Indigenous Knowledge and Traditional Uses of Bananas for Health

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ABSTRACT

Bananas are huge herbaceous blooming plants of the genus Musa that produce an elongated, edible fruit. They have been a significant part of diets in numerous parts of the world, and their leaves are utilized for various purposes. Banana trees thrive in tropical and subtropical conditions across various regions of India, except for those bearing harsh winters, such as Himachal Pradesh and Jammu and Kashmir. Maharashtra is the Indian state that produces the most bananas. Bananas offer tremendous nutritional value, providing a significant number of calories, vitamins, and minerals. In southern India, they are frequently consumed as a staple food source due to their easy availability. Apart from their well-known scent, bananas are also rich in potassium, calcium, and sodium-free nutrients. They are the ideal food to provide essential nutrients as they contain three types of regular sugars: sucrose, fructose, and glucose, as well as fiber, contributing to boosting energy levels. They are a suitable source of calories for both children and adults, though limited in proteins and fats. Children might consume them as puree. Being a rich source of vitamins C, D, and E, and containing traces of minerals such as K, Mg, Zn, and Fe, bananas are often referred to as the 'health fruit'. They also contain beta-carotene, making them ideal for middle-aged women to help maintain vitality. The growth of bananas using tissue culture techniques has increased banana production, and efforts have been made to extend their shelf life. Additionally, bananas can be processed into various by-products with great commercial value, such as baby food, chips, juices, shakes, powder, rolls, and cakes.

Keywords— banana, biproducts, nutrition, health

#  INTRODUCTION

Banana (Musa paradisiaca L.) is a large herbaceous, monocotyledonous, and monocarpic plant belonging to the family Musaceae of order *Scitamineae*. It is also known as the "Apple of Paradise" and holds significant importance in the Indian sub-continent dating back to ancient times, as mentioned in the Ramayana (Approx. 2020 BC) and Kautilya's Artha Shastra (300-400 BC). The sculptures and paintings of Ajanta and Ellora (600 BC) further reinforce its legendary status. The edible banana is believed to have originated from *M. acuminata* and *M. balbisiana* in the hot, tropical regions of Southeast Asia, as depicted in figure 1.



Figure 1: Musa Acuminata which contains high value of sugars and *Musa acuminata* which contains high value of starch also have seeds.

The roots of *M. paradisiaca* and *M. acuminata* can be traced back to India. The utilization of the plant and its by-products in several events, both in a social context and as offerings to deities, constitutes an integral aspect of the Indian social heritage. Bananas are widely recognized as natural resources that are readily available to society. Moreover, plantains are regarded as a remarkable fruit and are extensively consumed on a global scale, providing a diet that is more adaptable than that of any other fruit or vegetable. The green banana, which undergoes a transformation into an edible form through the process of cooking, holds a significant position as a staple food source in the coastal parts of India, namely within the state of Kerala. The fruit possesses a notable abundance of readily metabolizable sugars, exhibiting a calorific value ranging from 67 to 137 K Cal per 100 grammes. Additionally, it serves as a substantial provider of essential vitamins such as A, C, B, and B2. Moreover, they serve as a substantial reservoir of essential minerals, including magnesium, sodium, potassium, phosphorus, calcium, and iron. According to a study [1], it has been estimated that a quantity of around 24 bananas, with an average weight of 100 g per banana, would be sufficient to meet the daily caloric needs of an adult individual, amounting to 2400 calories. The banana holds a prominent position as the primary fruit crop in India, constituting a substantial 36.6 percent share of global banana production. India is moreover recognized as the foremost consumer of bananas. The primary states in India that are known for their banana production include Tamil Nadu, Maharashtra, Kerala, Gujarat, and Karnataka. Banana cultivation in the Surat, Vadodara, Bharuch, Navsari, Valsad, Anand, and Kheda districts is predominantly facilitated by advantageous agroclimatic conditions and the presence of numerous wells and canals. The cultivar that holds the highest level of recognition in Gujarat and Maharashtra is Grande Naine (AAA). In Tamil Nadu, Kerala, and West Bengal, the principal cultivars are Pooven (AAB), Nendran (AAB), and Marthaman (AAB), respectively. These cultivars are given in Table 1. When examining the efficiency of banana production in India in comparison to other economically prosperous nations, it is evident that India's productivity is comparatively low, with a yield of 17.80 tons per hectare. The primary factors contributing to reduced agricultural output are the scarcity of high-quality planting material and the widespread incidence of detrimental diseases, including bunchy top, bacterial infection, leaf spot, and infestation by nematodes and other pests. The domestic consumption of produce constitutes the primary share, while a minor fraction (<1%) is allocated for exportation.

