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REVIEW ARTICLE

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FUTURE FOOD INNOVATION THROUGH FUNCTIONAL COOKIES ENRICHED WITH QUINOA, JAMUN SEEDS, AND NATURAL SWEETENERS

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ABSTRACT: Background: As food evolves from a source of sustenance to a tool for prevention and performance, the demand for functional snacks is redefining modern nutrition. Cookies once viewed as indulgent treats are now being reimagined as delivery systems for health. This review explores the revolutionary potential of quinoa, Jamun (*Syzygium cumini*) seeds, and natural sweeteners in creating a new class of functional cookies that align with the future of personalized, preventive, and planet-conscious food systems. Methods: A multidisciplinary review was conducted, bridging nutritional science, food technology, phytochemistry, and consumer behavior. The nutrient composition and bioactive properties of quinoa and Jamun seeds were analyzed through recent clinical and preclinical findings. Natural sweeteners like stevia, jaggery, and date syrup were evaluated for their metabolic benefits and flavor-enhancing roles. Emphasis was placed on formulation challenges, sensory optimization, and the functional synergy between ingredients. Results: Quinoa contributes complete proteins, prebiotic fiber, and essential minerals. Jamun seeds are rich in polyphenols and natural insulin mimetics, offering potential for glycemic control and oxidative stress reduction. Natural sweeteners not only lower the glycemic index but introduce layered flavor profiles. Combined, these ingredients transform cookies into "smart snacks"-balancing taste, texture, and therapeutic potential. Early product prototypes show promising results in antioxidant activity, consumer acceptance, and metabolic wellness. Conclusion: This review positions quinoa, Jamun seeds, and natural sweeteners at the intersection of tradition, science, and innovation. Their application in functional cookies marks a bold step toward food that doesn't just feed-but heals, performs, and inspires.

Keywords: Functional cookies, Quinoa, Jamun seeds, Natural sweeteners, Food innovation

INTRODUCTION

Food has long been transformed as a source of subsistence but in the present times, it has assumed a new role as a source of wellness and prevention of illnesses. The incidences of obesity, type 2 diabetes and cardiovascular issues are rising, which are not only affecting the consumers but also researchers and the food business. Consequently, it is witnessing an increasing need of more holistic nutritional solutions. This has led to increased popularity of functional foods, which provide health benefits in addition to those that can be attributed to their nutritional composition [1]. Snacking is one of the functional food categories that is rapidly turning out to be a strategic point of innovation. Snacks are consumed frequently, even as a replacement of full meals, especially by urban and younger populations. Most of the store-bought foods, including cookies, have a lot of sugar, saturated fat, and processed carbs. This is an opportune time to consider rebranding weary products and making them healthy by incorporating more nutrients without interfering with the taste [2].

The technology that offers such a unique chance in this transition is cookie due to its popularity, flexibility and acceptance by customers. They can be weaned off the empty-calorie sweets to functional wellness foods by replacing the nutrient-poor ingredients with nutrient-rich ones. Three natural ingredients, namely quinoa, Jamun (*Syzygium cumini*) seeds and natural sweeteners with their synergy potential attract attention in this situation.

Quinoa, a pseudo-cereal is reputable because of numerous health advantages it possesses, such as high protein value, numerous minerals, dietary fiber, and essential amino acids. Antidiabetic, antioxidant and anti-inflammatory properties of jamun seeds are attracting scientific attention [3]. The seeds are long used in Ayurvedic medicine. They are rich and renewable agricultural resource, yet these seeds are commonly discarded without any further consideration. It is possible to lower the glycemic load and introduce healthy phytochemicals into the product by using natural sweeteners instead of refined sugar, such as stevia, jaggery, or date syrup [4].

With the intention to produce functional cookies of the new generation, the review will examine the overall potential of quinoa, Jamun seed flour, and natural sweeteners combined. It will discuss their bioactive and nutritional properties, evaluate their functional performance within bakery systems, and will discuss formulation strategies, processing considerations and customer acceptance. This paper envisions a scenario in which cookies will not just be a snack; they will be a health and wellness tool of people due to the involvement of science, sustainability, and sensory pleasure [5].

2. Functional Ingredients for Cookie Innovation

One potential way to improve public health through nutrition is to add functional additives to common foods like cookies. Because of their adaptability and widespread use, cookies are perfect carriers for nutritional enrichment. This section delves into the three main ingredients that were used to create functional cookies with an emphasis on health: quinoa, Jamun seeds, and natural sugars [6].

