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INNOVATION IN THE MARKET OF SUPPLEMENTS WITH NATURAL INGREDIENTS: THE APPLICATION OF BEET (*Beta vulgaris*) AS A COMPETITIVE DIFFERENTIATOR

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ABSTRACT

Objective: The general objective of this study was to analyze the potential of beetroot (*Beta vulgaris*) as an innovative ingredient in the Brazilian natural supplements market.

Theoretical Framework: The global food supplement market has experienced growth, generated by increased consumer interest in healthier and, in most cases, natural products, in line with a healthy lifestyle.

Method: The methodology adopted for the development of this work is based on an exploratory and descriptive approach, composed of bibliographic research, market analysis and collection of primary data through opinion research.

Results and Discussion: Market analysis identified brands already using beetroot in sports-focused formulations, revealing innovative trends associated with the use of natural ingredients. Consumer research showed growing acceptance of beetroot-based supplements, despite barriers such as taste and price.

Research Implications: The data obtained reinforce the potential of *Beta vulgaris* as a competitive differentiator in the development of healthy, high-value-added products for the functional food and sports nutrition sector.

Originality/Value: The biochemical profile of beetroot, rich in nitrates, phenolic compounds and betalains, provides vasodilatory, antioxidant and anti-inflammatory properties, making it an excellent option for ergogenic applications, especially in the sports and cardiovascular context.

Keywords: Natural Supplements, Healthy Products, Sports Audience, Price, Flavor.

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INOVAÇÃO NO MERCADO DE SUPLEMENTOS COM INGREDIENTES NATURAIS: A APLICAÇÃO DA BETERRABA (*Beta vulgaris*) COMO DIFERENCIAL COMPETITIVO

RESUMO

Objetivo: O objetivo geral deste estudo foi analisar o potencial da beterraba (*Beta vulgaris*) como ingrediente inovador no mercado brasileiro de suplementos naturais.

Referencial Teórico: O mercado mundial de suplementos alimentares tem vivenciado um crescimento, gerado através do aumento do interesse dos consumidores por produtos mais saudáveis e, na maioria das vezes, naturais, em concordância com um estilo de vida saudável.

Método: A metodologia adotada para o desenvolvimento deste trabalho baseia-se em uma abordagem exploratória e descritiva, composta por pesquisa bibliográfica, análise de mercado e levantamento de dados primários por meio de pesquisa de opinião.

Resultados e Discussão: A análise de mercado identificou marcas que já utilizam a beterraba em formulações voltadas ao público esportivo, revelando tendências de inovação associadas ao uso de ingredientes naturais. A pesquisa com consumidores mostrou uma crescente aceitação de suplementos à base de beterraba, apesar de existirem barreiras como sabor e preço.

Implicações da Pesquisa: Os dados obtidos reforçam o potencial da *Beta vulgaris* como diferencial competitivo no desenvolvimento de produtos saudáveis e de alto valor agregado para o setor de alimentos funcionais e nutrição esportiva.

Originalidade/Valor: O perfil bioquímico da beterraba rico em nitratos, compostos fenólicos e betalaínas confere propriedades vasodilatadoras, antioxidantes e anti-inflamatórias, tornando-a uma excelente opção para aplicações ergogênicas, principalmente no contexto esportivo e cardiovascular.

Palavras-chave: Suplementos Naturais, Produtos Saudáveis, Público Esportivo, Preço, Sabor.

INNOVACIÓN EN EL MERCADO DE SUPLEMENTOS CON INGREDIENTES NATURALES: LA APLICACIÓN DE LA REMOLACHA (*Beta vulgaris*) COMO DIFERENCIADOR COMPETITIVO

RESUMEN

Objetivo: El objetivo general de este estudio fue analizar el potencial de la remolacha (*Beta vulgaris*) como ingrediente innovador en el mercado brasileño de suplementos naturales.

