplomas, income of 1 or 2 minimum wages and consumed chiefly proteins and amino acids. The researchers observed that there was a high level of lack of information among these consumers and the more in-depth studies should be conducted in order to assist the consumer in the proper usage of NS, avoiding future health problems [9].

In Potim/SP an exclusive research with 30 users of NS, outlined the profile of this sample as 87% male, 77% weight lifters, and whose objective in using supplements was increasing muscular mass. The “prescription” of NS in 53% of the cases was made by “physical education professionals” [45]. In Porto Alegre (state of Rio Grande do Sul) and Itapema (Santa Catarina), a research with 36 users of NS sought to evaluate the knowledge and prescription of NS. They concluded that 55.6% did not rely on adequate professional guidance and 53% had their knowledge classified as poor [46].

In Criciúma (Santa Catarina) in a sample with 39 subjects, 51% ingested proteins, 26% carbohydrates and 23% amino acids. Only 5 subjects reported sports drinks. Of those interviewed, 30.8% justified the use for aesthetic, health related reasons or the desire to achieve hypertrophy; 17.9% to gain strength or physical resistance. However, the research underlined that 51.3% of interviewees indicated antagonistic alternatives, such as strength and muscular resistance, evidence of a lack of understanding [47]. One can notice that, according to these studies, the majority of NS users are young men and higher education diplomas, but that are nonetheless not very knowledgeable of NS use, effects and risks to health, and also use without proper guidance.

Is the use of food supplements necessary? What do nutritionists and other specialists think?

In general nutritionists say that the indication of the use of NS depends on individual case evaluations. As noted by Braggion [48], there are specificities related to the eating habits of those who undertake physical activity, which requires a multiprofessional team to jointly analyze nutritional necessities:

“The nutritionist’s academic training does not satisfactorily apprehend content on the physiology of exercise and effort, principles of athletic training, rules and characteristics of different sports, despite the importance of this knowledge in order to understand the physiological and nutritional demand of practitioners of these activities, whether recreational or at the athletic competition level. Hence the importance of multiprofessional team work, in which the physical education professional and the physiologist have a fundamental role in sharing information, working plan and evaluating results” [48]. Carvalho et al. [49] reinforce this when they underline that in order to evaluate and plan diets it is necessary to have access to very accurate estimates of energy consumption. The choice of the method to estimate this depends and can be influenced by the population being examined, its goals, time available and the team of evaluators.

Johann & Berleza [42] point out that “a balanced and quality diet supplies the daily recommendations of a physical conditioning program for healthy individuals.” The authors compare the nutritional state and anthropometric profile of 61 frequent gym goers, between ages 19 and 25, supplement users and non-users; in five cities in the state of Rio Grande do Sul. They verified that 40.98% of the studied population used NS, and that both users and non-users followed a diet high in protein. This denotes that the majority follows the widespread discourse that protein is what builds muscle, ignoring the biochemical and physiological process in which the absorption of protein requires the presence of water and carbohydrates.

As for physical education professionals, the majority agrees with nutritionists. But there are some contrary opinions, such as that of Barros Neto [50], who states that using NS is the same as underestimating the effect of physical activity. Adopting the comparison to studies with Growth Hormones (GH) supplementation and physical exercise for hormonal replacement as a parameter, the author points out the importance of returning to the benefits of exercise, since they create physiological ergogenic effects that need to be valued and disseminated. Except for Barros Neto [50], the majority of specialists, whether from the field of Physical Education or Nutrition, view eating habits as a minor player in the attainment of the results aimed with athletic training [2], being that this diet may or may not include dietary supplements, something contingent on the evaluation by a multiprofessional team, including a nutritionist and physical educator. This guidance is in fact the most

appropriate because the quantity of NS to be ingested is an individual criterion that depends on the stage of the physical training program, since in initial days, when muscles are adapting to exercise, protein demand is higher [51].

Do food supplements work? What does science have to say?