2.1. Quinoa: A Nutrient-Dense Pseudocereal

Quinoa (*Chenopodium quinoa*) is a miraculous nutritional profile grain that has acquired the name of a super grain in the global arena (Fig. 1). Quinoa is also excellent because it is a complete protein containing all nine essential amino acids, which makes it suitable to the needs of vegetarians and gluten-free people. This is what distinguishes it among most plant sources. Their protein level is great to repair muscles, feel satiated and stabilize the metabolism [7].

Quinoa is as well beneficial to digestion, blood sugar levels and intestinal health due to its fiber richness. Its assortment of micronutrients (B-vitamins, magnesium, potassium, iron, and zinc) additionally aids with overall health [8].

Quinoa contains antioxidant flavonoids, which have demonstrated potential in lessening aggravation and heart defense, including quercetin and kaempferol. It can replace refined wheat flour as a better alternative and thus enhances the nutritional benefits of cookies besides providing structure and texture (Table 1) [9].

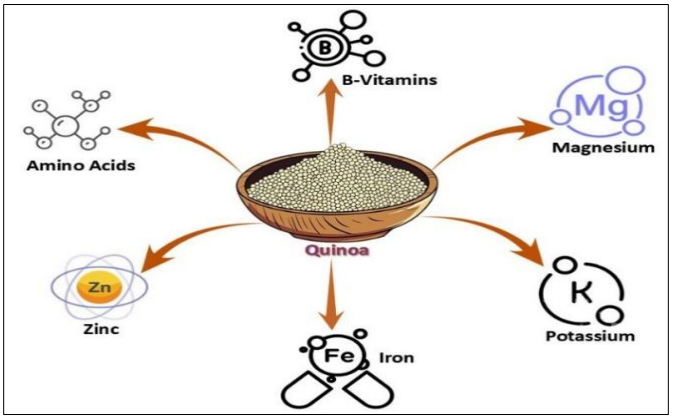

FIG. 1: NUTRITIONAL PROFILE OF QUINOA AND ITS KEY HEALTH BENEFITS

2.2. Jamun Seeds: A Phytochemical Rich Resource

Syzygium cumini (jamun) seeds that are normally discarded are a treasure trove of bioactive chemicals with immense medicinal potential (Fig. 2). Jamun seeds have been long used in Ayurvedic and common medicine and now science has been able to backup these findings [10].

They are potent antioxidants due to their high polyphenols, flavonoid, and ellagic acid levels, but are needed to keep cells safe against free radicals and other cell-wreaking havoc. Also, jamun seeds possess antidiabetic effects by inhibiting the activity of 17-glucosidase, enhancing insulin sensitivity, and managing blood glucose [11].

Their functionality as anti-inflammatory agents along with antibacterial properties increases their value as a functional component. Jamun seeds when made into flour can be incorporated into cookie dough. They contribute a subtle earthy taste, an aesthetical look of its own, and enhance the nutritional and shelf life of the product (Table 1) [12].

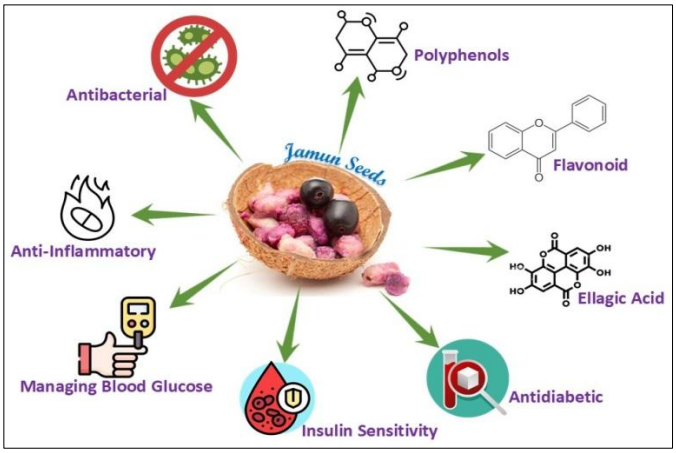

FIG. 2: HEALTH BENEFITS AND BIOACTIVE PROPERTIES OF JAMUN SEEDS

TABLE 1: NUTRITIONAL COMPOSITION OF QUINOA AND JAMUN SEEDS [13]