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| --- | --- |
| State | Cultivars |
| Andhra Pradesh | Dwarf Cavendish (AAA), Robusta (AAA), Amritpani (Rasthali AAB), Thella Chakkrakeli (AAA), Karpoora Chakkrakeli (Poovan AAB) |
| Assam | Jahaji (AAA), Dwarf Cavendish, Bor-Jahaji (AAA, Robusta), Malbhog (AAB), Chinia (AAB), Manohar (ABB), Kanchkol (AAB), Chini Champa (AB), Bhimkol (AAB) |
| Bihar | Dwarf Cavendish, Alpan (AAB), Chini Champa, Malbhog, Muthia (ABB), Kothia(ABB), Monthan (ABB) |
| Gujarat | Dwarf Cavendish, Lacatan (AAA), Harichal (Lokhandi, AAA) |
| Karnataka | Dwarf Cavendish, Robusta, Poovan, Ra*saba*le (AAB, Rasthali), Hill Banana (AAB), Monthan, Elakki Bale (AB) |
| Kerala | Nendran (AAB), Palayakodan (Rasthali), Dwarf Cavendish, Robusta, Monthan, Red Banana (AAA) |
| Maharashtra | Basrai (Dwarf Cavendish), Robusta, Lal Velchi (AAB), Safed Velchi (AB), Rajeli (AAB, Nendran) |
| Tamil Nadu | Red banana, Poovan, Rasthali, Nendran, Monthan |
| West Bengal and Odisha | Champa (AAB), Morthman (AAB, Rasthali), Amrit Sagar (AAB), Giant Grover (AAA), Lacatan, Monthan |

Table 1: Various varieties which are grown in different states of India.

Suckers represent the usual approach employed for the propagation of banana plants. The utilization of in vitro tissue culture techniques in banana cultivation has expedited the production of pathogen-free and genetically consistent plantlets. This advancement has resulted in enhanced ease of transportation and improved crop yield when compared to conventional methods. This is primarily due to the limited number of suckers per plant, which ranges from 5 to 8 plants every year. The expeditious evaluation and enhancement of advanced genotypes of bananas have the potential to optimize planting efficiency across all seasons. Therefore, the enhancement of banana farming on a global scale necessitates the imperative improvement of in vitro techniques for the propagation of banana plants [2-8]. The importance of conducting systematic research has grown in recent years due to its role in the preservation and representation of genetically diverse types, the development of cultivars that are resistant to both biotic and abiotic stresses, and the adoption of technology to enhance profitability through high-quality soil evaluation. The Indian states engaged in banana production encounter shared challenges. The dynamic nature of these difficulties underscores the need for rigorous and adaptable research in order to optimize productivity and profitability in banana cultivation. This research should adopt an interdisciplinary and holistic strategy that prioritizes the preservation of the surrounding ecosystem. In the recent quarter-century, there has been a significant increase of over tenfold in banana production, particularly in the past decade, mostly attributed to the implementation of revolutionary methodologies in banana growing. The cultivated area has had a notable growth, increasing from 0.20 million hectares in the mid-1970s to 0.802 million hectares in 2014. This expansion in cultivated land has corresponded with a substantial rise in productivity, with output increasing from 3 million tons to 29.7 million tons. The observed growth becomes apparent when conducting a comparative analysis of banana yields in relation to other fruits such as apple and grape, as depicted in Figure 2.

Figure 2: Production of apple, banana and grapes per million tons annually in India (NHB 2016).