Souza Júnior et al. [52] presents a contrast of the opinion of researchers with a history of relevant publications on nutritional supplementation and muscle hypertrophy in Brazil to answer questions on the issue. The questions referred to: a) the efficacy of nutritional supplements aimed at muscular growth and strength; b) future perspectives for research concerning nutritional supplementation and muscular hypertrophy; c) the limitation of said research and controversial issues in literature. After responding these questions, the researchers received the responses of other participants according to the blind system and had the chance to discuss diverging points of views. In general, despite limitations and controversial points, there was a general consensus in the responses presented by researchers.

Regarding efficiency, there was consensus among researchers in relation to the supplementation with creatine, which was pointed as one of the main strategies to gain lean muscle matter. In turn, the opinion of specialists concerning the ideal moment of ingesting protein supplements presented divergences and the question remains controversial. Regarding the possible synergy of nutritional supplements, the combination of carbohydrates and proteins was cited by four out of five invited researchers. All researchers agreed that research presented several limitations such as: little encouragement, lack of nutritional control, inadequate quality control and the possible contamination of nutritional supplements, the confusions between acute responses and chronic adaptations, different levels of training within the sample, among others. Finally, the perspective for future research, suggested by specialists, encompass the effects of nutritional supplements on the molecular mechanisms that modulate the hypertrophy and the possible clinical applications of nutritional supplements [52].

Next we will present some of the specific studies on the effects of NS most frequently used: creatine; branch chain amino acids; L-Carnitine: CLA; bicarbonate and chrome.

With respect to the consensus presented by Souza Junior [52] concerning creatine being capable of

contributing to the gain of lean muscle mass, it is important to note that this can be more aesthetic than functional. This is evident in the study performed by Fontana [53], which analyzed 32 volunteers, submitted to three different types of supplementation (placebo, creatine and glutamine) and carried out physical training during 8 weeks. Fontana's findings (2006) [53] are evidence that despite the gain of muscle mass and creatine-phosphate reserves (ATP-CP), the protein involved in the process of muscular contraction, this did not reflect in enhanced anaerobic performance.

Coelho et al. [54] evaluated supplementation of L-carnitine in the weight loss of 21 subjects (11 taking supplements and 10 not), in which there was no significant difference in food ingestion (-244.66 vs. -126.00 kcal/day), in body composition (-0.07 vs. -0.17 kg/m²), in basal metabolic rate (0,06 vs. -0,02 kcal/day), in respiratory coefficient in resting state (3.69 vs. -1.01) and in exercise (0,01 vs. -0,01), nor in the VO₂máx test (0.50 vs. 1.25 mL/kg/min) for the supplemented group in relation to the control group. In other words, the L-carnitine was not effective in terms of any of the variables analyzed in the study, all of which related to weight loss.

Costa et al. [55] carried out a review of the literature on the effects of L-Carnitine and Combined Linoleic Acid (CLA) on the reduction of body fat. Articles published between 2000 and 2010 were reviewed. As to supplementation with L-carnitine, none of the studies was able to prove the efficacy of this supplement for the reduction of body fat. The use of CLA, in turn, stands out in terms of pondered reduction with serious collateral effects, such as: increase of the reduction to insulin, the increase of glycaemia and insulinemia in fasting; the elevation of lipidic peroxidation and the reduction of HDL-cholesterol in individuals with metabolic syndrome. Gomes & Tirapegui [56] analyze five highly widespread supplements - creatine, L-carnitine, bicarbonate, chrome and branch chain amino acids (BCAA) - and alert that most of the effects caused by these supplements during physical activity have still not been totally clarified by the literature, specially considering long term effects.

We examined some specific studies on the opinion of the scientific literature concerning the most widely used NS used to gain muscle mass (creatine and chrome), to retard muscular fatigue (BCAA) and weight reduction (L-carnitine and CLA), and it is remarkable that there are still no clear-cut conclusions on the effects, benefits or dangers of food supplements.

Are food supplements used by athletes?