Nutrient	*Quinoa (per 100g)*	*Jamun Seeds (per 100g)*
Protein	14.1 g	1.9 g
Dietary Fiber	2.8 g	6.0 g
Polyphenols	10 mg	20 mg
Iron	4.6 mg	0.7 mg
Magnesium	64 mg	22 mg
Potassium	563 mg	82 mg
Calcium	47 mg	35 mg
Phosphorus	282 mg	140 mg
Zinc	3.1 mg	0.9 mg
Manganese	2.2 mg	0.2 mg
Copper	0.6 mg	0.1 mg
Sodium	5 mg	4 mg
Vitamin B1 (Thiamine)	0.4 mg	0.2 mg
Vitamin B2 (Riboflavin)	0.3 mg	0.1 mg
Vitamin B3 (Niacin)	1.5 mg	0.6 mg

2.3. Natural Sweeteners as Sugar Alternatives

Refined sugar, which is used as a typical cookie ingredient, is strongly associated with metabolism disorder, including

obesity and diabetes (Table 2). Substituting it with natural sweeteners is a health and sensory benefit [14]. Lower glycemic sugar alternatives like date syrup, stevia, jaggery, coconut sugar or honey, reduce the chance of a rise in blood sugar levels following a meal. Depending on the source, natural alternatives may also consist of trace minerals, antioxidants and prebiotic fibers [15].

These sweeteners normally enhance the overall sensory profile; besides, they affect texture, moisture retention and browning properties of cookies, focusing on functional aspects. As an example, honey and jaggery will provide a caramel-like taste and smooth consistency, whereas stevia offers a calorie-free substitute, which does not destroy when heated [16].

Choosing the right combination and ratio of sweeteners is essential to maintain consumer acceptability and achieve desirable health outcomes.

TABLE 2: NATURAL SWEETENERS AND THEIR FUNCTIONAL ROLES IN COOKIES [17]

Sweetener	*Glycemic Index*	*Key Nutritional Benefits*	*Sensory Impact*
Stevia	~0	No calories, antioxidants	Possible aftertaste
Jaggery	50-60	Minerals, antioxidants	Caramel flavor
Date Syrup	~42	Vitamins, fiber, minerals	Rich fruity sweetness
Honey	~55	Antioxidants, antimicrobial	Sweet, floral flavor
Coconut Sugar	35	Minerals, antioxidants	Mild caramel flavor
Maple Syrup	~54	Vitamins, minerals	Sweet, maple flavor
Agave Nectar	~15	Low glycemic, antioxidants	Mild, neutral sweetness
Molasses	~55	Iron, calcium, antioxidants	Rich, robust flavor
Brown Rice Syrup	~98	Vitamins, minerals	Mild, neutral sweetness
Monk Fruit	~0	No calories, antioxidants	Strong sweetness without aftertaste
Yacon Syrup	~1	Prebiotic, low glycemic	Mild, caramel-like sweetness
Palm Sugar	~35	Minerals, antioxidants	Mild caramel flavor
Birch Syrup	~35	Antioxidants, low glycemic	Sweet, slightly minty flavor
Blackstrap Molasses	~55	Iron, calcium, antioxidants	Strong, slightly bitter flavor
Brown Sugar	~64	Minerals, trace vitamins	Soft, molasses flavor

3. Functional Cookie Formulation

Formulation of functional cookies is not simply about substituting unhealthy ingredients with healthier options. Understanding how the ingredients will react to each other during mixing, baking and storage of the recipe is the key (Fig. 3). When bakers use natural sweeteners, quinoa flour or Jamun seed powder in their recipes they have to make adjustments to ensure that their products taste, feel and are healthy as per the expectations of their customers. In order to produce cookies that are more nutritious, this section reviews some convenient options of substitution and processing concerns [18].