Marco Teórico: El mercado mundial de complementos alimenticios ha experimentado un crecimiento, generado por el creciente interés de los consumidores por productos más saludables y, en la mayoría de los casos, naturales, acordes con un estilo de vida saludable.

Método: La metodología adoptada para el desarrollo de este trabajo se basa en un enfoque exploratorio y descriptivo, compuesto por investigación bibliográfica, análisis de mercado y recolección de datos primarios a través de investigación de opinión.

Resultados y Discusión: Un análisis de mercado identificó marcas que ya utilizan remolacha en fórmulas deportivas, lo que reveló tendencias de innovación asociadas al uso de ingredientes naturales. Un estudio de consumo mostró una creciente aceptación de los suplementos a base de remolacha, apesar de barreras como el sabor y el precio.

Implicaciones de la investigación: Los datos obtenidos refuerzan el potencial de Beta vulgaris como diferenciador competitivo en el desarrollo de productos saludables de alto valor añadido para el sector de la alimentación funcional y la nutrición deportiva.

Originalidad/Valor: El perfil bioquímico de la remolacha, rico en nitratos, compuestos fenólicos y betalaínas, le confiere propiedades vasodilatadoras, antioxidantes y antiinflamatorias, convirtiéndola en una excelente opción para aplicaciones ergogénicas, especialmente en el contexto deportivo y cardiovascular.

Palabras clave: Suplementos Naturales, Productos Saludables, Público Deportista, Precio, Sabor.

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1 INTRODUCTION

It is known that adequate nutrient intake is related to the improvement of the body's performance against sports performance. In order to maximise results in the exercises, practitioners are led to search for resources in order to achieve the goal in the short term. Among these resources, food supplements stand out (Almeida *et al*., 2021). In addition, the interest of consumers for healthier and, in most cases, natural products has increased, in accordance with a healthy lifestyle.

According to Grand View Research (2023), the natural supplements sector is expected to grow at a rate of 8.6% per year by 2030, reaching a market value of US$ 230 billion. In Brazil, this global trend reflects the behaviour of consumers who also seek healthy and natural alternatives to improve physical performance and health in general, with 63% of physical activity practitioners using supplements regularly (Abenutri, 2023).

Among the natural ingredients, beetroot (*Beta vulgaris*) stands out due to functional and ergogenic properties. Beetroot is rich in nitrates, compounds that increase the concentration of nitric oxide (NO) after metabolism, promoting vasodilation, improvement in blood flow and the supply of oxygen and nutrients in the body, resulting in improved athletic performance (Jones *et al*., 2014).

Beetroot consumption for the purpose of supplementation, in the form of juice or concentrated extract, can increase physical resistance by up to 16% during aerobic exercise (Coggan *et al*., 2015). In addition, research conducted by Coggan *et al.* (2015) with healthy men and women showed that ingestion of 140 ml of beetroot juice containing 11.2 mmol of nitrate resulted in a 4% increase in knee extensor power at the highest angular velocity tested. This improvement was accompanied by a 61% increase in respiratory nitric oxide levels ($p < 0.001$), highlighting the effectiveness of beetroot nitrate in enhancing muscle performance.

In addition to increasing performance through the intensification of physical potency (ergogenic benefits), beetroot naturally contains phenolic compounds, flavonoids and betalains, which have antioxidant properties, reducing oxidative stress and post-exercise inflammation.

These compounds help in muscle recovery and minimise the damage caused by intense training (Clifford *et al*., 2017).

In the study by Jones *et al*. (2014), individuals who consumed 250 ml of beetroot juice daily for four weeks showed a reduction of 5 mmHg in systolic blood pressure and better regulation of blood flow, aiding in processes such as coagulation and inflammation, factors that directly reflect on the cardiovascular health of athletes and physical activity practitioners.