In the case of Brazil, the question “do athletes use supplements” certainly must take into account the most famed sport in the country, football. The study conducted by Fransolin et al. [57] assessed the use of NS by professional players – the investigation comprised 19 males athletes with careers of 10-13 and a median age of 24. The athletes trained for 5 hours daily, 5 to 7 days a week, and despite being classified as eutrophic (defined as a BMI of $23.52 \text{ Kg/m}^2 \pm 0, 78$), 89% resorted to NS. Among the most used NS were BCAAs, followed by carbohydrates and minerals. Among the goals justifying supplementation was the increase of muscle mass, the optimization of performance, faster rehydration and recovery of energy. Of the 17 athletes (89%) which used these products, 11 (64.7%) received a prescription from a physical trainer, 4 (23.52 % (by a nutritionist, 1 (5.88%) by a doctor and 1 did not mention where the suggestion came from. Of the 19 athletes analyzed, 8 (47%) followed some kind of diet; however, 50% of these individuals received diet guidance by a physical educator and 37.5% by a nutritionist.

Fransolin et al. [57] highlighted that the athletes had a very restricted knowledge of NS, underscoring that the lack of information on the products and its effects (whether positive or negative) bring attention to the need of guidance from a specialist. In the context researched, 57.89% of the athletes do not follow an adequate diet and do not receive nutritional guidance from a professional nutritionist or a doctor specialized in sports nutrition, clearly showing the improper use of these resources in achieving the ergogenic effects intended to enhance professional performance.

Cabral et al. [58] carried out a study to diagnose the nutritional state of the Permanent Weight Lifting Team of the Brazilian Olympic Committee (athletes). The authors found adequate intake of macronutrients, although the total energy consumption and the percentage of body fat were below recommended rates. And this was taking into consideration values recommended for daily intake and percentage of body for the population in general, and not values specified for athletes of this sport. And this is the problem of many of these studies, the non-consideration of the specificities alerted by Braggion [48], as the specific sport and the kind of energy demanded – a triathlete for example has different needs than a runner, a swimmer or a cyclist, for example. This specificity must also consider age, since in children and adolescents this need is different [59], and in general adolescents eat inappropriately, even those who are athletes [60]. Matos

& Liberalli [61] researched the use of NS among 56 athletes who participated in an athletic event (*Travessia Aquática da Lagoa do Peri* - 3.000m) in Santa Catarina. Among them, 26% used NS, especially Maltodextrine (42.31%), indicated by nutritionists for energy recovery.

Just for the sake of a simple parameter of comparison with a case outside Brazil, we considered Sousa's study (2008) [62] evaluated 85 triathlon athletes in Portugal and noted that despite intake above the recommended for most nutrients, 94.1% of the athletes used one or more NS and did not rely on much information. As observed, there are not many studies on the use of NS among athletes. With the exception of the study by Matos & Liberalli [61], the studies found presented widespread of NS combined with the lack of information of the product-following the same pattern among non-athletes.

Regulation of food supplements in Brazil

Borges [63] points to the deterioration of the Brazilian regulation system in the last years. Proença et al. [64] point out that despite the advances in more than ten years of regulation in Brazil, there are still challenges to be faced, such as the fragmented character of norms, the fragmented capacity of regulation institutions, as well as the deficient mechanisms of coordination [64].

There are several limitations for the regulation of NS in Brazil – one of them is the gap between the demand and the capacity of the ANVISA, as shown by Pelaez, Silva & Araújo [65] in their comparison of regulation institutions in Brazil, the United States and the European Union. Furthermore, the training of workers and the private and political interests involved in certain products, hinder the work of the ANVISA [66]. In addition, we must consider that there is informal market of supplements due to the demand caused by the advertising of the results promised by NS, the lack of information and the difference of the legislation that applies to Brazilian products and imported products.

Specifically in terms of the regulation of the NS, it is “outdated, fragmented and often contradictory” [67]. This is what Bill nº 233 of 2014 being processed in the National Congress, elaborated by the Center of Research and Studies on Sanitary Rights of the University of São Paulo, ABENUTRI and nutritional countries, which purports to harmonize the legislation that regulates NS in Brazil, and protect health, and a systemic action in the process of regulation. This defragmentation is observed by the on-and-off prohibitions of the ANVISA [21,22], and very few partnerships to deal with the issue [19].