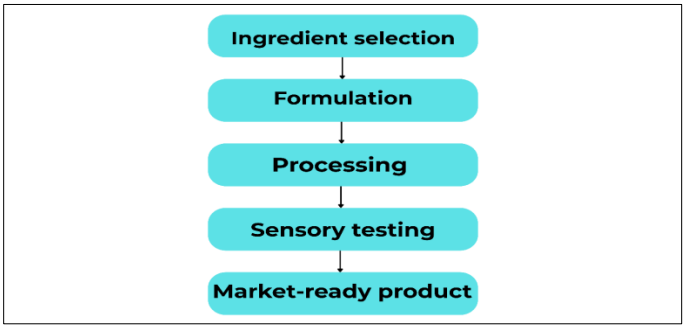

FIG. 3: SCHEMATIC OF FUNCTIONAL COOKIE DEVELOPMENT PROCESS [19]

3.1. Ingredient Substitution Strategies

Replacing Wheat Flour with Quinoa Flour

Refined wheat flour cookies are structurally sound cookies, but not very healthy. Quinoa flour is an excellent alternative as it is rich in protein, fibre and minerals, including zinc, iron and magnesium. Sadly, quinoa lacks the viscoelastic properties required to make dough because it is inherently gluten-free [20]. Using it, your cookies may not spread as much and be crumbly. To compensate, inventors often include hydrocolloids (such as xanthan gum) or mix in a little starch (such as corn or tapioca) with quinoa flour to stiffen it. In a majority of cookie recipes, quinoa can replace 30-60 percent of the wheat flour using the appropriate binding agents. It will not be yucky, either [21].

Incorporating Jamun Seed Powder

Jamun seed powder also contains unique phytochemicals such as gallic acid, flavonoids and ellagic acid. This ingredient is specifically useful in functional cookies that are developed to maintain blood sugar level. Its gritty nature and somewhat bitter personality might prove to be an issue at higher dosages [22]. To make it a healthier recipe that will not compromise on the taste, replace 5-10 percent of the flour with jamun seed powder. To mellow its astringency and to complement the other flavors in cookies, consider adding chocolate, nuts, or spices such as ginger or cinnamon [23].

Replacing Refined Sugar with Natural Sweeteners

Some of the natural sweeteners include stevia, honey, jaggery, date syrup and coconut sugar which are becoming popular because of their nutrition and low GI. Stevia is calorie-free and excellent in diabetic-friendly cooking, although it might incorporate an aftertaste. Jaggery and coconut sugar, on the other hand, bring minerals and antioxidants along with a caramelised taste [24]. These sweeteners affect moisture retention and Maillard browning when used in baking. A

combination of ingredients such as jaggery to provide structure and stevia to provide sweetness would result in a synergistic mixture to meet both requirements. To make these substitutes prevent the spreading or sogginess of cookies, the recipe developers will have to experiment with the proportions of liquids and the baking times [25].

3.2. Processing and Baking Considerations

Dough Rheology and Baking Behavior

The dough's capabilities in terms of water absorption, flexibility, and handling are greatly affected by functional additives. The hydration requirement is higher for quinoa flour because it absorbs more water than refined flour. Dough may become less malleable and stiffer due to the fibrous mass that jamun seed powder adds [26]. These ingredients can make doughs denser and less spreadable, thus to make them workable, you usually have to add more fat or emulsifiers (like lecithin) to make them smoother and easier to work with. In order to achieve uniform shape and bite in cookie formulations, it is helpful to conduct texture analyses and spread ratio studies [27].

Thermal Stability of Bioactives

The polyphenols and anthocyanins that are beneficial to Jamun seeds may be destroyed when baked because they are very heat sensitive. They can be baked at controlled temperatures (lower temps for longer periods) to keep their functionality. Encasing delicate bioactives in microcapsules can sometimes make them more stable and prevent them from being damaged by heat processing [28]. But quinoa's contents, especially its protein and mineral content, do not change or lose their nutritious value even after baking. Browning and crispness are affected by the interplay of sweeteners and baking temperature; this relationship needs to be optimized so that consumers are satisfied [29].

4. Nutritional and Health Benefits

Enhanced Nutrient Profile Compared to Conventional Cookies

Traditional cookies have a lot of sugar, refined flour, and saturated fat, so they are full of calories but not much nutrition. On the other hand, functional cookies made with natural sugars, quinoa, and Jamun seed powder have a far better nutrients profile. An excellent plant-based protein source, quinoa provides a complete protein that includes all of the essential amino acids [30]. Minerals like magnesium, iron, potassium, and B vitamins are also present. Phytochemicals such as flavonoids and ellagic acid are present in abundance in jamun seed powder, which is frequently disregarded when prepared meals. The seeds themselves are a good source of fiber and trace minerals. Stevia, jaggery, and honey are natural sweeteners that not only make the cookies lower in glycemic load, but they also offer antioxidants and trace nutrients that refined sugar takes away. Taken as a whole, these components elevate cookies to the level of useful, nutrient-dense snacks [31].