The acquisition of enhanced knowledge regarding advancements and development initiatives in the cultivation of bananas and plantains has resulted in a substantial augmentation in the production and profitability of these fruits. The advancements described were facilitated by the accessibility of genetically superior plant material, particularly within the Cavendish banana collection. Additionally, the implementation of an enhanced breeding framework and the integration of effective insurance strategies played a crucial role in managing and mitigating significant pests and diseases across diverse climatic contexts. The rapid expansion of the banana sector in the country can be attributed to a combination of various causes. In addition to their nutritional benefits, bananas are well recognized and valued on a global level due to their significant economic significance, particularly for small-scale producers in economically disadvantaged nations. Bananas and plantains hold a prominent position as the fourth most crucial staple crop globally, playing a vital role in ensuring food security within various tropical nations. Bananas and plantains are cultivated in over 130 countries worldwide, with a total land area of 5 million hectares. The combined global production of these fruits amounts to 103.63 million tons [9]. Most of the global banana production is concentrated in Africa, Asia, the Caribbean, and Latin America, primarily as a result of favorable meteorological conditions in these regions. The global production of bananas and plantains has exhibited significant expansion. Due to its consistent availability throughout the year, affordability, palatability, nutritional composition, and medicinal properties, this crop holds significant promise. India possesses a diverse range of Musa cultivars that exhibit distinct genetic and agro-climatic traits. This diversity enables the country to effectively address the nutritional requirements of its extensive population, considering the specific demands of local communities. India is recognized as the foremost producer of bananas in both Asia and the world, accounting for 25.57 percent of global production. This significant contribution is particularly noteworthy considering that the overall production in the region stands at 15.5 percent. Following India, China and the Philippines occupy the second and third positions, respectively, with production percentages of 9.8 and 8.9 [10]. The banana production rate, as reported by the Food and Agriculture Organization (FAO), is presented in Figure 3.

Figure 3: Banana production rate annually is given of India, China, and Malaysia.

# MECHANICAL INNOVATIONS IN PLANT TISSUE CULTURE

# The technique is essentially grounded on the concept that plant cells possess totipotency, which denotes the capacity of a single cell to distribute its complete genome during the process of cell division [11]. The ability of plant cells to modify their integration, growth, and enhancement, together with their totipotent capability, is of equal significance and essential for the complete recovery of the entire plant [12]. The plant tissue culture media contains all the necessary nutrients for the regular growth and development of a plant. The composition mostly comprises macronutrients, micronutrients, electrolytes, organic components, plant growth regulators, carbon sources, and occasionally gelling agents when used in solid mediums [13]. The Murashige and Skoog medium (MS media) is well recognized as the predominant medium employed for in vitro vegetative proliferation of several plant species. The pH level of the media has a substantial influence on both plant growth and the transportation of plant growth regulators. It is regulated within the range of 5.4 to 5.8 as per the induction technique. The response of the ex-plant is influenced by the composition of the medium, particularly the plant hormone and nitrogen source. Plant growth regulators (PGRs) play a crucial role in the regulation of plant cell and tissue development inside the culture medium. The plant growth regulators that are most utilized include auxins, cytokinin’s, and gibberellins. The selection and concentration of hormones employed are predominantly influenced by the botanical species, the specific tissue or organ being targeted, and the objective of the experimental study [14]. Elevated levels of cytokinin’s have been observed to facilitate shoot regeneration, whilst increased concentrations of auxins have been found to enhance root formation. The advancement of a callus, which is a mass of undifferentiated cells, occurs when the levels of auxin and cytokinin are in equilibrium. Meristematic tissue growth often serves as a mechanism for the elimination of waste resulting from infections and other prevalent pathogenic disorders. Micropropagation is a commonly employed in vitro tissue culture technique utilized to produce superior planting material in species that exhibit vegetative propagation. This technique is employed to enhance the growth of plants rapidly and consistently on synthetic nutrient media within a controlled environment. Micro-propagation offers several significant advantages. Firstly, it allows for the rapid production of a large quantity of disease-free propagules from a single plant. Additionally, micro-propagation enables year-round propagation, making it possible to cultivate proliferating material consistently throughout the year. Moreover, this technique allows for the efficient use of space, as it requires a small area for the proliferation of plant material. Another benefit is the reduction in labor.