The Brazilian legislation on the regulation of NS excludes products that contain stimulating pharmacological substances, pro-hormones (such as the testosterone precursors), hormones and other substances considered as doping by the International Olympic Committee. The regulation in other countries occurs differently, an aspect that must be considered by the Brazilian consumer. In the United States, for example, the legislation allows the presence of pro-hormones [68]. Some of the sources of safe information in this regard are the national regulation agencies, such as the ANVISA and the INMETRO, and international ones, such as the World Anti Doping Agency, as well as the guidelines of research agencies, such as the Brazilian Society of Sports Nutrition and the International Society of Sports Nutrition.

Carvalho and Araújo [69] alert that concerning products based on vitamins and minerals, increasingly more available in the Brazilian market, the differences in the dosages offered to consumers are the parameter for its classification as a NS or medication, according to the Brazilian sanitary legislation. Given that this limit is tenuous and considering the risk generated by the unaware use of these products, the authors analyze the juridical framework related to labeling. They concluded that this regulation is extensive and complex, with many norms of different hierarchies, which keeps salesmen from interpreting labels correctly, and also health professionals and consumers, and shortcomings in the application on the part of oversight agencies.

In a recent study by Silva & Ferreira [70] thought to evaluate the food security of nutritional supplements in Brazil. The authors researched the products sold through 36 websites, verifying the legal situation of the products and their makers, according to the Brazilian legislation and the Ministry of Health's database. The authors found a total of 3,526 commercialized supplements, 63% are aimed at weight loss and muscular augmentation. Amount the 3,526 products, 68.7% were subject to mandatory registration in the Ministry of Health, being the majority registered as "Food for Athletes" (49%, n=1189). It was concluded that 71% of the makers of 2,425 of the supplements (68% of the total) were either in non-compliance or commercialized products that did not comply with regulations. Among the 100 supplements with largest sales aimed at weight loss and hypertrophy, 40% were sold illegally. All the products sold legally sold for weight loss and 22% of those sold for hypertrophy were registered in categories non-compatible with commercial use. All websites offered NS as functional or phyto therapeutic and 27% sold animal based foods as

phytotherapeutics, which might cause harm to those with allergies or dietary restrictions. Among registered NS as enteral nutrition (n=91), 45% were sold for aesthetic purposes of muscular expansion. The authors concluded that (1) NS for muscular hypertrophy and weight loss constitute a market trend in Brazil; (2) the Ministry of Health's decision to exempt nutrition for athletes from registration, as well as other specific products, can be factors responsible for the inadequate registration, increasing consumer exposure to risk.

Zimberg et al. [71] evaluate the compliance of the labels on carbohydrate NS in accordance to the current legislation and nutritional recommendations. Between 34 labels analyzed, 85% indicated concentrations of carbohydrates greater than the recommended and 80% had no wording in accordance with the requirements of ANVISA, in addition to incorrect information. Lacking oversight compromises the proper labeling of products, leaving consumers at the mercy of the manufacturer.

An example of the ineffective control of Brazilian regulation of these products is the research conducted by the Department of Health of the State of São Paulo - Adolfo Lutz Institute (IAL), published in December 2008 [72]. During the year 2007 this study analyzed 111 samples of nutritional supplements [68]. The outcome of the survey showed that one in four nutritional supplements sold contained in its formula anabolic steroids not declared on the label [72]. Related to the origin of products, 85.6% of the nutritional supplements exhibit any information, 9% were imported and 5.4% were produced domestically. Another example is the research conducted by INMETRO [23] in 2014 with 15 brands of whey protein nutritional supplements. Eleven showed some degree non-compliance. One did not present in its label substance the substance caffeine, which it contained. It is important to highlight that many athletes use this supplement and caffeine - both are liable to be considered doping.