Regulation of Glycemic Response and Antioxidant Activity

These beneficial cookies can aid with blood glucose regulation, which is a big plus for your health. Jamun seed bioactives, including jamboline and polyphenols, along with low-glycemic sweeteners, help to reduce insulin resistance and slow down glucose absorption. People with diabetes or who are trying to control their blood sugar levels can enjoy these cookies because of this [32]. The product's capacity to fight oxidative stress, a key factor in the aging process and the development of chronic diseases, is further improved by the addition of antioxidant-rich substances such as quinoa and Jamun seeds. Antioxidants help the immune system and shield cells from damage [33].

Fiber-Rich Composition for Digestive and Metabolic Health

The fiber content of functional cookies is much higher compared to the regular ones. With their soluble and insoluble fibers, quinoa and jamun seed powder promote digestive health, a balanced microbiota in the stomach, and feelings of fullness for longer. There is some evidence that lowering cholesterol and increasing fiber consumption can help with intestinal regularity. Fasting for longer periods of time after eating high-fiber foods helps stabilize blood sugar levels and decreases appetite between meals from a metabolic perspective [34].

Potential in Preventing Lifestyle-Related Diseases

These practical cookies can be a useful weapon in the fight against non-communicable diseases thanks to the quinoa, Jamun seeds, and natural sweeteners that make them up. For example, their high fiber content, antioxidant activity, and low glycemic impact make them useful for managing diabetes and preventing obesity [35]. There may be an improvement in cardiovascular health due to the availability of heart-friendly substances including polyphenols and magnesium. In addition, these nutrients may work together to reduce inflammation, which is at the heart of many long-term health issues, such as metabolic syndrome and several malignancies [36].

5. Sensory and Consumer Acceptability

Challenges in Texture, Flavor, and Appearance

While functional additives have the potential to improve cookies' nutritional value, one of the greatest challenges in developing new products is keeping the sensory qualities that consumers like. Try making these cookies with quinoa flour instead of refined wheat flour and some Jamun seed powder for a thicker, less crunchy texture. Quinoa's strong protein and fiber content changes the dough's texture and can make it seem grainier. Additionally, using large amounts of jamun seed powder, which is fibrous by nature, could result in a texture that is rough or slightly sandy [37]. Some natural sweeteners, like stevia, have a strong aftertaste, and some ingredients, like jamun seed powder, can add bitterness or astringency, which might impact how consumers perceive the flavor. The cookie's

color might shift as well; people who are not familiar with Jamun powder or jaggery might think the deeper shades are "overbaked" or strange [38].

Optimization Techniques for Taste and Texture

Several optimization strategies have been developed to take these sensory challenges into account. You can hide the earthy bitterness and bitterness of jamun seed powder by adding other flavors like dried fruits, chocolate, cinnamon, or vanilla syrup. Aside from making the snack more appetizing, these modifications are in line with what customers anticipate from sweet snacks [39]. To change the texture and make the cookies lighter and crumblier, mix quinoa flour with softer gluten-free flours like oat or rice flour. For natural sweeteners, it is best to mix low-calorie and sugar-rich options (such stevia with dates or honey) to provide a balanced sweetness without any bad aftertastes [40].

Consumer Perception and Acceptance

Consumers are becoming more receptive to healthier snack options, according to functional cookie research. This is especially true when these options are marketed as natural, high-protein, or diabetes-friendly. Nevertheless, sensory clues like look, smell, and taste continue to govern first impressions. Achieving acceptable taste scores can be achieved by combining familiar flavors with moderate inclusion levels of quinoa and Jamun seed powder, according to trials [41]. Functional benefit-focused marketing (such as "supports blood sugar," "rich in antioxidants," or "no added sugar") also has a favorable effect on consumer perceptions. Particularly among diabetics, health-conscious people, and fitness enthusiasts, clear labeling and educational outreach can boost acceptability even further [42].

6. Regulatory and Safety Considerations
Food Safety and Shelf Life

Functioning cookies must first be tested for stability and safety before they can be sold. Natural sweeteners and jamun seed powder are two examples of unconventional substances that could affect the product's oxidative stability, moisture content, and microbiological load. Take jamun seed powder as an example [43]. Its high polyphenol content gives it potential natural preservation benefits, but how it interacts with lipids or proteins can impact how long it stays fresh. Because of its increased lipid content, quinoa flour has a higher rancidity risk than refined wheat flour. In order to find the best storage conditions and packaging materials, manufacturers need perform appropriate shelf-life testing, which includes monitoring water activity (a_w), lipid oxidation, and microbiological stability. In order to maintain customer confidence, it is vital to ensure that these cookies stay safe and sensory-flattering throughout their shelf life [44].