# Technological Protocols

Significant progress has been achieved in the field of plant cell culture and micropropagation in recent years, with a focus on their potential for practical commercial utilization. The procedure commences by carefully choosing plant tissues (ex-plant) from a robust mother plant that is free from any diseases, with the objective of producing micro-propagated planting materials [16]. Ex-plant material, such as the leaf, apical meristem, bud, and root, can be utilized from various parts of the plant [17]. Stage 0: Preparation of donor plant - In order to enhance the likelihood of success, it is recommended that the maternal plant be cultivated ex vitro in optimal conditions to minimize contamination in the subsequent in vitro culture [18]. Stage I: Initiation stage - During this initial phase, the ex-plant undergoes a process of surface sanitization and subsequent transfer into a nutritional media. It is advisable to employ a combination of bactericides and fungicides. The selection of items is contingent upon the specific ex-plant type to be introduced. The process of surface sanitization of the ex-plant using chemical solutions is a crucial procedure aimed at eliminating pollutants while causing little harm to plant cells [19]. The disinfectants that are commonly utilized include sodium hypochlorite (20), calcium hypochlorite (21), ethanol (22), and mercuric chloride (23). The culture is cultivated within a controlled environment, typically in a growth chamber, where it is subjected to either light or dark conditions, depending on the specific propagation technique employed. Stage II: Multiplication stage - The objective of this stage is to enhance the quantity of propagules by employing repeated subcultures, resulting in the multiplication of the propagule count until the target number of plants is attained [24]. Stage III: Rooting stage - The rooting stage might take place concurrently in the identical culture material utilized for explant duplication. In certain instances, it becomes imperative to modify the media by adjusting the nutrient content and altering the composition of growth regulators in order to stimulate the process of root formation and foster robust root growth. Stage IV: Acclimatization Phase - During this stage, the in vitro cultivated plants undergo the process of weaning and hardening. The process of hardening is often conducted in a progressive manner, starting with high humidity levels, and eventually transitioning to lower levels. Similarly, the hardening process begins with low light intensity and progressively increases to higher levels of light intensity. Subsequently, the plants are relocated to a suitable substrate, such as sand, peat, compost, or other appropriate materials, and subjected to a slow acclimatization process within a controlled greenhouse environment.

# Somatic Embryogenesis

The methodology described is an in vitro method used for plant regeneration, which is extensively employed as a significant biotechnological tool for ongoing clonal propagation [25]. Somatic cells or tissues undergo a process wherein they differentiate and develop into distinct embryos. These embryos can undergo complete plant development without the need for sexual fertilization, which is characteristic of zygotic embryos. Somatic embryogenesis can occur either directly from explants or indirectly through the formation of callus, which is a mass of undifferentiated cells [26]. Plants can be regenerated through somatic embryogenesis by producing embryogenic cultures from zygotic seeds, leaves, or stem segments, followed by the duplication of developing embryos. Numerous plant species, encompassing several families such as trees and ornamental plants, have been observed to display notable instances of somatic embryogenesis. The generation and subsequent development of somatic embryos within cultured cells are subject to the effect of numerous stimuli. A study has shown the achievement of successful somatic embryogenesis in grapevines by the implementation of a highly efficient technique, which demonstrated enhanced plant regeneration when the tissues were cultivated in a liquid medium [27]. Plant growth regulators (PGRs) are essential for the viability and reproductive success of somatic embryos. The highest level of proficiency in embryogenic callus formation in rose hybrids was observed when media was treated with several plant growth regulators (PGRs), either alone or in combination (28). The germination rate of the embryogenic callus was observed to be high when embryos were cultivated solely on abscisic acid (ABA). Somatic embryogenesis is well recognized as a valuable technique for genetic manipulation and as a means of plant regeneration for large-scale multiplication. According to Bouquet A. and Terregrosa L. [29], the technique can also be employed to generate plants that exhibit resistance to different forms of stress and to express certain features through genetic transformation. The authors of this study have successfully developed a protocol utilizing the aforementioned technique for the regeneration of cotton cultivars that exhibit resistance to Fusarium and Verticillium wilts [30].

