



A COMPREHENSIVE REVIEW ON THE PREPARATION AND DEVELOPMENT OF PROBIOTIC MIXED FRUIT JELLY CANDY

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ABSTRACT

In recent years, probiotics—live microorganisms that confer health benefits when consumed in sufficient amounts—have become pivotal in promoting gut health. Their benefits, including enhanced digestion, alleviation of lactose intolerance, and disease prevention, have long been recognized, with early contributions from Tissier's research on bifidobacteria in breastfed infants. The combination of probiotics with prebiotics has garnered increasing attention for its potential to further support gut microbiota. Capitalizing on this trend, the functional food market has seen the emergence of innovative products offering health benefits beyond basic nutrition. This paper introduces an innovative product: Probiotic Encapsulated Mixed Fruit Jelly Candy, a functional treat that combines probiotics with the health-promoting properties of wood apple, pineapple, and jaggery. Wood apple, known for its antioxidant, antimicrobial, and prebiotic properties, enhances probiotic benefits, while pineapple's bromelain supports digestion. Jaggery, a nutrient-rich natural sweetener, contributes essential minerals like iron and calcium. This candy offers a flavorful, nutrient-packed alternative to traditional sweets, supporting digestive health, immune function, and overall well-being. The product is created by carefully processing fruit pulps, jaggery, and encapsulated probiotics to preserve their efficacy, resulting in a chewy, tangy-sweet jelly that blends taste and health benefits. By incorporating probiotics with nutrient-dense ingredients, this candy redefines the role of functional foods in modern diets, offering consumers a convenient and enjoyable way to improve health through daily consumption.

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INTRODUCTION

Probiotics, the beneficial live microorganisms known for their positive impact on health, have emerged as a cornerstone of modern wellness, with a particular focus on gut health. The journey of probiotics, which began with early research by Tissier, who linked gut microbiota to infant health, has evolved significantly over the past century. Today, probiotics are recognized for their broad range of health benefits, including improved digestion, enhanced immunity, and reduced risk of chronic diseases. As consumers become increasingly health-conscious, the demand for functional foods—those that offer more than just basic nutrition—has surged, particularly for those enriched with probiotics.

Probiotics are live microorganisms that, when consumed in adequate amounts, provide a variety of health benefits, particularly in promoting gut health. Since Tissier's pioneering work, scientific understanding of probiotics has advanced considerably. Early research faced challenges such as strain specificity and the difficulty of cultivating probiotics outside of human milk. However, subsequent studies have yielded strong evidence supporting the positive effects of probiotics, including improvements in intestinal health, alleviation of lactose intolerance, and reduced risks of diseases. Strains of Lactobacilli and Bifidobacteria are now commonly available for human use, and their applications in health have expanded significantly.

The functional food market, especially in regions like Japan, Europe, and the United States, has experienced rapid growth, with probiotics at the forefront. According to the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), probiotics are live microorganisms that confer health benefits when consumed in adequate amounts as part of food (Hotel & Cordoba, 2001). A growing trend has

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seen probiotics being paired with prebiotics—nondigestible food substances that promote the growth and activity of beneficial gut microorganisms. This combination of probiotics and prebiotics is sometimes referred to as “conbiotics” or “symbiotics” (Hibson & Roberfroid, 1995; Berg, 1998). While prebiotics show promise for health benefits, further research is needed to fully understand their role (Ziemer & Gibson, 1998; Granato et al., 2010).

Probiotics are garnering significant attention for their potential to reduce cancer risk by modulating gut microbiota and enhancing immune responses (Hirayama & Rafter, 1999; Kumar et al., 2010). They may also contribute to heart health by lowering serum cholesterol and blood pressure (Sanders, 1999) and improve treatment outcomes for conditions such as bacterial vaginosis by supporting a healthy vaginal microbiota (Falagas et al., 2007).

One particularly exciting development in the functional food space is the Probiotic Encapsulated Mix Fruit Jelly Candy. This innovative product combines the gut-health benefits of probiotics with the natural goodness of wood apple, pineapple, and jaggery, offering a delightful and health-conscious treat. This candy not only serves as a delicious snack but also supports digestive health while providing essential nutrients. Sweetened with jaggery, a healthier alternative to refined sugars, the treat is rich in minerals such as iron, magnesium, and potassium. The probiotics are encapsulated to ensure they survive stomach acidity and reach the intestines, providing maximum digestive benefits.