In Brazil, companies such as Dobro, Shark Pro, Positive Brands and Stratus are pioneers in the innovation of the national market of natural supplements using beetroot with products aimed at the public fitness and high performance. Dobro's BT400 supplement stands out and provides 400 mg of nitrate per serving (Dobro, 2024), while Shark Pro's supplement combines powdered beetroot with coconut water to optimise hydration and electrolyte supply (Shark Pro, 2024).

Therefore, this study aimed to analyse the potential of beetroot as an innovative ingredient in the Brazilian market of natural supplements. As specific objectives we have: To highlight the main functionalities of beetroot; To analyse which are the main national brands that use this ingredient as a supplement; To verify the perception about the consumption of supplements based on *Beta vulgaris*.

2 METHODOLOGY

The methodology adopted for the development of this work is based on an exploratory and descriptive approach, composed of bibliographic research, market analysis and primary data collection through opinion research. The choice of this methodological framework aims to provide a comprehensive understanding of the innovative potential of beetroot (*Beta vulgaris* L.) as a functional ingredient in the natural supplement market, analysing both its physiological benefits and its commercial impact.

Initially, a bibliographic survey was carried out in scientific databases, such as PubMed, ScienceDirect and Scielo, as well as journals specialised in sports nutrition and food supplements. The objective of this stage was to gather information on the chemical composition of the beetroot, with emphasis on the levels of nitrates, betalains and phenolic compounds. Studies that relate beetroot consumption with increased production of nitric oxide (NO) were prioritised, an effect that promotes vasodilation and improvement of physical performance in athletes and regular physical activity practitioners.

Research by Coggan *et al*. (2015) and Jones *et al*. (2014) support much of the theoretical foundation, presenting evidence that the intake of beetroot juice results in a significant increase in muscle power and aerobic resistance, in addition to contributing to the reduction of blood pressure and improvement of endothelial function.

At the same time, a market analysis was conducted to identify national companies that already use beetroot as a competitive advantage in supplements. The research involved consulting the websites of companies such as Dobro, Shark Pro, Positive Brands and Stratus, with the objective of mapping available products, their formulations and value proposals. This qualitative analysis allowed the identification of emerging trends and the understanding of the marketing strategies applied by these brands, with emphasis on natural, healthy and sustainable ingredients.

In addition to the bibliographic research and market analysis, an opinion survey was applied with consumers, in order to evaluate the interest and perception of the target audience in relation to the use of natural beetroot supplements. Data collection was carried out through an online questionnaire, available on digital platforms and disseminated in social network groups focused on sports, health and nutrition. The questionnaire addressed aspects such as demographic profile, supplement consumption habits, knowledge about the benefits of beetroot and willingness to purchase products containing this ingredient. The sample consisted of 101 participants, aged between 18 and 50 years, most of them practising moderate to intense physical activities.

The collected data were analysed quantitatively and qualitatively, with the presentation of results in graphs and tables that reflect the preferences and expectations of consumers.

3 RESULTS AND DISCUSSIONS

3.1 NITRATE CONTENT AND ITS PHYSIOLOGICAL IMPORTANCE

Beetroot (*Beta vulgaris*) stands out as one of the richest plant sources in nitrates (NO_{33}), being widely recognised for its ergogenic potential and cardiovascular benefits. Nitrates present in beetroot are inorganic compounds that, when consumed, follow a metabolic pathway that results in the *production of nitric oxide (NO), a signalling molecule with important vascular and metabolic functions (Jones et al*., 2014).

After ingestion, nitrates are absorbed from the gastrointestinal tract and partly recirculate through saliva, where reducing bacteria convert the nitrate (NO_{33}) to nitrite (NO_{23}).

Once in the stomach, nitrite can be converted directly to nitric oxide (NO) or be temporarily stored in the form of circulating nitrite until specific physiological conditions, such as low oxygen concentration (hypoxia), stimulate its conversion to NO (Lansley *et al*., 2011). This process occurs predominantly during physical exercise, contributing to vasodilation and increased blood flow in active muscles.

