



Advocating Fruits, Vegetables, and Spices as Functional Foods for Sustainable Health

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Abstract

Functional foods, including fruits, vegetables, and spices, are pivotal in promoting sustainable health by offering essential nutrients and bioactive compounds that enhance well-being and prevent chronic diseases. This paper advocates for increased consumption of these foods as an integral strategy for nutrition education, health promotion, and resilience against non-communicable diseases. Fruits and vegetables are rich in vitamins, minerals, antioxidants, and fibre, which support immune function, improve digestion, and reduce the risk of lifestyle-related diseases such as obesity, diabetes, and cardiovascular conditions. Spices, often overlooked, contain potent phytochemicals with anti-inflammatory and antimicrobial properties, making them indispensable in disease prevention and management. The paper underscores the significance of nutrition education in fostering awareness and behavioural change. By integrating nutritional literacy into school curricula, educators can empower individuals with knowledge about the benefits of functional foods, cultivating lifelong healthy eating habits. Promoting resilience through informed dietary choices becomes a cornerstone of health promotion, particularly in addressing the increasing prevalence of chronic diseases. Collaboration among educators, policymakers, and public health practitioners is essential to advocating for accessible and sustainable food systems. This paper calls for a collaborative approach to prioritize functional foods in daily diets and educational frameworks. By highlighting their health benefits and proposing actionable strategies for nutritional education, this paper aims to inspire stakeholders to advance sustainable health and resilience through the adoption of functional foods.

Keywords: Functional Foods; Sustainable Health; Health Promotion; Nutrition Education.



Introduction

Food plays a crucial role in sustaining life, providing nourishment and impacting overall health and wellbeing. These roles start from the earliest stages of life even before birth and continue throughout every stage of life. Consuming nutritious food as a choice at each stage supports growth, development and health. In recent years, the role and science of food have transcended the simple goal of preventing hunger to include the prevention and management of nutrition-related, chronic diseases of lifestyle (NR-CDL). This evolution highlights the functionality of foods, emphasizing their ability to provide health benefits beyond basic nutrition. Functional foods, which include fruits, vegetables, and spices, have gained attention for their rich content of bioactive compounds, such as antioxidants, vitamins, minerals, and phytochemicals. These components play a significant role in reducing the risk of chronic illnesses such as cardiovascular disease, diabetes, and cancer, while also enhancing immune function and improving overall quality of life. Fruits, vegetables and spices are vital in this regard, offering a wide range of nutrients and fibre that support sustainable health.

Despite the recognized benefits, the global consumption of fruits, vegetables, and spices often falls below recommended levels, necessitating greater advocacy and awareness. Promoting the inclusion of functional foods like fruits, vegetables, and spices into daily diets aligns with the broader goals of sustainable health, as they are vital for individual well-being and environmental sustainability. Local production and consumption of these foods not only reduce the carbon footprint but also improve food security and support the livelihoods of communities, thereby addressing key Sustainable Development Goals (SDGs) (Food and Agriculture Organization of the United Nations [FAO], 2021). Teachers and educators play a pivotal role in this transformation by equipping individuals, particularly students, with the knowledge and skills needed to understand the value of functional foods. By integrating topics on the production, benefits, and promotion of fruits, vegetables, and spices into educational curricula, educators can inspire a new generation to prioritize sustainable and healthy dietary practices. They can foster awareness about the health benefits of functional foods, encourage local farming initiatives, and instil the importance of sustainability in food systems. Through workshops, school gardens, and classroom discussions, educators have the power to shape attitudes and behaviours that promote healthier eating patterns, empower communities, and ensure a healthier, more sustainable future for all.

Overview of Functional Foods

Functional foods are foods that not only sustain life but also help prevent and lower the risk of various diseases, thereby improving physiological functions (Cencic & Chingwaru, 2016). Lee and Foo, (2018) defined functional foods as foods that offer health benefits beyond basic nutrition. Functional foods are foods either whole, fortified, enriched or enhanced that not only provide essential vitamins and minerals but also provide significant health benefits when they are consumed at a sufficient level as part of a diversified diet regularly. For example, Fruits, Vegetables and Spices rich in lycopene, lutein and neoxanthin are considered functional foods. Functional foods can include essential macronutrients, micronutrients, or a mixture of flavonoids, lignin, carotenoids, chlorophylls, phenolic acids, and dietary fibres.