**V. Organogenesis**

The process involves establishing plant organs such as roots, branches, and leaves, which may emerge directly from the meristem or indirectly from the callus. Organogenesis is a method of plant recovery that involves the formation of calluses and the differentiation of atypical meristems into organs by altering the concentration of plant growth hormones in the nutrient medium. Skoog and Miller (1957) were the first to demonstrate that a high auxin to cytokinin ratio accelerated root regeneration, while a high cytokinin to auxin ratio stimulated the formation of shoots in tobacco callus.



Figure 4: Showing the 4 stages of micro-propagation.



Figure 5: Showing the different processes of germination in Plant tissue culture

# Nutritive Constituents

Bananas are rich in dietary fiber, potassium, and several vitamins, including vitamin C, which aids the body in defending itself and healing from illnesses. This vitamin is crucial for hematogenesis, connective tissue synthesis, and iron absorption. Additionally, bananas contain all major B-vitamins, such as folic acid, riboflavin, thiamine, and minerals such as, zinc, iron, calcium, and magnesium. Compared to many other alternatives, bananas are more nutrient-dense and easily absorbed. Banana fruit processing takes 105 minutes less time than apple (210 min). Bananas are well recognized for their potassium, calcium, and sodium content, as well as their scent, texture, and ease of peeling and eating. They are primarily consumed locally, especially in parts of East Asia where annual banana consumption as a staple food reaches its peak [31]. Bananas offer significant health benefits as they provide a considerable number of calories, vitamins, and minerals. In South India, bananas are frequently consumed as a nutritious part of the diet and are more nourishing and easily absorbed compared to some other natural goods [32]. Moreover, in vitro tests and clinical examinations demonstrate that bananas are effective as a food medicine for treating a variety of illnesses, including hypertension, ulcers, diarrhea, and Alzheimer's disease [33]. Bananas and plantains possess significant agricultural and nutritional significance on a global scale, being classified as the fourth most crucial crop following rice, wheat, and maize. These fruits are essential sources of energy and staple food, especially in tropical humid environments. Bananas and plantains are considered crucial components of a well-rounded diet due to their substantial carbohydrate and sugar content, as well as their abundance of vitamins (including vitamin C) and minerals (such as potassium, calcium, sodium, and magnesium). However, it is worth noting that their protein level is rather little. Recent research conducted on bananas cultivated in Africa and South America has unveiled a correlation between the coloration of the flesh, ranging from yellow to orange, and an elevated concentration of carotenoids. These pigments possess antioxidant qualities and are associated with potential health advantages. Certain varieties of bananas have been shown to possess a notably high concentration of carotenoids. The current surge in interest about the nutritional advantages of Musa species, encompassing bananas and plantains, has highlighted a dearth of published information pertaining to the diversity in micronutrient levels among various cultivars. However, the intake of banana cultivars that are rich in iron and zinc has the potential to treat micronutrient deficits in developing nations. Continuing research endeavors seek to further investigate the nutritional advantages associated with them and their potential efficacy in resolving nutritional insufficiencies. Food security is a crucial determinant of human well-being, yet it is noteworthy that despite the presence of a vast array of more than 20,000 distinct types of edible plants, a mere 20 species account for around 90% of global consumption [34-35]. There exists a significant number of indigenous species that are not well recognized, however they hold great importance in safeguarding food security for both local communities and future generations. The cultivation of the Musaceae family, encompassing bananas, is extensively practiced in tropical countries across Asia, Africa, and Australia [36]. The family in question is of a modest size, comprising solely of two genera, namely Musa and Ensete, with an estimated total of 50 species [37]. The primary geographical area of origin for Musa species is Asia, with a special emphasis on the southern and southeastern regions [38]. This assemblage encompasses a significant array of significant botanical specimens, particularly those that provide consumable fruits like as bananas and plantains. Plantains are commonly consumed in their unripe state as a vegetable, but bananas are typically enjoyed as desserts once they have reached maturity [39]. The edible bananas that are widely acknowledged are typically triploids, and their existence is frequently attributed to the hybridization process involving several subspecies of *M. acuminata* and