The refreshing tropical flavors of wood apple and pineapple, along with the detoxifying and energy-boosting properties of jaggery, make this candy an ideal balance of indulgence and well-being. Whether you're seeking a satisfying treat or a wellness boost, this probiotic-packed candy provides a fun and flavorful way to promote gut health.

Jaggery, also known as Gur, is a natural sweetener derived from the concentrated juices of sugarcane or palm trees. It boasts a unique flavor that blends brown sugar with molasses and is packed with essential nutrients. Unlike refined sugars, jaggery is rich in vitamins and minerals, particularly iron and copper, making it a healthier alternative. Jaggery is believed to offer numerous health benefits, including supporting iron levels, preventing anemia, purifying blood, regulating liver function, and providing a steady energy source. It is produced through more natural processes than white sugar, preserving its nutritional integrity.

In addition to its taste, jaggery is known for its digestive benefits, functioning as a mild laxative and promoting regular bowel movements (Shahi, 1999). Unlike refined sugar, which causes rapid blood sugar spikes and crashes, jaggery releases energy slowly, helping to maintain consistent energy levels throughout the day. Its high iron content also contributes to preventing anemia, making it a more nutritious sweetener option.

When compared to refined sugar, jaggery stands out as a more nutritious and balanced sweetener. Refined sugar provides only empty calories, whereas jaggery is packed with essential nutrients like iron, calcium, magnesium, and potassium, all of which support vital bodily functions such as bone health,

blood health, and heart health (FSSAI, 2018). Jaggery is also a source of antioxidants and plays a key role in digestion by regulating bowel movements (Shahi, 1999). Additionally, its complex sugar composition ensures a gradual release of energy, avoiding the spikes and crashes associated with refined sugar. In contrast, excessive consumption of refined sugar can contribute to various health issues (Nath et al., 2015).

Ingredients and Preparation Process

Key Ingredients

Wood Apple (*Feronia limonia*): A Nutrient-Rich, Medicinal Superfruit

Wood apple, scientifically known as *Feronia limonia*, is a remarkable and often overlooked fruit that has earned its place as a potent health ally. Native to the semi-arid regions of India, this hardy, drought-resistant fruit thrives in challenging climates, including the dry landscapes of southern Maharashtra, West Bengal, and Madhya Pradesh. Its ability to flourish in areas where other crops may struggle makes it a vital resource for communities in resource-scarce regions (Veeraraghavathatham et al., 1996).

The wood apple fruit ranges in size from 2 to 5 inches in diameter, encased in a tough, greyish-white rind. Upon opening, the pulp reveals a striking brown, mealy texture with a resinous, musky aroma that immediately sets it apart from other fruits. While the unripe fruit tends to be acidic, the ripe fruit develops a more complex flavor profile that blends sweet and tangy notes. With pulp comprising about 36% of the fruit's total mass, the wood apple is packed with essential nutrients, including vitamins and minerals such as calcium, iron, and vitamin C. It also boasts an impressive shelf life of up to two months when refrigerated, making it an attractive option for long-term storage and potential commercial use (Shyamala Devi & Kulkarni, 2018).

Wood apple's true value lies in its medicinal properties, which have been highly regarded in traditional Indian medicine for centuries. The fruit is particularly known for supporting liver health, promoting digestion, and providing relief from ailments like diarrhea, dysentery, and sore throats. It possesses anti-inflammatory, antimicrobial, and hepato-protective qualities, which further enhance its status as a powerful health-promoting ingredient (Shreya et al., 2020). Additionally, wood apple is believed to have prebiotic potential, which can support gut health by fostering the growth of beneficial microorganisms in the digestive tract. This makes it especially promising when paired with probiotics, creating a synergistic effect that enhances overall digestive wellness (Srivastava & Kumar, 2002).

Beyond its vitamins and minerals, wood apple is a powerhouse of bioactive compounds, including phenols, flavonoids, and tannins. These compounds are known for their antioxidant and antimicrobial properties, which contribute to reducing oxidative stress, combating inflammation, and bolstering immune function. The combination of these bioactive components with probiotics offers an exciting potential for enhancing digestive health and supporting a balanced gut microbiome (Singh et al., 2009).

Wood apple's unique flavor profile, a blend of sweet and tangy

with an underlying musky aroma, offers an exciting opportunity for culinary innovation. Its distinct taste can enhance a variety of foods and beverages, making it an ideal candidate for use in functional foods, such as probiotic jellies. These products not only mask the sometimes acquired taste of probiotics but also provide a more enjoyable and health-conscious option for consumers.