Martirosyan and Singh (2015) highlighted the basic characteristics of functional foods and emphasized that these foods must possess specific qualities. One key characteristic is that functional foods can be either natural or processed. Natural functional foods are those that have not undergone any human interference, such as fresh fruits and vegetables. On the other hand,

processed functional foods refer to those that have been altered through chemical modifications, which may include the addition, removal, alteration, or enhancement of a chemical compound to improve the bioavailability of certain nutrients (Vasileva, 2015). Another important characteristic of functional foods is that they must contain bioactive compounds, which can be either known or unknown. These biologically active components are crucial to the effectiveness of functional foods, as they work synergistically to provide health benefits. Although these bioactive compounds are typically present in small amounts, they play a significant role in the food's potential health effects. Lastly, functional foods must provide clinically proven and documented health benefits. The acceptability and success of functional foods are largely determined by their ability to demonstrate efficacy in clinical studies or tests involving humans. Functional foods need to be tested and proven in the prevention, management, or treatment of chronic diseases (Litwin et al., 2018). This clinical evidence ensures that functional foods deliver tangible health benefits and contribute to improved well-being.

Doyon and Labrecque (2008) opined that for food to be regarded as functional, it should be conceptualized based on four key aspects. First, the health benefits of the food are central, as functional foods must enhance target functions or reduce the risk of specific diseases. Second, the nature of the food is important, with many definitions emphasizing that a functional food should resemble a traditional food, and may involve fortification, enrichment, or the removal of harmful components like excess salt or sugar. Third, the level of function is crucial, as functional foods must offer benefits beyond basic nutritional needs, providing additional health-promoting effects. Finally, the consumption pattern is significant, as a functional food must fit into a normal diet within a specific geographic or cultural context, meaning its functionality may vary across different regions or populations.

Examples of these foods include fruits and vegetables, whole grains, fortified foods and beverages and some dietary supplements. In 2017, inadequate consumption of fruits and vegetables was linked to approximately 3.9 million deaths globally (World Health Organization [WHO], 2019). It is estimated that insufficient fruit and vegetable intake contributes to roughly 14% of deaths from gastrointestinal cancers worldwide, 11% of deaths from ischemic heart disease, and 9% of deaths resulting from stroke (Afshin et al., 2019). Recognizing the importance, the World Health Organization recommend that Fruits, Vegetables, and Spices be consumed per day to meet the body's needs (FAO, 2021). Fruits, Vegetables, and Spices are considered functional foods because they are not only essential to life but play significant roles in the prevention of diseases and the reduction of disease risk factors (Sharanya & Penchalaraju, 2016). Hence, in promoting health and prolonging lives, a food consumption pattern that includes an adequate intake of functional foods like fruits, vegetables, and spices is essential. A lower risk of chronic diseases, a better quality of life, and longevity are associated with a diet rich in fruits, vegetables, and spices (Schulze *et al*, 2018).

Sustainable Health

The World Health Organization defines health as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity (WHO, 1948). This comprehensive view underscores the saying 'Health is wealth,' as true prosperity lies in the ability to thrive physically, mentally, and socially. The term “Sustainability” refers to the ability to meet the needs of the present generation without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development [WCED], 1987). Sustainable health can therefore be defined as the practice of maintaining and



improving long-term physical, mental, and social well-being in ways that do not compromise the ability of future generations to achieve similar health outcomes. It involves adopting healthy lifestyle choices, which include; the consumption of functional foods, regular physical activity, and equitable access to healthcare among others.

Functional food consumption is integral in achieving sustainable health and aligns closely with several Sustainable Development Goals (SDGs). The UN's agenda, comprising 17 global goals, highlights the importance of sustainable and improved nutrition in Goal 2 (Zero Hunger) and emphasizes good health and well-being in Goal 3 (Grosso et al., 2020). These goals recognize the need for adequate consumption of fruit and vegetables as part of a diversified and healthy diet addressed for sustainable health and development. Functional foods, rich in nutrients and bioactive compounds, contribute significantly to these objectives by supporting better health outcomes, preventing diseases, and enhancing overall well-being.