Studies indicate that supplementation with beetroot, rich in nitrate, is able to improve muscle efficiency, prolong the time to exhaustion and increase aerobic resistance (Wang *et al*., 2025). Coggan *et al.* (2015) observed that ingestion of 140 mL of beetroot juice containing 11.2 mmol of nitrate resulted in a significant 4% increase in knee extensor power in healthy subjects. This effect was accompanied by a 61% increase in respiratory nitric oxide levels ($p < 0.001$), reflecting the increased bioavailability of NO throughout the body.

The physiological relevance of nitric oxide extends beyond sports performance, acting in reducing blood pressure and improving endothelial function. Jones *et al*. (2014) demonstrated that a daily intake of 250 mL of beetroot juice for four weeks resulted in an average reduction of 5 mmHg in systolic blood pressure. This action occurs by the ability of nitric oxide to relax the walls of blood vessels, facilitating flow and decreasing peripheral resistance (Unienville *et al*., 2021).

In addition to cardiovascular benefits, the increase in nitric oxide due to beetroot intake is associated with a reduction in oxygen cost during exercise, allowing the muscle to work more efficiently (Lansley *et al.*, 2011). This effect is particularly important in endurance sports, in which oxygen savings can prolong performance and delay the onset of fatigue (Lundberg *et al*., 2007).

The amount of nitrate in the beetroot may vary according to factors such as cultivation method, soil conditions and post-harvest processing. On average, 100 g of fresh beetroot contains between 250 mg and 400 mg of nitrate, while *concentrated products, such as juices and powdered extracts, may contain higher amounts, reaching standardised doses between 400 mg and 800 mg per serving (Wickham et al.,* 2019).

Beetroot supplementation, therefore, emerges as a promising nutritional strategy, with scientific support in several areas, from sports performance to the promotion of cardiovascular health. Its regular consumption, combined with an active lifestyle, represents a natural and effective approach to improving physical performance and general well-being.

3.2 PHENOLIC COMPOUNDS AND FLAVONOIDS

Beetroot (*Beta vulgaris*) is a rich source of phenolic compounds and flavonoids, groups of secondary metabolites that play key roles in health promotion and protection against oxidative stress and inflammation. These bioactive compounds are known for their antioxidant, anti-inflammatory and vasodilatory properties, being relevant both for cardiovascular health and for improving physical performance and muscle recovery (Clifford *et al*., 2017).

Phenolic compounds are a class of molecules that have one or more hydroxyl groups attached to aromatic rings, giving them high capacity to neutralise free radicals. In beetroot, the main phenolics identified include ferulic acid, gallic acid, p-coumaric acid and chlorogenic acid (Hobbs *et al.*, 2012). These compounds are directly associated with the reduction of oxidative stress, one of the main factors contributing to muscle fatigue and cellular ageing.

Flavonoids, a subclass of phenolic compounds, are also present in beets, especially rutin, quercetin and kaempferol. Rutin, in particular, is recognised for its ability to strengthen blood capillaries and reduce vascular fragility, while quercetin has vasodilator and anti-inflammatory effects (Ganeshpurkar; Saluja, 2016). These actions are critical to improving blood flow, lowering blood pressure, and accelerating post-exercise recovery.

The consumption of beetroot rich in phenolic compounds can contribute to the reduction of inflammatory markers, such as C-reactive protein (CRP), and modulate the immune response after intense physical activity (Wickham *et al*., 2019). This effect is crucial for athletes and practitioners of high-intensity exercises, as it helps prevent muscle injuries and promote tissue regeneration.

The simultaneous presence of phenolics and flavonoids in the beetroot also exerts a synergistic effect, enhancing the bioavailability and stability of nitrates (NO ⊗) present in the vegetable. Studies suggest that phenolic compounds act in the protection of nitrates against oxidation, prolonging their action in the body and increasing the efficiency of the conversion of nitrite (NO_2) to nitric oxide (NO) (Clifford *et al*., 2017).