The versatility of wood apple extends beyond simple fruit consumption, as it holds great potential for the development of value-added products like jams, jellies, and beverages. Its richness in bioactive compounds and health-promoting properties makes it a valuable ingredient in the functional food industry, offering an opportunity to transform the way we approach health and wellness through food (Pal et al., 2019).

Pineapple: A Nutrient-Packed, Functional Fruit for Probiotic Jelly

Pineapple is one of the world's most popular tropical fruits, widely cultivated in regions such as South America. Renowned for its vibrant flavor and tropical aroma, pineapple ranks as the third most produced tropical fruit, following bananas and citrus (Abu Bakar et al., 2013). Its rich nutritional profile and bioactive compounds, such as antioxidants and bromelain, make it an excellent candidate for inclusion in probiotic-based products, particularly probiotic jelly formulations, where it contributes both flavor and health benefits.

Pineapple is a rich source of essential vitamins and minerals, most notably vitamin C, which is essential for supporting immune function and protecting cells from oxidative damage. Additionally, pineapple's high fiber content promotes digestive health and supports overall gut function, making it a beneficial addition to probiotic products. The fruit also contains vital minerals such as manganese, magnesium, and copper, which are integral to energy production and bone health (ANSES, 2020). These nutrients elevate the nutritional value and functionality of probiotic jelly, ensuring that the product not only supports gut health but also provides broader health benefits, including enhanced immune function and metabolic support.

Pineapple contains several bioactive compounds, particularly bromelain, which play a crucial role in supporting digestive health. Bromelain, a proteolytic enzyme, aids digestion by breaking down proteins, enhancing the effectiveness of probiotic cultures within the jelly (Hossain & Rahman, 2011). Moreover, pineapple is rich in phenolic compounds and flavonoids, which contribute to its potent antioxidant properties. These compounds help mitigate inflammation and oxidative stress, further aligning with the therapeutic goals of probiotics. Additionally, these bioactive compounds help preserve the viability of probiotics during storage, ensuring that the beneficial effects of both the fruit and the probiotics remain intact.

The anti-inflammatory properties of pineapple further enhance its value as an ingredient in probiotic jelly. By reducing inflammation in the gastrointestinal tract, pineapple facilitates smoother digestion, while its antioxidants protect gut cells from oxidative damage caused by free radicals. This combination of anti-inflammatory and antioxidant effects, along with its support for gut health, makes pineapple an ideal ingredient for probiotic jelly, offering dual benefits for consumers. This

synergy between pineapple and probiotics creates a powerful functional food that promotes digestive wellness while reducing inflammation.

In addition to its health benefits, pineapple adds a refreshing, distinct flavor to probiotic jelly. The natural sweetness and tropical aroma of pineapple enhance the overall taste of the product, improving its palatability and encouraging regular consumption. Its pleasing flavor profile can effectively mask the sometimes-acquired taste of probiotics, thereby increasing consumer acceptance and making the product more enjoyable. Furthermore, pineapple's ability to enhance flavor without the need for refined sugars makes it an ideal choice for health-conscious consumers seeking nutritious alternatives to conventional sugary snacks.

Jaggery: A Natural Sweetener with Health Benefits for Probiotic Jelly

Jaggery, a traditional unrefined sugar derived from sugarcane or palm juices, holds cultural significance in many regions around the world. Unlike refined white sugar, jaggery retains a rich nutritional profile, providing essential minerals such as iron, calcium, magnesium, and phosphorus, alongside a variety of vitamins, including A, B-complex, and C (Shahi, 1999; Sahu & Paul, 1998). Its distinctive, aromatic flavor and slower digestion compared to refined sugars make it a healthier alternative, offering sustained energy without causing the rapid blood sugar spikes commonly associated with processed sugars.

The inclusion of jaggery in probiotic jelly candy not only enhances the flavor profile but also offers numerous health benefits. Its high iron content supports blood purification, while also promoting digestive health, liver function, and alleviating constipation (Kumar, 1999; Gautam et al., 2008). Moreover, jaggery's role in supporting digestion complements the benefits of probiotics, making it an ideal ingredient in functional food formulations. By contributing to digestive wellness, jaggery enhances the overall efficacy of probiotic jelly candy.