The transformation of the fruits and vegetables sector will play a key role in boosting their consumption, thereby contributing sustainably to healthier diets and improved health. The Food and Agriculture Organization of the United Nations, (2021) highlights that growing fruits and vegetables improves the quality of life for family farmers and their communities by providing a source of income, creating job opportunities and contributing to food and nutrition security. Adequate nutrition, which includes daily consumption patterns of fruits, vegetables, and spices, is fundamental to a good quality of life and longevity at all life stages (Pem & Jeewon, 2015). Recognizing their importance, the United Nations General Assembly declared 2021 as the International Year of Fruits and Vegetables, raising awareness of their nutritional and health benefits and their contribution to a healthy diet and lifestyle.

Roles of Fruits, Vegetables and Spices in Sustainable Health

Fruits and vegetables are quintessential functional foods, offering health benefits beyond basic nutrition. They are an indicator of a healthy overall diet. Rich in vitamins, minerals, fibre, and bioactive compounds, they play a crucial role in disease prevention and health promotion. They also play a role in reducing or reversing the usual degenerative changes that occur with increasing age (Nwaramah & Otitoju, 2014). Regular consumption of a variety of fruits and vegetables can reduce the risk of chronic diseases, support digestive health, and enhance overall well-being. Incorporating a diverse range of these plant-based foods into daily meals is a natural and effective strategy to boost health and longevity. For example, Fruits, and Vegetables because they are rich in phytochemicals such as lycopene, lutein, carotenoid, flavonoid and neoxanthin are considered functional foods. They have also been described as an appropriate diet for weight management and protection against overweight and obesity (Tavassoli et al, 2015).

Fruit is the part of a flowering plant that contains the plant's seeds. The word 'fruit' comes from the Latin word 'fruit', meaning 'enjoy' and is commonly used to refer to the juicy, sweet or tart kinds that people enjoy as desserts or snacks (Zahra et al, 2021). Broadly, the botanical term fruit refers to the mature ovary of a plant, including its seeds, covering and any closely connected tissue, without any consideration of whether these are edible. As related to food, the term fruit refers to the edible part of a plant that consists of the seeds and surrounding tissues. This includes fleshy fruits (such as blueberries, cantaloupe, poach, pumpkin, and tomato) and dry fruits, where the ripened ovary wall becomes papery, leathery, or woody as with cereal grains, pulses (mature beans and peas) and nuts. Edible parts of plants that contain the seeds and pulpy surrounding tissue; have a sweet or tart taste; generally, fruits are consumed as breakfast beverages, or side dishes (for example orange juice, berries, grapefruit, melon)



lunch side-dish or dessert snack food between meals or dinner dessert. Raw and canned fruits are also used as appetizers, salad ingredients and side dishes. They can also be consumed as dried or frozen fruits.

They are nutrient-dense foods that play a vital role in maintaining health and preventing diseases. They are rich in essential vitamins like C, A, K, E, and folate, which support immune function, vision, skin health, blood clotting, and fetal development. Fruits also provide important minerals, including potassium for blood pressure regulation, magnesium for enzymatic functions, and small amounts of calcium and iron. Their high dietary fibre content aids digestion, lowers cholesterol and reduces the risk of chronic diseases like heart disease and type 2 diabetes. Packed with antioxidants such as flavonoids, carotenoids, and polyphenols, fruits combat oxidative stress and inflammation while supporting cardiovascular and eye health. Additionally, their high-water content promotes hydration. Phytochemicals like lycopene, anthocyanins, and tannins enhance their disease-preventing properties, while their fibre component aids in weight management. Regular fruit consumption supports cardiovascular health, cancer prevention, digestive health, and overall well-being.

Nigeria is blessed with many seasonal fruits such as Oranges, Grapefruits, Guavas, Avocado Pear, native pears, Apples, Pineapples, Cashew, Mangoes, Lemon, Pawpaw (papaya), Tomatoes, Banana, Udara (*Chrysophyllum albidum*) and so many others. Fruits not only have sensory properties but also possess nutritive and functional properties that help promote health and fight diseases.