interspecific crosses between *M. acuminata* and *M. balbisiana*. This pattern holds true in most cases, with only a few outliers [40]. As a result, wild bananas have a significant impact on the advancement of cultivated types [41]. Nevertheless, the precise nutritional composition of certain wild species, namely M. acuminata and *M. balbisiana*, has yet to be definitively determined. Within the Musaceae family, specifically the separate variation known as Ensete Horan, it is noteworthy that only one species, is known to inhabit the Western Ghats region of India. The species, which is native to the given geographical area, is now underutilized and exhibits a fragmented distribution across elevated terrains. The edible potential of indigenous forms of Musa. The genus Ensete, commonly known as the "tree against hunger," serves as a significant food security crop in various African nations [42]. However, it has been subjected to limited research and insufficient scholarly investigation. Throughout the course of human civilization, plants have played a significant role in promoting and enhancing human health and overall well-being [43]. The concentrations of nutrients in plants are substantially influenced by the stage of plant development [44-45]. Therefore, it is crucial to carefully select the suitable stage of harvesting [46]. The therapeutic properties of commonly found plants have been thoroughly researched and documented. However, there is a dearth of information regarding the potential of these plants during various phases of growth, leading to their underutilization. Throughout the course of fruit growth and development, a multitude of developmental alterations take place. These activities encompass synchronized alterations in many catabolic and anabolic processes [47], resulting in the production or buildup of a diverse array of bioactive molecules. As a result, fruits at different phases of growth may display notable bioactive properties, which justifies the need for more investigation in the domains of nutrition and medicines. In addition, it has been demonstrated that substances obtained from ethno-botanical sources possess potential bioactive properties, hence presenting increased opportunities for the creation of products [48]. The shelf-life or storage capacity of a fruit is influenced by the specific stage of growth at when it is collected [49]. Fruits that are taken during the early stages of growth may exhibit diminished quality upon ripening, despite possessing an extended storage capacity [50]. Conversely, the act of harvesting fruits at a more mature stage of development is deemed inappropriate for those fruits that are intended for long-distance transportation, as their storage life is significantly reduced. Based on the findings of the study referenced as [51], it has been determined that the optimal period for harvesting unripe plantains to obtain the greatest advantages is within the twelfth and fourteenth week. The duration of fourteen days provides an enough timeframe for the various stages involved in the process of harvesting, distributing, marketing, and utilizing the produce prior to its ripening. The enhancement of vegetable consumption and utilization has a pivotal role in mitigating the prevalence of nutritional deficiencies. Research has indicated that specific plant species have the capacity to enhance the consumption of vital nutrients and phytochemicals that support overall well-being. Phytochemicals are ubiquitously found in a wide range of fruits, vegetables, legumes (such as beans and peas), and grains that are often consumed, hence facilitating their integration into the dietary habits of most individuals. *Musa paradisiaca* L is classified as an herbaceous plant, characterized by a large inflorescence featuring a rosy-brown tract, which is commonly consumed as a vegetable. *Musa sapientum*, commonly referred to as the genuine banana or dessert banana, is typically ingested in its raw state upon reaching maturity. The organism in question is classified under the AAA genomic group. *Musa saba* L is predominantly utilized as a cultivar for culinary purposes, although it can also be consumed in its uncooked state. The banana variety in question holds significant importance within Philippine cuisine and is commonly referred to as the Cardaba banana or Saba banana. The Saba bananas are classified within the saba subgroup, denoted by the genetic grouping ABB. The Saba banana is classified as a triploid (ABB) hybrid, resulting from the crossbreeding of the seeded banana species *Musa acuminata* and *Musa balbisiana* [52]. The genetic composition of this organism is primarily characterized by the presence of genes derived from *Musa acuminata*. The cultivar in question is officially recognized as *Musa acuminata* × acuminata Colla (ABB Group), commonly referred to as 'Saba' [53]. Minerals are substances that occur naturally, lack organic origin, and are characterized by a chemical formula and a well-defined atomic structure [54]. Like vitamins, minerals are important for the maintenance of optimal bodily processes.

