

## Bioproducts based on guarana (*Paulinia cupana*) for practitioners of physical activity

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### Abstract

*Currently, several researches have related that the properties of methylxanthines and tannins that guarana has can delay the fatigue process and improve sports performance in trained individuals. In this sense, the purpose of this work is to present bioproducts developed based on guarana (Paulinia cupana) relating its effects to the practice of physical activity.*

**Keywords:** Supplements; Stimulant; Antioxidant.

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## 1. INTRODUCTION

The practice of physical activity is essential for the health of people in general, but without adequate guidance and prescription, it can cause some damage to various systems of the body.

With the technological advances observed in the food industry, concerns about food security are increasing. For this reason, researchers have applied nanotechnology to develop from smart packaging, product tracking and, more recently, bioactive microencapsulations. Caffeine is the most consumed psychoactive chemical in the world, being then classified among the methylxanthine compounds, structurally identified as 1,3,7-trimethylxanthin (Tfouni et al. 2007). It is an alkaloid found in various plants, such as coffee, tea, mate, cola nuts, cocoa and guarana (Adnadjevic, Koturevic, e Jovanovic 2017).

Following this trend, guaraná fruit native to the Amazon region, whose seeds have always been used as a stimulant and as a traditional remedy by indigenous tribes in Brazil over the years, has come to be consumed as soft drinks, energy drinks and supplements (Mendes & Carlini, 2007; Smith & Atroch, 2010).

It is a substance widely used in the pharmaceutical, food and cosmetic industries, acting as a stimulant for the heart, airways and central nervous system, being a vasodilator and a diuretic (Jun, 2009). The stimulating, tonic and aphrodisiac factors found in guarana are therapeutic properties that became known worldwide from the first recorded indigenous reports, which led to the inclusion of guarana in the list of medicinal plants, in addition to the increased use and commercialization (Schimpl et al. 2013).

Food supplements containing various ingredients and caffeine have become one of the most widely used alternative medicines in the United States (Gurley, Steelman, e Thomas, 2015).

Based on this context, this work aims to present bioproducts developed based on guaraná relating its effects to the practice of physical activity.

## **2. PROPERTIES OF GUARANA (*Paulinia Cupana*)**

The chemical components found in the guarana fruit include stimulants derived from methylxanthines (caffeine, theophylline and theobromine) and condensed tannins, which are composed of interconnected monomer units, the main ones being catechin and epicatechin, in addition to phosphorus, iron, magnesium, potassium, calcium, vitamin A and vitamin B1 (de Sousa et al. 2011).

Guarana seed has a high percentage (2.5% to 6%) of caffeine (1,3,7-tri-methylxanthine) in addition to lower proportions of other purine alkaloids, such as theobromine (3, 7-dimethylxanthine) and theophylline (1,3-dimethylxanthine) (Heckman et al., 2010). Its seeds also contain a high concentration of polyphenols, particularly proanthocyanidins (Yamaguti-Sasaki et al., 2007; Mara et al., 2007; Ruchel et al., 2016).

Regarding the biological effects of methylxanthines, caffeine (1,3,7-trimethylxanthine) has a stimulating effect on the central nervous system, cardiac muscles, respiratory system and gastric acid secretion, being also considered as a weak diuretic and muscle relaxant; theobromine (3,7-dimethylxanthine) has a diuretic action; and theophylline (1,3-dimethylxanthine) has a predominantly bronchodilating effect (Alves & Bragagnolo, 2010; Maria, 2007).

Tannins, another chemical constituent of guarana, demonstrate antioxidant, antiviral, bactericidal, molluscicidal activity and inhibition of some extracellular enzymes (Santos et al., 2007; Yamaguti-Sasaki et al., 2007).

There are other substances present in guarana that have therapeutic properties. The effects of antioxidant and anti-inflammatory activity stem from the high concentrations of phenolic compounds, such as tannins, and the activity to the presence of saponins (Kuskoski et al., 2005).

Among the therapeutic properties caused by the concentrations of phenolic compounds there is the protective effect against gastric lesion induced in vivo by ethanol and indomethacin (Campos et al., 2003), the antigenotoxic actions in vivo (Fukumasu et al., 2006) and antibacterial and antioxidant in vitro (Basile-doelsch et al., 2014).

### 3. GUARANA-BASED BIOPRODUCTS

The guaraná plantation in the state of Amazonas comes from small and large producers. Large corporate groups have plantations ranging from 80 to 500 ha. According to Smith & Atroch, (2010b) guarana is grown on small and large farms, as a monoculture or alongside other crops, being harvested manually in the dry season.