Vegetables, according to the International Agency for Research on Cancer (IARC, 2017) are plant cultivated for its edible parts (s), such as the stems and stalk (celery), root (carrot), tuber (potato), bulb (onion), leaves (spinach, lettuce), flower (globe artichoke), fruit (apple, cucumber, pumpkin, strawberries, tomato) or seeds (beans, peas). Vegetables are essential components of healthy diets and they supply essential micronutrients (vitamins and minerals), dietary fibre, and phytochemicals (Dias, 2018).

Vegetables are rich sources of essential nutrients that contribute to overall health. They contain a substantial amount of complex carbohydrates (potatoes, sweet potatoes, and corn), plant-based proteins (peas, spinach, and broccoli), and unsaturated fatty acids. Additionally, they are also rich sources of micronutrients, including vitamin A (found in carrots, sweet potatoes, and spinach), vitamin C (found in bell peppers, broccoli, and tomatoes), vitamin K (found in leafy greens like kale and spinach), potassium (found in potatoes, spinach, and bananas), calcium (kale, broccoli, and okra), iron (spinach, beet greens, and lentils), magnesium (found in leafy greens), and phytonutrients compounds like flavonoids, carotenoids, and Glucosinolates. Furthermore, Vegetables such as cucumbers, lettuce, and waterleaf have high water content, contributing to hydration.

Daily consumption of Vegetables has been strongly linked with overall good health, reduction in the risk of diseases and cancers and improvement of gastrointestinal health. Each Vegetable contains a unique combination of bioactive ingredients (phytochemicals) that protect humans against free-radical damage, and detoxification of carcinogens thereby reducing the risk of diseases (Hurtado-Barroso et al., 2020). In addition, the dietary fibre present in Vegetables also contributes to the overall health benefits by improving bowel transit, lowering cholesterol, blood glucose concentration management, and transporting minerals and phytochemicals through the human gut.



Spices are aromatic, coloured, and pungent dried plant stuff used mainly for seasoning food. They are obtained from the parts of plants such as fruits, seeds, roots, flowers, and bark. Spices are different from herbs as they are dried parts of plants other than leaves whereas herbs are fresh or dried leaves. Spices have a long food preparation and culinary history as they are commonly used to enhance the sensory properties of food and they are characterized by their strong flavors. The use of spice extends beyond its culinary and domestic use as it has been reported to play significant roles in the pharmaceutical and cosmetic industries (Arachchige et al., 2021).

Spices are important sources of natural antioxidants such as phenolics, phospholipids, carotenoids, and vitamin C. These bioactive compounds are responsible for the medicinal and antioxidative properties of Spices and also prolong the shelf life of foods by altering oxidation reactions thereby preventing off-flavour in foods (Wani et al., 2022). Spices are known for their flavouring, colouring, nutritional, antioxidant, and preservative properties. Essential oils and oleoresins are the major flavouring agents in Spices. Some Spices serve both as flavour and colour enhancers for example parsley, turmeric, chili powder, Locust beans, Ginger and Garlic. Compounds responsible for colouring in Spices are β -carotene, neoxanthin, and lutein. Spices are considered functional foods because they provide not only potential health benefits but also are rich sources of nutrients such as vitamins, minerals, antioxidants, essential oils, and phytonutrients. They are also essential sources of minerals such as zinc, magnesium, phosphorus, and calcium. In addition to their nutritional properties, Spices contain phenolic components thereby possessing antioxidative properties such as scavenging activity, oxygen quenching, and increasing the activities of antioxidative enzymes (Sipra, et al 2024). Unlike Fruits and Vegetables, Spices are easily preserved and they have a longer shelf life.

Conclusively, the colours of fruits, vegetables, and spices are not just visually appealing; they also serve as indicators of the nutrients and phytochemicals they contain. Each type is often linked to specific health benefits (FAO, 2021). For example, red fruits like tomatoes and strawberries are rich in lycopene and anthocyanins, which have antioxidant properties. Similarly, green vegetables like spinach and broccoli are packed with chlorophyll, fibre, and vital minerals. Spices, with their bold colours, are often concentrated sources of beneficial compounds such as curcumin in turmeric or capsaicin in chili peppers. The table below illustrates the relationship between these natural colours and the key phytochemical they represent.