Jaggery's low moisture content and crystalline structure help improve the texture of probiotic jelly candy. Additionally, its slight acidity provides an optimal pH balance for the growth and viability of probiotic cultures during the manufacturing process. By using jaggery as a natural, minimally processed sweetener, manufacturers can ensure that the final product maintains the health-promoting properties of both the probiotics and the nutrient-dense ingredients. This combination offers a clean, wholesome alternative to refined sugars, aligning with the growing consumer preference for natural and minimally processed food options.

In addition to its numerous nutritional benefits, jaggery also functions as a prebiotic, a substance that supports the growth and activity of beneficial gut bacteria. By nourishing these microorganisms, jaggery works synergistically with probiotics, enhancing the digestive and immune-boosting effects of the jelly. This prebiotic action helps optimize the benefits of probiotics, ensuring a balanced and thriving gut microbiome. The symbiotic relationship between jaggery and probiotics maximizes the health benefits of the product, offering consumers a functional food that promotes digestive health while providing sustained energy.

Jaggery's traditional appeal, particularly in regions where it is a staple sweetener, further boosts the acceptance of probiotic jelly candy. By incorporating jaggery, manufacturers can cater to consumers seeking natural, minimally processed sweeteners that also deliver added health benefits. This fusion of flavor, tradition, and health makes jaggery a standout ingredient in the creation of probiotic jelly candy, ensuring that the product is both delicious and functional.

Step-by-Step Preparation

Fruit Preparation

Extraction of Wood Apple and Pineapple Pulp

For wood apple, the outer shell is cracked, and the flesh is homogenized with water, heated to 60°C for 30 minutes, then filtered to yield smooth pulp. Similarly, pineapple is peeled, cut, blended, and filtered to obtain smooth pulp, ready for use in the jelly candy mixture.

Jaggery Processing: Melting and Incorporation

Jaggery is melted in a separate vessel and combined with the prepared fruit pulp. The mixture is heated and stirred continuously to ensure uniform integration, creating a smooth blend.

Encapsulation and Mixing: Addition of Probiotics

After blending the fruit pulp and jaggery mixture, it is cooled to 45°C, and probiotics are added. The probiotics are evenly distributed to maintain potency and efficacy in the final product.

Setting the Jelly Candy: Achieving Desired Texture

The mixture is poured into molds and cooled to set. Once the jelly reaches the desired consistency, it is cut into cubes and stored under optimal conditions to preserve quality and freshness.

HEALTH BENEFITS

Probiotics for Gut Health

- **Improved Digestion:** Probiotics play a crucial role in maintaining a healthy balance of gut bacteria. By promoting the growth of beneficial bacteria, probiotics help improve digestion, prevent constipation, and reduce symptoms of irritable bowel syndrome (IBS), such as bloating, diarrhea, and gas. Additionally, probiotics can help break down food and absorb nutrients more efficiently, leading to better overall digestive health (Toma and Pokrotnieks, 2006; Salminen et al., 2005).
- **Enhanced Immunity:** The gut is a key component of the immune system. Probiotics contribute to the body's immune defense by enhancing the production of certain antibodies and increasing the activity of immune cells like macrophages and T lymphocytes. They also help to maintain the gut barrier function, which protects against harmful pathogens (Ziener and Gibson, 1998; Granato et al., 2010). Regular intake of probiotics may lead to fewer infections and better overall immunity.
- **Reduced Disease Risk:** Research indicates that probiotics can play a role in reducing the risk of chronic diseases, including certain types of cancer, particularly gastrointestinal cancers. They help by

modulating the intestinal microbiota and boosting immune response. In addition, they reduce the risk of gastrointestinal disorders such as inflammatory bowel disease (IBD) and irritable bowel syndrome (IBS) (Hirayama and Rafter, 1999; Kumar et al., 2010). Probiotics have also been linked to reduced symptoms of lactose intolerance, enabling individuals to better digest dairy products (Sanders, 1999).

- **Heart Health:** Probiotics may have a protective effect on heart health. Studies have shown that certain strains of probiotics can help reduce total and LDL cholesterol levels. This may be beneficial in preventing cardiovascular disease, as high cholesterol is a known risk factor for heart attacks and strokes. Additionally, probiotics have been shown to lower blood pressure, offering another heart-healthy benefit (Sanders, 1999). The modulation of gut bacteria by probiotics has also been linked to improved blood circulation and cardiovascular function.
- **Women's Health:** In women, probiotics have shown promise in managing gynecological health. They support the natural vaginal microbiota, preventing or treating conditions like bacterial vaginosis (BV) and yeast infections. Some studies have also suggested that probiotics can improve the treatment outcomes of urinary tract infections (UTIs) by balancing the vaginal flora and preventing pathogen overgrowth (Falagas et al., 2007).