Supplementation with beetroot, rich in phenolic compounds and flavonoids, offers a natural approach to promoting vascular health, improving sports performance and preventing chronic diseases (Bailey *et al*., 2010). This bioactive profile reinforces the role of *Beta vulgaris* as a functional and innovative ingredient in the food supplement market.

3.3 SYNERGISTIC INTERACTIONS BETWEEN NITRATES, BETALAINS AND PHENOLIC COMPOUNDS

Beetroot (*Beta vulgaris*) is a notable example of functional food whose physiological efficacy is the result of the interaction between different classes of bioactive compounds (Wang *et al*., 2025). The nitrates (NO_{33}), betalains and phenolic compounds present in beetroot act synergistically, amplifying the beneficial effects on health, especially with regard to physical performance, cardiovascular health and modulation of oxidative stress (Clifford *et al*., 2017).

The synergy between these compounds occurs at different metabolic levels, with each class exerting complementary functions that result in the potentiation of the ergogenic and antioxidant effects. Nitrates, when metabolised, promote the production of nitric oxide (NO), an essential vasodilator for improving blood flow and oxygen transport to muscles during exercise (Jones *et al*., 2014). This increase in NO bioavailability, by itself, already contributes significantly to aerobic resistance and reduced muscle fatigue.

Beetroot, a natural plant root, is rich in nitrate and betaine, which are metabolised in the body via nitrate-nitrite-nitric oxide (NO), increasing the bioavailability of NO. NO is an important vasodilator that can improve blood flow and reduce blood pressure. In addition, beetroot active compounds may further potentiate their health effects by altering the activity of the oral microbiome (Wang *et al*., 2025).

Phenolic compounds, such as ferulic acid, gallic acid and rutin, play a crucial role in the protection of nitrates against oxidative degradation. These compounds act as "natural protectors", stabilising nitrates and prolonging their conversion to nitrite (NO_{23}) and, consequently, to nitric oxide (Clifford *et al*., 2017). In addition, phenolics have vasoprotective properties, helping to maintain vascular elasticity and reducing endothelial inflammation, factors that, together, promote the improvement of blood circulation and cardiovascular health (Wang *et al*., 2025).

A study conducted by Clifford *et al.* (2017) investigated the effect of beetroot juice rich in nitrates and betalains on athletic performance. The results showed that the combination of these compounds resulted in a 5% improvement in the time of exhaustion in cycling tests, compared to the control group. The same study identified a significant reduction in markers of inflammation and an acceleration in the muscle recovery process, suggesting that the interaction between betalains and nitrates plays a crucial role in reducing post-exercise stress.

Another relevant aspect of this interaction is the ability of betalains and phenolic compounds to modulate the oral microbiota, essential for the conversion of nitrate to nitrite.

The presence of these compounds in the diet stimulates the growth of nitrate-reducing bacteria in the oral cavity, optimising metabolic conversion and maximising nitric oxide production (Lansley *et al*., 2011).

From the nutritional and commercial point of view, the synergy between nitrates, betalains and phenolic compounds reinforces the potential of beetroot as a complete functional ingredient (Herbach *et al*., 2007). This combination makes beetroot an attractive choice for the development of dietary supplements aimed at athletes, physical activity practitioners and individuals seeking to improve cardiovascular health and general well-being.

3.4 OVERVIEW OF THE NATIONAL AND INTERNATIONAL MARKET

The market for natural food supplements, especially those based on beetroot (*Beta vulgaris*), has shown significant growth in recent years. This expansion is driven by increased awareness of health, well-being, and physical performance. The interest in natural ingredients, rich in bioactive compounds, reflects a significant change in consumer behaviour, which seeks functional products with proven benefits, prioritising natural and sustainable alternatives.