# Banana By-products

# Bananas are widely acknowledged as easily accessible and convenient fruits, characterized by their natural protective covering, rendering them adaptable for a multitude of purposes, including consumption as a snack, utilization in culinary preparations, or incorporation into healthful smoothies. Tropical fruits are cultivated in over 122 countries across the globe. According to available data, the planted area had expanded to 3.8 million hectares by the year 2004. During this period, the total output of the fruit amounted to 56.4 million metric tons. This placed the fruit as the fourth most produced crop, following rice, maize, and milk [55-56]. In contemporary times, there has been a growing utilization of banana waste in diverse industrial domains, encompassing biofuel production, biosorbents, pulp and paper manufacturing, cosmetics, energy-related operations, organic fertilizers, environmental remediation, and biotechnology-related procedures [57-59]. In recent decades, the global production and consumption of bananas have experienced significant growth, resulting in its current status as the second-largest fruit crop worldwide. It is estimated that the gross production of bananas exceeds 139 million tons [60]. Local communities have undertaken efforts to investigate the potential applications of banana plants beyond their traditional use as a food source. Nevertheless, a substantial expanse of land is currently occupied by banana plantations, which has resulted in the emergence of pollution-related issues. This is primarily due to the practice of felling and abandoning the trees in the fields after the harvesting process. Consequently, this has facilitated the proliferation of illnesses such as Sigatoka [61]. The banana, also known as the "Common Man’s Fruit," is renowned for its substantial nutritional value and rich flavor profile. India is the leading global producer of bananas, commanding a significant 25 percent share of the annual production output. In the preceding twenty years, there has been notable expansion and evolution observed in the cultivation of this fruit crop. Tissue culture has been extensively embraced as a method of propagation, notably in India, hence facilitating the growth of banana cultivation and production by reducing harvest cycles and increasing yields. Nevertheless, it should be noted that bananas exhibit a certain level of fragility and vulnerability, as their post-harvest longevity is limited to a mere span of five to ten days [62].

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Nutrients | Chips | Flour | Baby Food  | Health Drink | Soup | Biscuits | Pasta | Bread | Juice |
| bananachips.png | bananaflour.jpg | Banana-Baby-Food1-500x467.jpg | banana-smoothie-700-519.jpg | bananasoup.jpg | bananabiscuits.jpg | bananapasta.jpg | sk-ultimate-banana-bread.jpg | set-of-banana-juice-and-two-fresh-bananas-isolated-vector-15604121.jpg |
| Energy(Kcal/100g) | 434.4 | 248 | 184 | 257.3 | 60 | 277 | 290 |  | 59.48 |
| Carbohydrate (%) | 46.7 | 60 | 40 | 60 | 11 |  | 71.4 | 35.2 | 14.6 |
| Protein (%) | 0.38 | 1.25 | 4.2 | 2.6 | 3.5 | 0.89 | 83 | 3.81 | 0.17 |
| Acidity (%) | 0.18 | 0.48 | 0.46 | 0.31 | 0.68 |  | 1.80 | 0.21% | 0.30 |
| Oil Content (%) | 27.4 |  |  |  |  |  |  |  |  |
| Fat (%) |  | 0.34 | 0.8 | 0.78 | 0.07 | 1.26 | 0.23 | 2.74 |  |
| Starch (%) |  | 74.50 |  |  |  |  | 73.2 | 15.6 |  |
| Sugar (%) |  | 0.56 | 20.7 | 28.3 |  | 13.5 | 2.6 | 5.60 | 12.93 |
| Phosphorus (%) |  | 0.10 |  | 0.15 |  |  |  |  |  |
| Potassium (%) |  | 1.1 |  | 0.85 |  |  |  |  |  |
| Calcium (%) |  | 1.21 |  | 1.60 |  |  |  |  | 0.065 |
| Magnesium (%) |  | 1.21 |  | 0.49 |  |  |  |  | 0.009 |
| Sodium (%) |  | 0.3 |  | 0.30 |  |  |  |  |  |
| Iron (ppm) |  | 3.3 |  | 286 |  |  |  |  |  |
| Copper (ppm) |  | 5 |  | 135 |  |  |  |  |  |
| Manganese (ppm) |  | 26 |  | 97 |  |  |  |  |  |
| Zinc (ppm) |  | 4.2 |  | 54 |  |  |  |  |  |
| Vitamin C (mg/100g) |  |  | 6.6 | 9.4  |  |  |  |  | 7.14 |
| Moisture (%) |  |  |  |  |  | 3.73 | 5 |  |  |
| Total CHO (%) |  |  |  |  |  | 66 |  |  |  |
| Fiber (%) |  |  |  |  |  | 9.2 |  |  |  |
| Carotene (mg/100g) |  |  |  |  |  | 300 |  |  |  |

Table 2: Contains the nutrient content of different banana products.