Nutritional Value of Jaggery

- **Iron and Copper:** Jaggery is particularly rich in iron and copper, both of which are vital for the production of red blood cells and prevention of anemia. Iron helps in transporting oxygen throughout the body, while copper is involved in several enzymatic processes that regulate iron absorption and utilization. Jaggery's iron content is significantly higher than that of refined sugar, making it a better choice for individuals at risk of iron deficiency (FSSAI, 2018; Shahi, 1999). It is particularly beneficial for pregnant women, children, and people suffering from anemia.
- **Essential Minerals:** In addition to iron and copper, jaggery contains calcium, magnesium, and potassium. These minerals are crucial for various bodily functions. Calcium contributes to strong bones and teeth, magnesium supports over 300 biochemical reactions in the body, and potassium helps regulate blood pressure and fluid balance. The combination of these minerals makes jaggery a wholesome alternative to refined sugar (FSSAI, 2018).
- **Energy Boost:** Unlike refined sugar, which causes rapid blood sugar spikes followed by crashes, jaggery provides a more stable and gradual release of energy due to its complex sugar composition. This helps maintain energy levels throughout the day and reduces the likelihood of fatigue or irritability. Jaggery also promotes a healthy metabolism and may assist in weight management by preventing the excessive hunger pangs caused by sugar fluctuations

(Nath et al., 2015).

- **Digestive Support:** Jaggery has long been used in traditional medicine for its digestive benefits. It acts as a mild laxative, aiding in the smooth passage of stools and preventing constipation. It also helps in cleansing the stomach by flushing out harmful toxins and impurities. Jaggery's digestive benefits make it an excellent choice for those with digestive issues, offering relief without the harsh effects of over-the-counter laxatives (Shahi, 1999).
- **Blood Purification:** Jaggery is traditionally used as a natural detoxifier, helping purify the blood by removing toxins and supporting liver function. Its antioxidant properties help neutralize free radicals in the bloodstream, reducing the risk of oxidative stress and promoting overall health (FSSAI, 2018). This makes jaggery an ideal addition to a detoxifying diet.

Health Benefits of Wood Apple and Pineapple

Wood Apple:

- **Digestive Health:** Wood apple (*Feronia limonia*) is celebrated for its digestive benefits. It has anti-inflammatory and antimicrobial properties, which can soothe the gastrointestinal tract and combat infections. The fruit's natural compounds can help in reducing bloating, indigestion, and acidity, providing relief from common digestive disorders (Vidhya and Narain, 2011; Shreya et al., 2020).
- **Liver and Heart Health:** Wood apple has hepatoprotective properties, making it beneficial for liver health. It is believed to detoxify the liver, improve its function, and reduce the buildup of harmful substances in the body. Additionally, the fruit's anti-inflammatory compounds support cardiovascular health by reducing blood pressure and improving circulation (Vidhya and Narain, 2011).
- **Rich in Nutrients:** The pulp of the wood apple is rich in essential vitamins and minerals, such as riboflavin (vitamin B2), vitamin C, calcium, and iron. These nutrients support various bodily functions, from boosting the immune system to strengthening bones and improving blood health (Pal et al., 2019). Regular consumption of wood apple can contribute to better overall health.
- **Antioxidant Properties:** The fruit is rich in phenolic compounds, flavonoids, and tannins, which have potent antioxidant properties. These compounds help protect the body from oxidative damage, reducing the risk of chronic diseases like cancer, heart disease, and diabetes (Singh et al., 2009; Anuradha, 2005).

Pineapple:

- **Vitamin C:** Pineapple is a rich source of vitamin C, an essential nutrient that plays a crucial role in supporting the immune system, promoting collagen production, and protecting the body from oxidative damage. Vitamin C also enhances the absorption of iron from plant-based foods, improving overall

nutrient intake (ANSES, 2020).