Globally, the natural supplements market was valued at $182.3 billion in 2023 and is expected to continue growth with an annual compound rate of 8.6% by 2030 (Grand View Research, 2023). Ergogenic supplements, especially those that use beetroot, have been consolidated as a relevant category due to the content of nitrates and antioxidant compounds. The popularity of beetroot juice and its derivatives, such as powders and capsules, has increased among athletes and endurance sports practitioners in the United States and Europe.

Scientific studies that prove the role of nitrates in improving physical performance, vasodilation and cardiovascular health have boosted the consumption of beetroot-based products. The search for functional foods that promote the increase of nitric oxide (NO) highlights beetroot as an essential ingredient in the sports and preventive nutrition market (Clifford *et al*., 2017).

In Brazil, the natural supplements market has followed this global trend, with a growth rate of 10% per year (Abenutri, 2023). The segment of supplements aimed at sports performance and muscle recovery represents one of the main areas of expansion, with an approximate turnover of R$ 3.5 billion in 2023.

The growing popularity of beetroot in Brazil is associated with its appeal as a natural alternative for pre-workout supplementation and cardiovascular health promotion. The national market has seen an increase in the supply of products that use beetroot, consolidating the

ingredient as an option for consumers seeking plant-based supplements, free of artificial additives.

The growth of this market is also driven by the expansion of the public practising sports and physical activities. According to the Brazilian Association of Academies (ACAD Brasil, 2023), Brazil has more than 10 million regular practitioners of bodybuilding and endurance sports, representing a significant target audience for natural ergogenic products.

3.5 TOP BRANDS AND PRODUCTS AVAILABLE

The market for beetroot-based supplements (*Beta vulgaris*) has expanded globally, driven by the growing interest in natural products that promote cardiovascular health, physical endurance and muscle recovery (Clifford *et al.*, 2017). Several brands, both national and international, have stood out by incorporating beetroot in formulations aimed at athletes, endurance sports practitioners and consumers seeking natural alternatives to improve physical performance (Euromonitor International, 2022).

Among the main brands, Beetroot It Sport (James White Drinks) stands out, one of the market leaders in Europe and the United States (Beetroot It Sport, 2024). The brand offers shots and concentrated beetroot juices, recognised for their high concentration of nitrates (approximately 400 mg per dose). These products are widely used by Olympic athletes and elite sports teams, supported by scientific studies that demonstrate improvement in aerobic capacity and exhaustion time during high intensity exercises (Wickham *et al.*, 2019).

Another relevant brand is Pure Clean Beetroot, which develops powder supplements, providing flexibility for consumers to add the product to shakes and juices. The differential is the use of dehydrated organic beetroot, offering a product free of additives. The brand emphasises purity and practicality, which attracts consumers concerned about the composition of supplements (Pure Clean Beetroot, 2024).

Beetroot Pro takes a similar approach, focussing on high-performance athletes. Its products combine beetroot powder with antioxidants and amino acids, creating a formula that not only raises nitric oxide levels, but also favours muscle recovery and the reduction of post-exercise inflammation (Beetroot Pro, 2024).

In Brazil, brands such as Dobro have stood out with innovative formulations. The company offers powdered supplements that combine beetroot, ginger and green tea, creating a functional product that acts both as a pre-workout and as a regenerative beverage. The

practicality of the sachet format has attracted consumers who are looking for natural options to increase energy and endurance during training (Dobro, 2024).

Positive Brands invests in ready-to-drink beverages, using beetroot as the main ingredient. Its products have detox appeal and are promoted as allies of muscle regeneration and cardiovascular health. Available in supermarkets and natural products stores, these beverages have conquered space among consumers seeking healthy and convenient alternatives in daily life (Positive Brands, 2024).

Shark Pro offers beetroot powder aimed at the sports audience, promoting the supplement as a natural alternative to conventional pre-workouts. The product is marketed in pots and aimed at athletes seeking improvement in aerobic endurance and performance during competitions (Shark Pro, 2024).