Allergenicity and Dosage Limits

Though quinoa is typically thought to be hypoallergenic, there have been reports of allergy reactions, mostly caused by saponins found in the seed coat. Washing or heat treatment are two processing procedures that can lessen them. Jamun seed powder has a long history of usage in traditional medicine, but it has only recently found a home in popular cuisine [45]. Because of its powerful bioactive components, which may exert pharmacological effects at large doses, careful dosing is essential. Natural sweeteners like stevia also have limits set by regulators to prevent off-flavors and gastrointestinal problems. When combining various functional components, it is crucial that formulators assess acceptable daily intake levels and take into account any synergistic effects [46].

Current Status in Food Regulations (FSSAI, FDA, EFSA)

From a regulatory perspective, functional cookies are a type of health food, which is subject to increased scrutiny for the veracity of health claims, the safety of ingredients, and the correctness of labeling. When it comes to general food categories, the Food Safety and Standards Authority of India (FSSAI) approves quinoa and jamun, but only if the ingredients are properly labeled and within the allowed additions [47]. There is currently a lack of standardization when it comes to using jamun seeds in functional meals, thus to get their products approved, developers may have to present safety data or ingredient dossiers. The FDA has given the GRAS designation to quinoa and Rebaudioside A, an extract from stevia, to the two foods in the United States. Although safety studies are necessary to support its utilization, the FDA has not yet approved jamun seeds as a GRAS food additive. Health claims are subject to particularly stringent regulation by the European Food Safety Authority (EFSA). Clinical evidence and claims approved by the EFSA are necessary for any product that claims to regulate blood sugar or provide antioxidant effects [48].

7. Market Potential and Commercial Perspectives
Trends in Functional and Clean-Label Snacks

There has been meteoric rise in the demand for functional and clean-label snacks, driven by the worldwide trend toward health and wellbeing. Snacking options that are nutrient dense, artificial additive free, and suitable for specific diets (such as gluten-free, vegan, or diabetic-friendly) are in high demand as consumers become more conscious of the link between food and long-term health [49]. This fad is well-suited to functional cookies, which may be created using quinoa, Jamun seeds, and natural sugars (Fig. 4). Features like "rich in antioxidants," "plant-based," "high in protein," and "low glycemic" are especially attractive to health-conscious millennials, fitness fanatics, and anyone dealing with long-term health issues like excessive weight or diabetes [50].

Market Size and Innovation Opportunities

Functional bakery goods are part of a rapidly expanding area of the functional food market, which is expected to top USD 275 billion globally by 2030. Among them, functional cookies and other healthy snack options are becoming increasingly popular. The perceived health benefits and variety of quinoa-

based products are driving their sales to double-digit annual rates [51]. At the same time, new opportunities for sustainability-driven innovation and local resource usage are opening up with the growing use of indigenous components like Jamun seeds in value-added goods. Additionally, there is unrealized potential in catering to certain demographics with tailored cookies that have specific health benefits, such regulating blood sugar, promoting intestinal health, or enhancing cognitive function. This may be done for athletes, seniors, or youngsters [52].