Table No. 1: Nutritional Significance of Colours in Fruits, Vegetables, and Spices

Colour	Phytochemicals	Fruits, Vegetables, and Spices
Red	Lycopene	Tomatoes and tomato products, red papaya, beetroots, red onion, watermelon, pepper.
Red Purple	Anthocyanins, and polyphenols	Grapes, berries, red wine,
Orange	Alpha and Beta-carotene	Carrots, mangos, pumpkin
Orange-yellow	Beta-cryptoxanthin and flavonoids	Cantaloupe, peaches, apricot, pineapple, pumpkin, sweet corn, yellow apple, tangerines, papaya, oranges.
Yellow-green	Lutein and Zeaxanthin	Spinach, avocado, honeydew, melon, pear
Green	Glucosinolates and indoles	Broccoli, kale, cucumber, green apple, leek, lettuce, okra, spinach, cabbage
White-green	Allyl sulfides	Garlic, onion, chives, banana, date, ginger, mushroom, eggplant, white corn, shallots.

(Source: FAO, 2021)



Educational Strategies for Promoting Functional Foods

Food consumption has evolved beyond merely satisfying hunger to becoming a key factor in enhancing health, well-being, and preventing diseases. Improving dietary habits and increasing physical activity are now recognized as essential strategies for reducing the risk of non-communicable diseases and promoting overall health (International Life Science Institute [ISLI], 2009). A dietary habit that includes daily consumption of fruits, vegetables, and spices has been at the advocacy frontline of many national and international organizations as part of the strategies toward achieving sustainable health (FAO, 2021). However, global fruit and vegetable consumption is significantly lower than the World Health Organization's recommended minimum of 400 grams for a healthy diet, especially in sub-Saharan Africa where they consume about one-third of this recommendation (WHO, 2019). This low consumption of fruits and vegetables has been reported to be associated with poor knowledge and awareness of their functional properties. Hence, the increasing risk of nutrition-related, chronic diseases of lifestyle (NR-CDL) such as cardiovascular diseases, obesity, type 2 diabetes, and certain types of cancer (Olatona et al, 2018, Oladosu et al 2022). This evolvement of the global health landscape underscores the growing need to educate consumers about the diverse benefits of these foods. Integrating functional foods into daily diets presents an opportunity for proactive health management. However, achieving widespread adoption requires effective educational strategies including targeted communication, public health campaigns, and educational programs, highlighting the importance of evidence-based information in fostering consumer awareness and behaviour change. Some of these educational strategies include: Engaging teachers in nutritional advocacy, incorporating nutritional literacy into school curricula, and fostering collaboration between educators and health practitioners.

Engaging Teachers and Educators in Nutritional Advocacy

Teachers and educators play a pivotal role in shaping the health and well-being of individuals, especially students. Birch et al (2015) opined that the involvement of educators in advocacy for health and nutrition education programs is imperative to achieving sustainable health. As trusted figures in students' lives, they are in a position to influence attitudes toward nutrition and foster healthy habits that can last a lifetime. Engaging teachers and educators in nutritional advocacy is critical in promoting functional food consumption, improving health outcomes, and addressing the rising rates of NR-CDL. One of the most effective ways to engage teachers in nutritional advocacy is through comprehensive education and training. Teachers can benefit from professional development programs that focus on the importance of functional foods, their impact on learning and behaviour, and how to integrate nutrition education into the classroom. Although educators are significant actors in school-based nutrition education, they often have inadequate resources and knowledge necessary to deliver effective nutrition education, making specialized training crucial. This gap has also been documented in previous studies. Jones and Zidenberg-Cherr (2014) in a study in California asserted that the promotion of existing resources may encourage teachers to provide effective nutrition education. Wiradnyani et al (2021) in a study in Indonesia also highlighted the need for significant support for teachers and educators to engage in efficient and effective nutrition education programs. These studies underscored resource promotion and proper training for teachers and educators on nutrition education to implement nutrition education activities that aligned with students' active participation and parents' involvement. Engaging and training educators in nutrition helps them not only in fostering healthy habits in students but also in creating supportive environments where students can learn about the benefits and consume functional foods, hence, achieving sustainable health.