Finally, Stratus has developed beetroot powder extracts, aimed at the preparation of shakes and smoothies. The brand emphasises the functionality of the ingredient in improving blood circulation and physical performance, highlighting beetroot as a natural ergogenic resource (Stratus, 2024).

3.6 INNOVATION TRENDS AND OPPORTUNITIES

Sports dietary supplements promote improvement of physical activity by providing nutrients. In search of body development in general, the market for dietary supplements has been popularising, causing increased consumption (Carvalho; Tavares; Pereira, 2024). One of the main trends that shape the current market is the diversification of consumer formats. Beetroot supplements have evolved from traditional powders and capsules to concentrated shots, energy bars and functional beverages, allowing greater flexibility in consumption and expanding the target audience. Products in practical and fast-absorbing formats, such as oral gels and beetroot nitrate-enriched biscuits, gain space, especially among athletes seeking quick and effective alternatives to pre-workout.

Another important movement is the development of synergistic formulations, which combine beetroot with other functional ingredients. The incorporation of adaptogens (such as ashwagandha and maca peruana), antioxidants (such as turmeric and ginger), and natural vasodilators creates a more complete approach to health and performance. This synergy of ingredients provides multiple benefits, reinforcing not only the increase in aerobic capacity, but also muscle recovery, strengthening the immune system and reducing inflammatory processes.

There is a huge amount of turmeric supplements on the market, with a great variability of values and therapeutic doses, the indication of a dose of 130mg would be safe and ideal to start the use of turmeric supplementation, highlighting the need for a guideline with indication of therapeutic dose, probably in association with piperine, for better results and performance of the nutritionist (Sá; Lima; Fidelix, 2023).

Customising supplementation is a rising opportunity. Adjustable supplements, which offer doses of nitrate adaptable to the type of training or specific need, are being explored. Products that allow the consumer to modulate the amount ingested, either by individual sachets or by gradual release capsules, create an experience more aligned to the objectives of each user, reinforcing the perception of value.

The bet on microencapsulation and controlled release technologies also represents a promising innovation. These technologies allow to preserve the stability of the bioactive compounds of beetroot, ensuring a prolonged release of nitrates and antioxidants during exercise or throughout the day. This not only maximises the physiological benefits, but also differentiates the product in the market, creating a technical and scientific appeal that attracts more demanding consumers.

In the food area, encapsulation is performed using bioactive components, such as flavour components, micronutrients, fatty acids, vitamins, enzymes, antioxidants, polyphenols, known as core materials, and carbohydrates, gums and proteins, as shell material (coating), as emphasised by Yüksel, Istek and Bulca (2023).

In the field of sustainability, innovation turns to the full use of beetroot. Companies have invested in the use of agricultural waste and underutilised parts of the plant, such as leaves and bark, in the formulation of supplements, promoting a zero-waste approach. This practice not only reduces the environmental impact, but also adds a competitive advantage for brands that adopt circular economy practices and socio-environmental responsibility.

Finally, the development of products that communicate their benefits clearly and objectively is essential. The use of transparent labelling, especially the amount of nitrates and studies that prove the effectiveness of the product, generates consumer confidence. The creation of partnerships with universities and research centres to validate formulations also presents itself as an opportunity for differentiation, reinforcing scientific credibility and increasing competitiveness in the market. Innovation in beetroot supplements is directly linked to the ability of companies to translate emerging consumer needs into differentiated, convenient and scientifically validated products.

3.7 CONSUMER OPINION POLL

To understand the potential for approval and the main impressions of consumers regarding the use of beetroot as an ingredient, we conducted an opinion survey in order to identify the profile of the consumer public, assess the level of knowledge about the benefits of beetroot, map preferences of supplementation formats and understand the purchase disposition against different influencing factors.

We sought to identify the consumer profile based on variables such as age and gender, as well as identify their habits related to the practice of physical activities and the consumption of supplements. The level of involvement with the fitness and sports universe is considered determinant in the propensity to experiment with new products with functional appeal, such as beetroot-based supplements.