# Consequently, this renders them prone to potential harm and impairment throughout the process of transportation [63]. Exposure to ethylene during the period of mass storage expedites the ripening process of fruits, frequently resulting in untimely deterioration prior to their arrival at their intended location [64]. Several factors can contribute to an excess supply of bananas in the local market, leading to a decline in pricing and diminishing motivation among farmers to engage in large-scale cultivation of this crop [65]. Hence, it is imperative to generate an increased demand for this fruit crop to effectively address this situation [66]. One potential approach to tackle this matter involves investigating the feasibility of transforming bananas into a commercially viable cash crop [67]. Historically, fruit juices have had widespread popularity and have been highly coveted commodities derived from the process of crushing or mashing substantial quantities of fruits [68]. Nevertheless, when it comes to bananas, this procedure yields a viscous and irregular substance lacking in fluid content. To obtain banana juice, it is possible to utilize many banana cultivars, including Basrai, Harichal, or Cavendish [69]. A novel technique has been devised to efficiently extract around 60 to 70 percent of the overall solvent constituents present in bananas, resulting in the production of juice [70]. This innovative technology has obtained a license. A series of taste panels were carried out by a group of 30 experts affiliated with the Food Technology Division at FIPLY, BARC [71]. The purpose of these panels was to assess the sensory attributes of banana juice, banana powder, and various food products that were manufactured using banana powder, including banana bread rolls, banana cake, and banana baby food [72]. The juice that has been extracted has the potential to be diluted and offered as a nectar, or alternatively, carbonated to create a beverage. In addition, it is worth noting that banana juice has the potential to be utilized in the production of banana wine, which holds significant commercial significance [73]. The dry powder has the potential to serve as an addition in confectioneries, milkshakes, and chilly [74]. In the laboratory setting, a range of goods, including rolls, cake, and baby food, have been produced from commercially available banana powder. The expansion of these innovative practices offers a promising prospect for the advancement of unconventional banana-based items [75].

# Conclusion

This chapter emphasizes the nutritional significance of native bananas and the application of plant tissue culture technology for their regeneration. Bananas are renowned as the "fruit of prosperity" due to their abundant content of essential vitamins such as C, D, and E, along with the presence of -carotene. Additionally, bananas contain various minerals including potassium (K), magnesium (Mg), zinc (Zn), and iron (Fe). India is considered a primary origin for M. paradisiaca, and M. acuminata also has Indian origins. The cultural and religious importance of this plant in India is noteworthy and deeply embedded in its traditions. Traditional propagation of bananas is typically achieved through suckers, which yield a modest number of new plants per year (5-8 plants). Nevertheless, the implementation of in vitro tissue culture methodologies has brought about a significant transformation in the field of banana propagation. This approach presents a multitude of benefits, including accelerated growth rates, the generation of uncontaminated and pathogen-free uniform plantlets, simplified transportation processes, enhanced crop yield, expedited evaluation and enhancement of superior genotypes, as well as the provision of planting materials throughout the year. The production of plantains and bananas in India encompasses a wide range of tropical and subtropical regions, such as Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, Orissa, Bihar, Eastern Uttar Pradesh, West Bengal, Assam, and the north-eastern states. These regions possess considerable economic and social significance. Micro-propagation, a tissue culture (in vitro) technique, plays a crucial role in producing high-quality planting material in species with vegetative spread. It ensures quick and consistent growth of plants under controlled conditions, contributing to agricultural efficiency. While numerous efforts are underway to extend the utilization of bananas, significant progress has already been made in their processing to create a variety of valuable products with high commercial value. These byproducts include banana chips, banana juice, banana shakes, banana powder, banana rolls, and banana cakes. Moreover, bananas serve as a vital ingredient in baby food due to their energy-rich composition. In summary, the nutritional richness of bananas combined with the advancements in tissue culture techniques has led to their wide cultivation, making them a prominent crop with diverse applications in the food industry.

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