Problems like this are not restricted to Brazil, they also occur in the United States. Published in the British Medical Journal in 2014, a study carried out in the University Liverpool found the presence of the drug tamoxifen, used to treat breast cancer in Esto Suppress, a NS aimed muscle mass enhancement, produced by Pharma Labs (Chicago). The drug was being used with the aim of blocking the increase of the breast (gynecomastia), one side effect of steroids. The researchers warned that since 2000 an increasing number of NS for gym-goers have included, in an unlawful manner, anabolic steroids,

stimulants and appetite suppressants, but did not include this information on the label or indicating only their chemical name, thereby preventing proper identification [73].

The Risk of Food Supplement Use

The presence of prohibited or harmful substances in NS, as discussed above in the previous topic, reveals the danger of their intake without supervision [36], either by lack of guidance and consumer knowledge [44,47], and/or the lack of a coherent regulation with consumer health in mind due to incorrect composition of the products (UOL-B 2014). The danger faced by the consumer involves risk of death. One aspect that has popularized the use of NS is marketing the belief that they are natural and complementary food products, and therefore, safe and healthy options.

Even supplements that comply with the rules are not harmless and should not be consumed without proper guidance. Those with large protein content, for example, can cause kidney problems if taken in incorrect quantity, since dosage varies among individuals and is dependent on the nutritional status of each. Carvalho, Molina & Fontana [74] and Castro [75] analyzed the effects of creatine supplementation on kidney and liver function, finding no damage. However, there are few similar studies, so we do not know the effects of many NS, especially in the long term.

Schmitt [16] warns that the effectiveness and, above all, the safety of the interaction of these substances is not yet known, since studies on the pharmacological and toxicological synergy of this association are practically non-existent. In his work, the author elucidated their acute and sub chronic toxicological profile, complete with an assessment of oxidative stress and physiological changes in mice who took p-synephrine, ephedrine, caffeine and salicin (stimulating NS). The results showed a reduction in motor activity, convulsions, salivation, restlessness, piloerection in females, as well as deaths in males caused by cardiopulmonary bleeding, occurrence of neurotoxicity in males, sub chronic toxicity, oxidative stress, hepatic and kidney injury in rats and a decrease in growth hormone. The different toxicity profile between males and females suggests hormonal influence on the pharmaco-toxicological effects. Therefore, the combination of p-synephrine, ephedrine, caffeine and salicin, at the tested doses, presents a considerable toxicity profile. Schmitt [16] indicates the need for more detailed toxicological tests for a complete understanding of the effects, including evaluations related to the

influence of the presence of estrogen and long-term exposure.

The analysis method developed by Schmitt [16] can be used in the quality control of products, so as to identify and quantify these substances in a wide variety of matrices. This means that the technology required for analysis of these products is not an issue in Brazil.

Conclusion

The limitations that have been identified in this article reflect the limitations of the scientific literature as a whole concerning the issues approached here. With respect to the mapping of the use of NS, there not an accurate outline of the situation in Brazil – we were only able to access the data from studies conducted with athletes and gym-goers in four regions of the country – all of which indicated a high rate of usage of NS. Despite this, consumers, whether or not athletes, are unaware of the effects of NS, and use them without proper guidance. Research shows uncertainty as to the effectiveness of the use of NS for physical performance, with the exception of creatine, although its long-term effect is unknown. Among the risks of the use of NS are those caused by insufficient and inefficient regulation and oversight, being that there have been death reports [14,15] and possible doping sanctions imposed to Brazilian athletes [76,77].

Considering all that has been presented, it is a fact that the widespread and indiscriminate use of NS is based on popularly held beliefs that NS are natural products, and that their efficacy has been scientifically proven, in addition to information disseminated in the media that only proteins in isolations are necessary for the building of muscular mass. The explanation may lie in the social construction of the artifact NS by science [18,19], which is explained by the understated view held be common sense of scientific knowledge as an absolute (Cholakov 1993) without a critical vision of technology [26] and of technological determinism [25]. The media greatly contributes to the dissemination of these false beliefs [78].

The discussion demonstrates the need to bring the attention of oversight agencies to bringing up to date the use of technologies [16] and also adopting grater organization [63,64], as well as nutritionists, physical educators [79], doctors and consumers in search of greater awareness and the responsible use of these substances.

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