The socioeconomic relevance of guarana planting in the Amazon region is associated with the high caffeine content found in its seeds. Most of the production is used by the soft drink industry and the rest is sold in the form of syrup, toothpick, powder and extracts (Antonelli-Ushirobira et al. 2010).

One of the first ways of commercializing guarana was through the use of smoked sticks, which are prepared by hand from dried seeds crushed in wooden mortar with the addition of small amounts of water. Subsequently, the sticks are subjected to smoking in ovens using woods known to the Indians that provide flavor and characteristic aroma. This conservation practice is used by the indigenous tribes who grind the guaraná sticks in the dry tongue of the pirarucu fish (regional grater) for rituals, during fishing and hunting of animals (Silva et al. 2017).

Rovellini & Fusari (2015) found that food products, when undergoing a secondary oxidation process (decomposition of hydroperoxides), forming hydroxides, diepoxides and keto acids, may have undesirable toxicological effects on the human organism with the development of specific diseases at the cellular level, premature aging, coronary diseases (arteriosclerosis) etc.

As for the quality parameters of food products containing lipid raw material, oxidation causes impairment in the integrity of the cell membrane (degradation of its unsaturated fatty acids), consequently interfering with human health (Rovellini e Fusari 2015).

Thus, in addition to the characterization of the physical and chemical parameters indispensable for the definition of the quality of food products, it is essential to define appropriate strategies to assess stability and safety, as well as expiration dates. (*shelf-life*) (Rovellini e Fusari 2015).

The increasing use of products obtained from guarana has generated a qualitative interest in the various industrial sectors, since the chemical structure is predominantly unsaturated, in the proportion 76:24 (unsaturated / saturated), susceptible to the oxidation phenomenon that can compromise the food quality (Valentim-Silva et al., 2014; Rovellini & Fusari, 2015).

In the health area, scientific investigations have shown that the consumption of guarana has possible positive effects related to cardiovascular metabolic diseases, linked to lipid metabolism and low density lipoprotein oxidation (Portella et al. 2013), antioxidant biological activity of polysaccharides (Dalonso & Petkowicz, 2012), protective effects on NIH-3T3 fibroblasts (Bittencourt et al., 2013) and improvement of breast cancer patients who have undergone chemotherapy treatments (Oliveira Campos et al., 2011), reduction in oxidative stress in healthy individuals (Yonekura et al., 2016).

In this way, guarana powder started to be used by the pharmaceutical industry in capsules, with the following attributes: dietary food, organic stimulant due to the presence of caffeine, analgesic, antipyretic, antifermentation, diuretic, antioxidant, vascular tonic (anti-atheromas) and then considered elixir of long life. In the food industry it is used in the preparation of soft drinks, extracts and syrups (Portella et al., 2013; Zanuto et al., 2006).

### **3.1. Guarana based bioproducts for physical activity**

Energy drinks have great market potential, given the wide variety of components in their formulation, each containing its functionality features. As they are still relatively new products on the market, there are many controversies regarding the appropriate concentrations of use and regarding the real effects of these ingredients in the body, requiring research on the interactions of these components with other substances such as alcohol. (Marques de Carvalho et al. 2006).

The preference for food products and beverages is modeled in large part by brand image through marketing and advertising strategies. The significant association between the consumption of energy drinks and the exposure to television advertising described in this analysis suggests that advertising is aimed at those who are

already consuming or is being used to stimulate consumption among those who were not consuming energy drinks (Stacey et al. 2017).

The safety of energy drinks in vulnerable populations has not been established. Although the target consumers of energy drinks are teenagers and young adults, they are marketed to consumers who need more “energy”, which includes patients of all ages with congenital heart disease. The risk of consuming energy drinks in the general population and in those with underlying structural heart disease in particular should be determined. Warning labels should be required to inform consumers of the risks posed by those drinks and of appropriate limits on consumption (Ward, Lipshultz, e Fisher 2014). Numerous energy drinks containing guarana are hitting supermarket shelves, gas stations and convenience stores every year. Both multinational corporations and small independent companies have ventured into the dispute. The names given by the manufacturers try to evoke the energy factor, coming from the people who consider guaraná to be a primary source of energy in the Amazon. However, despite the potential of guarana or caffeine-based beverages, there was an increase in the combined consumption of these beverages with alcoholic beverages (Smith; Atroch, 2010).

Klein et al. (2013) developed in their study the development of tablets and microcapsules containing semipurified guarana extract. However, the results showed that microcapsules have a easier delivery of markers than tablets in the process of in vitro drug release. In the research carried out by Soares et al. (2001), clarified and concentrated cashew juice and guarana extract were used, which obtained good acceptance by the tasters, making it an important option for the consumer.