- **Bromelain:** Bromelain, a proteolytic enzyme found in pineapple, aids in the breakdown of proteins, promoting efficient digestion and improving gut health. Bromelain also possesses anti-inflammatory properties, which can reduce swelling and pain in conditions such as joint inflammation, arthritis, and post-surgery recovery (Hossain & Rahman, 2011).
- **Antioxidant and Anti-inflammatory:** Pineapple's antioxidants, including phenolic compounds, flavonoids, and vitamin C, help reduce oxidative stress, which can damage cells and tissues. This antioxidant action is especially beneficial in reducing inflammation in the gastrointestinal tract, helping to improve gut health and reduce symptoms of inflammatory diseases like Crohn's disease and ulcerative colitis (Zdrojewicz et al., 2018).
- **Immune and Heart Health:** Beyond its digestive benefits, pineapple supports immune function, promoting better resistance against infections. The fruit's antioxidants and bromelain also support heart health by reducing inflammation and oxidative stress, both of which contribute to cardiovascular disease (Khalid et al., 2016; Dittakan et al., 2018).

CONCLUSION

In conclusion, the Probiotic Encapsulated Mixed Fruit Jelly Candy is a groundbreaking product that beautifully merges the enjoyment of a tasty treat with the benefits of functional nutrition. By combining the digestive and immune-boosting power of probiotics with the nourishing qualities of wood apple, pineapple, and jaggery, this candy offers a convenient, guilt-free way to enhance your well-being. As the market for health-focused snacks continues to grow, this innovative candy presents a delicious and effective solution for consumers looking to integrate beneficial nutrients into their daily routine. With its balanced flavor, chewy texture, and health-promoting properties, it's set to redefine snacking, making healthy indulgence both easy and enjoyable.

References

1. Abu Bakar, B. H., Ishak, A. J., Shamsuddin, R., & Wan Hassan, W. Z. (2013). Ripeness level classification for pineapple using RGB and HSI colour maps. *Journal of Theoretical and Applied Information Technology*, 57(3), 587–593.
2. Ancos, B., Sánchez-Moreno, C., & González-Aguilar, G. A. (2016). Pineapple composition and nutrition. In *Handbook of Pineapple Technology: Postharvest Science, Processing and Nutrition* (pp. 221–239). Wiley. <https://doi.org/10.1002/9781118967355.ch12>.
3. ANSES. (2020). ANSES-CIQUAL French food composition table version 2020. <https://ciqual.anses.fr/#>.
4. Anuradhra, K. (2005). *Studies on processing of wood apple* (M.Sc. thesis). Acharya N G Ranga Agriculture University, Rajendranagar, Hyderabad.
5. Asokan, S. (2007). Sugarcane juice and jaggery as