In order to evaluate the public's relationship with supplements that use beetroot as an active ingredient, questions were included about the degree of knowledge of the participants regarding the physiological effects of *Beta vulgaris*, such as vasodilation, increased energy and muscle recovery. In addition, we investigated whether respondents had already consumed beetroot products in their composition and, if so, what their perception was.

Considering the different forms of presentation of supplements in the market, this section sought to understand which formats consumers consider more attractive or convenient, such as capsules, dilution powder, ready-to-drink drinks or energy bars. In addition, the interest in multifunctional products was evaluated, that is, supplements that combine beetroot with other natural ingredients with synergistic effects, such as turmeric, ginger or natural caffeine.

The last section of the research was devoted to the analysis of the willingness of consumers to purchase beetroot-based supplements, considering aspects such as taste, price, practicality and scientific credibility. Possible barriers that may limit consumption, such as lack of knowledge of the benefits, perception of high cost or resistance to the taste of beets, were also raised.

The opinion poll had the participation of 101 individuals, with a predominance of the age groups of 26 to 35 years (46.5%) and 18 to 25 years (26.7%). Most reported practising physical activities 3 to 5 times a week (41.6%) or daily (23.8%), indicating a sample aligned with the consumer profile of ergogenic supplements, that is, it is able to improve performance in physical activities sports, or even occupational.

Regarding the interest in health and well-being, 50.5% reported having a moderate level and 40.6% a high level of interest. Regarding the current consumption of supplements, 43.6% of respondents said they consume regularly and 36.6% occasionally.

The types of supplements most consumed are vitamins and minerals (44.6%), followed by pre-workouts (38.6%) and supplements for immunity (18.8%). Regarding the criteria of choice, participants consider natural ingredients (32.7%) and indications from professionals (26.7%) the main decisive factors.

When asked about the consumption of beetroot-based supplements, 24.8% reported having already consumed and approved the results, while 54.5% showed interest if there was availability in the market. The most expected benefits include increased energy (37.6%) and improved physical performance (34.7%). The preferred format of consumption was capsules (49.5%), followed by powder to dilute (43.6%).

4 CONCLUSION

Based on the literature review, the market evaluation and the results of the opinion poll, it is possible to conclude that beetroot (*Beta vulgaris*) has a high potential as an innovative ingredient in the market of natural food supplements. Its biochemical profile rich in nitrates, phenolic compounds and betalains gives beetroot vasodilating, antioxidant and anti-inflammatory properties, making it an excellent option for ergogenic applications, especially in the sports and cardiovascular context.

In the marketing aspect, the analysis revealed that both international and national brands already exploit beetroot as a competitive differential in their formulations, with an emphasis on practicality, purity of ingredients and functional benefits. Brazilian companies such as Dobro, Shark Pro and Positive Brands stand out for developing innovative products that dialogue with the growing demand for natural and healthy solutions.

The data from the opinion poll with 101 participants reinforce the commercial viability of beetroot supplements. It was observed that most consumers practice physical activities regularly, have a high interest in health and well-being, consume supplements frequently and have demonstrated a high willingness to purchase *Beta vulgaris*-based products, especially when there is scientific proof of the benefits. In addition, formats such as capsules and dilution powder were the most valued, indicating clear guidelines for the development of new products.

The conclusion of this work points to the need for investments in technological innovation, such as microencapsulation and controlled release, as well as in strengthening the

scientific communication of the benefits of beetroot on the labels and marketing strategies. For food engineers and industry professionals, beetroot represents not only a functional ingredient, but an innovation platform with promising applications in sports, clinical and preventive nutrition.

Finally, this study reinforces the role of natural ingredients in the reformulation and evolution of the supplement market, and highlights the importance of aligning science, technology and consumer perception to generate effective, safe and sustainable solutions. The *Beta vulgaris*, therefore, is not only a passing trend, but a strategic component for the future of natural food supplementation.

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