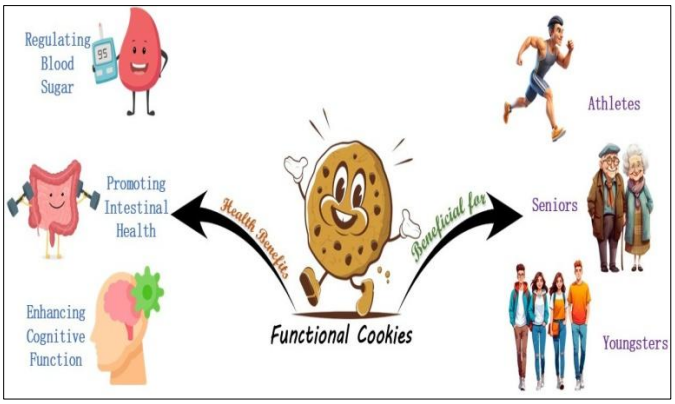

FIG. 4: HEALTH BENEFITS AND TARGET DEMOGRAPHICS OF FUNCTIONAL COOKIES

Case Studies and Emerging Products

This opportunity is being investigated by a number of new and existing food businesses. Cookie makers in India and Southeast Asia, for instance, have started offering diabetic-friendly varieties that include stevia and classic Ayurvedic ingredients like jamun [53]. You can find quinoa cookies branded with "supergrain" in most health food stores and wellness website in the US and Europe these days. Still, innovators can benefit from being the first to market as jamun seed powder integration is still new and underused. Sustainable sourcing, functional health benefits, and narrative surrounding traditional ingredients are becoming more important for organizations looking to attract eco-conscious and wellness-focused consumers [54].

8. Challenges and Future Directions

Technical Limitations in Formulation and Stability

Several technological hurdles need to be surmounted before quinoa, Jamun seeds, and natural sweeteners can be used in cookies, despite their potential functional and nutritional advantages. If you want to make cookies that do not spread as much or have a denser texture, try using quinoa flour instead of wheat. It changes the dough's structure and elasticity. In the same vein, adding too much jamun seed powder could alter the texture of the food and make it taste bitter [55]. Product quality and consistency are further complicated by the fact that various natural sweeteners bring diverse flavors and levels of moisture retention to the table. Additionally, there are concerns regarding the preservation of nutrients during baking due to the heat sensitivity of bioactive components, particularly the antioxidants found in Jamun seeds. To overcome these obstacles, optimal processing methods and formulation strategies are required, such as regulated baking conditions, component blending, and encapsulation [56].

Need for Clinical Validation of Health Claims

Despite the promising therapeutic potential of these substances, as shown in in vitro and animal research, there is a dearth of strong clinical evidence to back up the health claims made by functional cookie marketers. This is especially true when it comes to blood glucose management, antioxidant effects, and digestive health [57]. Human clinical trials assessing the real health effects of frequent consumption of such cookies are urgently required for greater consumer confidence and regulatory approval. Product legitimacy and opportunities for international distribution can be enhanced by validation of claims, which can aid in obtaining approvals from agencies such as FSSAI, FDA, and EFSA [58].

Sustainability and Cost-Efficiency of Ingredients

The long-term viability of getting functional ingredients from an economic and ecological perspective is another obstacle. Despite its high nutritional value, quinoa is difficult to grow in some areas and can be quite pricey. Similarly, in order to gather and process Jamun seeds on a big scale—which are frequently seen as a waste product—it is necessary to create infrastructure and supply chains in order to guarantee consistent quality and availability [59]. There may be regional and seasonal limitations for natural sweeteners as well, such as honey and coconut sugar. Sustainable farming practices, local ingredient procurement, and cost-effective processing methods should be the emphasis of future endeavors to guarantee scalability and affordability. Improving environmental and social sustainability can be achieved through exploring underutilized regional crops or establishing farmer-processor relationships [60].

CONCLUSION

The development of functional cookies using quinoa, Jamun seeds, and natural sweeteners represents a promising intersection of nutrition science, traditional knowledge, and modern food innovation. These ingredients individually contribute significant health benefits quinoa for its high-quality protein and micronutrients, Jamun seeds for their antioxidant and antidiabetic properties, and natural sweeteners for reducing glycemic impact without compromising taste. When combined, they offer a unique platform for creating cookies that go beyond indulgence to support wellness and preventive health.

Throughout this review, it is evident that functional cookies can serve as effective vehicles for delivering essential nutrients and bioactive compounds in a format that is both familiar and enjoyable. They address critical consumer needs for clean-label, nutrient-rich, and disease-supportive foods. However, technical challenges in formulation, sensory

acceptability, and ingredient stability must be addressed through continued research and product optimization.

Looking ahead, such cookies have the potential to play a transformative role in personalized nutrition, offering tailored benefits for specific health concerns like diabetes, obesity, and digestive disorders. With proper clinical validation and sustainable ingredient sourcing, they can become part of mainstream dietary solutions. As the food industry shifts toward preventive health and functional innovation, these cookies could emerge not only as popular snack choices but also as tools for long-term wellness and food system sustainability.

In essence, functional cookies made with quinoa, Jamun seeds, and natural sweeteners symbolize the future of smart snacking where health, taste, and innovation work hand in hand.

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