- health drink and sweetener. *Food and Beverage News Food & Beverages Specials*, 1-3.
6. Barretto, L. C. de O., Moreirade, J. de J. da S., dos Santos, J. A. B., Narain, N., & dos Santos, R. A. R. (2013). Characterization and extraction of volatile compounds from pineapple (*Ananas comosus* L. Merrill) processing residues. *Food Science and Technology*, 33(4), 638–645. <https://doi.org/10.1590/S0101-20612013000400007>.
 7. Berg, R. D. (1998). Probiotics, prebiotics or conbiotics? *Trends in Microbiology*, 6(3), 89-92.
 8. Chaudhary, V., Kumar, V., Sunil, Vaishali, Singh, K., Kumar, R., & Kumar, V. (2019). Pineapple (*Ananas comosus*) product processing: A review. *Journal of Pharmacognosy and Phytochemistry*, 8(3), 4642–4652.
 9. Chiet, C. H., Zulkifli, R. M., Hidayat, T., & Yaakob, H. (2014). Bioactive compounds and antioxidant activity analysis of Malaysian pineapple cultivars. *AIP Conference Proceedings*, 1589, 398–399. <https://doi.org/10.1063/1.4868827>.
 10. Das, B. C., & Das, S. N. (2003). *Cultivation of minor fruits* (pp. 107–111). Kalyani Publishers.
 11. Dittakan, K., Theera-Ampornpunt, N., & Boodliam, P. (2018). Non-destructive grading of Pattavia pineapple using texture analysis. *International Symposium on Wireless Personal Multimedia Communications*, 144–149. <https://doi.org/10.1109/WPMC.2018.8713088>.
 12. Falagas, M. E., Betsi, G. I., & Athanasiou, S. (2007). Probiotics for the treatment of women with bacterial vaginosis. *Clinical Microbiology and Infection*, 13(7), 657–664.
 13. Food Safety and Standards Authority of India (FSSAI). (2018). *The Food Safety and Standards Act, 2006* (Act No. 34 of 2006, dt. 23-8-2006) (V. Gupta, Ed.). Commercial Law Publishers (India) Pvt. Ltd. (10th ed., pp. 375-378).
 14. Gangwar, L. S., Solomon, S., & Anwar, S. I. (2015). Policy brief: Technological and policy options for modernization of jaggery industry in India. *Indian Institute of Sugarcane Research*, 65-70.
 15. Gautam, C., Saha, L., Sekhri, K., & Saha, P. (2008). Iron deficiency in pregnancy and the rationality of iron supplements prescribed during pregnancy. *Medscape Journal of Medicine*, 10(12), 283.
 16. Gibson, G. R., & Roberfroid, M. B. (1995). Dietary modulation of the human colonic microbiota: Introducing the concept of prebiotics. *The Journal of Nutrition*, 125(6), 1401–1412.
 17. Granato, D., Branco, G. F., Nazzaro, F., Cruz, A. G., & Faria, J. A. (2010). Functional foods and nondairy probiotic food development: Trends, concepts, and products. *Comprehensive Reviews in Food Science and Food Safety*, 9(3), 292-302.
 18. Hirayama, K., & Rafter, J. (1999). The role of lactic acid bacteria in colon cancer prevention: Mechanistic considerations. *Antonie van Leeuwenhoek*, 76, 391-394.
 19. Hossain, M. A., & Rahman, S. M. M. (2011). Total phenolics, flavonoids, and antioxidant activity of tropical fruit pineapple. *Food Research International*, 44(3), 672–676. <https://doi.org/10.1016/j.foodres.2010.11.036>.
 20. Hotel, A. C. P., & Cordoba, A. (2001). Health and nutritional properties of probiotics in food including powder milk with live lactic acid bacteria. *Prevention*, 5(1), 1-10.
 21. Jadhav, N., & Bhutani, K. (2005). Ayurveda and gynecological disorders. *Journal of Ethnopharmacology*, 97, 151–159.
 22. Khalid, N., Suleria, H. A. R., & Ahmed, I. (2016). Pineapple juice. In F. Shahidi & C. Alasalvar (Eds.), *Handbook of Functional Beverages and Human Health* (pp. 489–500). CRC Press. <https://doi.org/10.1201/b19490-43>.
 23. Kumar, K. (1999). Oscillation in jaggery and khandsari industry. In *National Seminar on Status, Problems and Prospects of Jaggery and Khandsari Industry in India* (p. 87). Lucknow.
 24. Kumar, M., Kumar, A., Nagpal, R., Mohania, D., Behare, P., Verma, V., ... & Yadav, H. (2010). Cancer-preventing attributes of probiotics: An update. *International Journal of Food Sciences and Nutrition*, 61(5), 473–496.
 25. Laires, M. J., Monteiro, C. P., & Bicho, M. (2004). Role of cellular magnesium in health and human disease. *Frontiers in Bioscience*, 9, 262–276.
 26. Lasekan, O., & Hussein, F. K. (2018). Classification of different pineapple varieties grown in Malaysia based on volatile fingerprinting and sensory analysis. *Chemistry Central Journal*, 12(1), 1–12. <https://doi.org/10.1186/s13065-018-0505-3>.
 27. Manay, S. N., & Shadaksharaswamy, M. (2001). *Food, facts and principles* (2nd ed., pp. 410-424). New Age International (Pvt.) Ltd.
 28. Martínez, R., Torres, P., Meneses, M. A., Figueroa, J. G., Pérez-Álvarez, J. A., & Viuda-Martos, M. (2012). Chemical, technological and in vitro antioxidant properties of mango, guava, pineapple, and passion fruit dietary fibre concentrate. *Food Chemistry*, 135(3), 1520–1526. <https://doi.org/10.1016/j.foodchem.2012.05.057>.
 29. Nath, A., Dutta, D., Kumar, P., & Singh, J. P. (2015). Review on recent advances in value addition of jaggery-based products. *Journal of Food Processing Technology*, 6, 440.
 30. Nayaka, H. M., Sathisha, U. V., Manohar, M. P., Chandrashekar, K. B., & Shylaja, D. M. (2009). Cytoprotectivity and antioxidant activity studies of jaggery sugar. *Food Chemistry*, 115, 113-110.
 31. Pal, R., Abrol, G., Singh, A. K., Punetha, S., Sharma, P., & Pandey, A. K. (2019). Nutritional and medicinal value of underutilized fruits. *Acta Scientific Agriculture*, 3(1), 16-22.
 32. Rao, J., Das, M., & Das, S. (2007). Jaggery – A traditional Indian sweetener. *Indian Journal of*