In the study developed by Oliveira, Takase and Gonçalves (2009), gluten-free biscuits were developed from medicinal plants such as guarana (*Paulinia cupana*) and catuaba (*Anemopaegma mirandum*) aiming at supplementation with copper, iron and zinc that achieved good acceptance among consumers and possibilities for sensory growth as well. They present satisfactory amounts of copper, iron and zinc, acting as important aids in supplementing each of these minerals. In addition, these plants can be considered sources of fiber and important options to replace bakery products for celiac patients.

#### **4. EFFECTS OF GUARANA-BASED BIOPRODUCTS ON PHYSICAL ACTIVITY PRACTITIONERS**

The popularity of bioproducts as an aid to improvements in health indicators (wl: weight loss) during the practice of physical activities has increased, being supported as a fast and low-invasive method to obtain the desired results (Alkhatib et al., 2015) with high degree of effectiveness. (Blanck et al., 2001).

Guarana is a tropical rainforest plant that was domesticated in the Amazon for its caffeine-rich fruits and has long been used to increase energy (Da Costa Miranda et al., 2009). The first studies with guarana were initially conducted with a view to improving athletes' performance. However, guarana has become more consumed as one of the components of energy drinks and is used by consumers for weight loss. Advertising campaigns with phrases that suggest burning calories and stimulating metabolism imply the concepts of consumption for weight loss (Ballard et al., 2010).

Some authors suggest that the thermogenic effects of mixtures of multiple ingredients (ex: caffeine and guarana) may work together, demonstrating effectiveness in improving the function of the central nervous system and stimulating fat metabolism and lipolysis based on their effects on androgen receptors and their actions as an adenosine receptor antagonist that would accelerate cell activity and prolong lipolysis (B. Sokmen et al, 2008; Alkhatib et al., 2015).

The effects of guarana are often attributed to its high concentrations of caffeine (Schimpl et al., 2013b). In addition, guarana seeds harbor several other possible psychoactive stimulants (Espinola et al., 1997; Mattei et al., 1998; Scholey & Haskell, 2008) that may be associated with improvements in cognitive function (Pomportes et al., 2017). Thus, guarana is expected to have similar effects to caffeine (Ballard et al., 2010).

In this sense, a recent study (Pomportes et al., 2017) sought to investigate the influence of guarana mouthwash on cognitive performance during submaximal exercise in physically active individuals. Among other findings, conditions with guarana and caffeine led to improvements in information processing in terms of speed, accuracy and temporal performance. Such research proposes

new paths for studies with guarana analyzing psychophysiological aspects that play an important role in the active behavior of the general population (Garber et al., 2011; Kong et al., 2016; Kinnafick et al., 2018; Burn & Niven, 2019).

In addition, the recent review conducted by Higgins et al (2018) suggests that most studies are aimed at young and healthy individuals, usually active university students. In addition, as most compounds containing guarana are a mixture of energy with an unknown amount of the ingredients mentioned on the label, it is very difficult to identify whether it is a specific ingredient or a combination of them that leads to a certain effect. Thus, the changes in weight loss and body composition observed with the guarana-based energy drink were modest. Increases in energy expenditure and weight loss are likely to be subject to decreasing returns as users get used to caffeine. The amounts of guarana found in popular energy compounds are below the amounts expected to cause adverse events (Clauson et al., 2008). However, some young adults were admitted to emergency services with an overdose of caffeine after an excess of guarana-based energy compounds (Smith & Atroch, 2010b). It is noteworthy that the high concentrations of caffeine in guarana, that caffeine causes insomnia, nervousness, arrhythmias, osteoporosis, cardiovascular diseases, anemia, complications in pregnancy and childbirth as well as gastrointestinal disorders (J. P. Higgins et al., 2010). It is also worth noting that overdose of guarana extract can lead to caffeine intoxication and atrial fibrillation (Burke, 2008).

## 5. CONCLUSIONS

Considering the results presented in this study, it is evident that the components present in guarana bioproducts have stimulating and antioxidant properties, minimizing the effects of physical activity on oxidative stress.

Studies have shown that guarana bioproducts came to be used by the pharmaceutical industry in capsules and microcapsules. The food industries started to use in the preparation of soft drinks, extracts and syrup.



Several studies have demonstrated the effects of guarana bioproducts, such as stimulating fat metabolism and lipolysis, improving cognitive function and processing information in terms of speed, accuracy and temporal performance.

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