Integrating Nutritional Literacy into School Curricula

Food and nutrition literacy are two interconnected concepts, often used interchangeably, but they represent different aspects of health. Silva et al (2023) described Food literacy as the knowledge, skills, and attitudes necessary to make informed decisions about food and its impact on health while Zoellner et al (2009) and Watson et al (2013) defined Nutrition literacy as the degree to which individuals can obtain or access, process, and understand the basic nutrition information and services they need to make informed nutrition decisions. Krause et al (2018) described nutrition literacy as a subset of food literacy emphasizing that, the focus of nutrition literacy on the ability to understand basic nutrition information is a prerequisite for a wider range of skills described in food literacy. Food and nutrition literacy remains a global issue among different backgrounds and socioeconomic groups despite the growing awareness of their importance.

The widespread misperception about functional food and healthy eating practices arises from the vast amount of nutrition information available, which often appears inconsistent and contradictory. This challenge is exacerbated by a perceived lack of consensus among scientists and difficulty distinguishing credible sources. Consequently, even well-educated individuals may struggle to make informed dietary choices, inadvertently increasing the risk of unhealthy habits. Integrating food and nutrition literacy into school curricula can address this gap by equipping individuals from an early age with the skills to critically evaluate nutrition information, understand evidence-based guidelines, and make informed decisions to promote lifelong health (Silva et al, 2023). A school's curriculum offers a structured environment where teachers can influence students' perceptions of functional foods. Including lessons on the importance of consuming functional foods, the bioactive component of foods, and the impact of functional foods on health can provide students with the foundational knowledge to make informed decisions about what they eat. According to Amahmid et al. (2019), nutrition education integrated into school curricula results in improved dietary knowledge and behaviours among students. Teachers can be equipped with the tools to teach students about functional foods, the significance of fruits, vegetables, and spices, and how to read food labels for better decision-making.

Fostering collaboration between educators and health practitioners

Promoting partnerships between educators, food, and health practitioners can significantly enhance efforts to advocate for the consumption of functional foods. Health professionals such as nutritionists, and public health experts can work with teachers to develop accurate, evidence-based nutrition education materials that highlight the benefits of functional foods. This collaboration ensures that educators are teaching the latest, scientifically supported information about nutrition and functional foods, and it provides opportunities for health professionals to engage students directly through workshops, demonstrations, and outreaches. For example, demonstrating how to incorporate functional foods into daily meals can make these concepts tangible for students. Research by Amahmid et al. (2019) indicates that when teachers collaborate with food professionals and family members, the nutritional education provided becomes more accurate, relevant, and impactful, making it more likely to translate into behaviour change.

Additionally, teachers can be advocates for school-based initiatives that encourage the inclusion of functional foods in daily diets. Schools are ideal settings for implementing policies and programs that support better nutrition. These may include incorporating fruits and



vegetables as healthy snacks in vending machines, offering nutritious meals in cafeterias, or even creating school gardens where students can learn about growing these foods. Teachers, as influential figures in students' lives, can encourage participation in these initiatives, cultivating an understanding of the health benefits of functional foods. The findings of Chaudhary et al (2020) highlighted the potential of school-based nutrition programs to improve students' consumption of functional foods and overall health outcomes.

Beyond the classroom, teachers equipped with knowledge about functional foods can take leadership roles in advocating for healthier eating habits within their communities. By engaging with colleagues, parents, and community members, teachers can champion discussions about functional foods, their role in disease prevention, and their importance in promoting long-term health. This collaborative, community-based approach fosters a supportive environment where students and families are encouraged to make informed dietary choices. Functional food advocacy, when integrated into school nutrition programs and supported by teachers and health practitioners, can reinforce positive behaviours that benefit students' health both inside and outside the classroom.

Conclusion and Recommendation

In conclusion, advocating for the consumption of fruits, vegetables, and spices as functional foods is a pivotal step toward achieving sustainable health. These foods not only provide essential nutrients and bioactive compounds that support physical, mental, and social well-being but also play a crucial role in preventing and managing chronic diseases. The inclusion of these functional foods in daily diets aligns with global priorities, such as the Sustainable Development Goals, by enhancing food security, improving livelihoods, and fostering environmental sustainability.

Educators and teachers hold a unique position to influence positive dietary habits through education, advocacy, and community engagement. By incorporating nutritional literacy into school curricula and fostering collaborations with health professionals, they can equip individuals with the knowledge and skills needed to make informed food choices. This collaborative effort underscores the importance of functional foods in building resilience, promoting healthy lifestyles, and ensuring a sustainable future for generations to come.



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