- Traditional Knowledge*, 6(1), 95–102.
33. Sahu, A. P., & Paul, B. N. (1998). The role of dietary whole sugar-jaggery in prevention of respiratory toxicity of air toxics and in lung cancer. *Toxicology Letters*, 95, 154.
 34. Salminen, S. J., Gueimonde, M., & Isolauri, E. (2005). Probiotics that modify disease risk. *The Journal of Nutrition*, 135(5), 1294–1298.
 35. Sanders, M. E. (1999). Probiotics. *Food Technology (Chicago)*, 53(11), 67–77.
 36. Shah, S. V., Baliga, R., Rajapurkar, M., & Fonseca, V. A. (2007). Oxidants in chronic kidney disease. *Journal of the American Society for Nephrology*, 18, 16–28.
 37. Shahi, H. N. (1999). Sustainability of jaggery and Khandasari industry in India. In *National Seminar on Status, Problems and Prospects of Jaggery and Khandasari Industry in India* (pp. 15–20).
 38. Shreya, P., Kerkar, S. P., Patil, A. S., Arya, S. S., Dabade, A., & Sachin, K. S. (2020). Limonia acidissima: Versatile and nutritional fruit of India. *International Journal of Fruit Science*, 10, 108–110.
 39. Shrivastav, P., Verma, A., Walia, A., Rehana, P., & Singh, A. (2016). Jaggery: A revolution in the field of natural sweeteners. *European Journal of Pharmaceutical and Medical Research*, 3(3), 198–202.
 40. Shyamala, D. V., & Kulkarni, U. N. (2018). Physico-chemical characteristics and nutrient composition of wood apple (*Feronia limonia* Swingle) fruit with and without seeds. *Journal of Farm Science*, 31(2), 192–195.
 41. Shyamala, D. V., & Kulkarni, U. N. (2018). Physico-chemical characteristics and nutrient composition of wood apple (*Feronia limonia* Swingle) fruit with and without seeds. *Journal of Farm Science*, 31(2), 192–195.
 42. Singh, D., Chaudhary, M., Chauhan, P. S., Prahalad, V. C., & Kavita, A. (2009). Value addition to forest produce for nutrition and livelihood. *The Indian Forester*, 1271–1287.
 43. Singh, J. (2008). Nutritive and eco-friendly jaggery. In J. Singh & R. D. Singh (Eds.), *Processing, handling and storage of sugarcane jaggery* (pp. 3–10). IISR.
 44. Sipes, B., & Wang, K. H. (2016). Pests, diseases and weeds. In *Handbook of Pineapple Technology: Postharvest Science, Processing and Nutrition* (pp. 62–88). Wiley Blackwell. <https://doi.org/10.1002/9781118967355.ch4>.
 45. Srivastava, R., & Kumar, S. (2002). Fruits and vegetable preservation: Principles and practices. *International Book Distribution Company*, Lucknow, 192–197.
 46. Toma, M. M., & Pokrotnieks, J. (2006). Probiotics as functional food: Microbiological and medical aspects. *Acta Universitatis Latviensis*, 710, 117–129.
 47. Uppal, S. K., & Sharma, S. (1999). Evaluation of different methods of jaggery (gur) storage in subtropical region. *Indian Journal of Sugarcane Technology*, 14(1), 17–21.
 48. Veeraghavathatham, D. M., Jawaharlal, S. J., & Rabindran, K. (1996). *Scientific fruit culture: Underutilized and underexploited horticultural crops* (K. V. Peter, Ed.). New Delhi Publishing Agency.
 49. Veldhuyzen-van Z., (1999). New uses for panela. *Food Chain*, 25, 11–13.
 50. Vidhya, R., & Narain, A. (2011). Development of preserved products using under exploited fruit wood apple (*Limonia acidissima*). *American Journal of Food Technology*, 6(4), 279–288.
 51. Zdrojewicz, Z., Chorbińska, J., Bieżyński, B., & Krajewski, P. (2018). Health-promoting properties of pineapple. *Pediatrica i Medycyna Rodzinna*, 14(2), 133–142. <https://doi.org/10.15557/PiMR.2018.0013>.
 52. Ziemer, C. J., & Gibson, G. R. (1998). An overview of probiotics, prebiotics, and synbiotics in the functional food concept: Perspectives and future strategies. *International Dairy Journal*, 8(5-6), 473–479.

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