



ISSN (E): 2277- 7695  
ISSN (P): 2349-8242  
NAAS Rating 2017: 5.03  
TPI 2017; 6(7): 223-228  
© 2017 TPI  
www.thepharmajournal.com  
Received: 01-05-2017  
Accepted: 02-06-2017

**Narayan Lal**  
Department of Horticulture,  
Jawahar Lal Nehru Krishi  
Vishwa Vidyalay, Jabalpur-  
482004, Madhya Pradesh, India

**Nisha Sahu**  
Division of Remote Sensing  
Application, ICAR-National  
Bureau of Soil Science and Land  
Use Planning, Nagpur,  
Maharashtra, India

**Govind Shiurkar**  
Department of Horticulture,  
Jawahar Lal Nehru Krishi  
Vishwa Vidyalay, Jabalpur-  
482004, Madhya Pradesh, India

**Dalit Kumar Jayswal**  
Department of Horticulture,  
Jawahar Lal Nehru Krishi  
Vishwa Vidyalay, Jabalpur-  
482004, Madhya Pradesh, India

**Sonbeer Chack**  
Department of Crop Physiology,  
Assam Agricultural University,  
Jorhat-785013, Assam, India

**Correspondence**  
**Narayan Lal**  
Department of Horticulture,  
Jawahar Lal Nehru Krishi  
Vishwa Vidyalay, Jabalpur-  
482004, Madhya Pradesh, India

## Banana: Awesome fruit crop for society (Review)

**Narayan Lal, Nisha Sahu, Govind Shiurkar, Dalit Kumar Jayswal and Sonbeer Chack**

### Abstract

Recent trend in Banana processing, its medicinal values and by-products are reviewed for utilizing it in a better way. India is largest producer of banana in the world and it is grown almost all parts of the India. All the parts of banana are useful and it has great medicinal and tradition values in human health. Banana fruits are excellent food supplements and its leaf is used as vegetable in different parts of India in diverse form. Banana processing is a boon of science and technology with multiple benefits. It has made it possible to transport the fruit overseas in the form of products. It has made them all season available. In India the development of commodities of consumer interest by value addition of fruits is less than 2% of the annual agricultural produce. Hence there is a tremendous scope for enhancing its processing. In fact Banana processing can play vital role in Indian economy because not only banana fruits are processed but other parts are also used in processing. The present paper highlights the major products of banana processing, its medicinal and traditional values.

**Keywords:** Banana, fruit processing, medicinal value, tradition value

### 1. Introduction

The banana plant referred to as a 'tree', is the largest herbaceous flowering plant. All the parts of a banana plant just above the ground grow from a fleshy rhizome usually called a 'corm' (Stover and Simmonds, 1987) [36]. The ripe banana is a soft and delicate with a post-harvest shelf life of 5- 10 days (Surendranathan *et al.*, 2004) [39]. In developed countries 40 – 50% of the annual agricultural produce is converted into value added commodities. However, in India it is less than 2% annually. India is the largest producer of banana in the world with a production of approximately 29725 thousand tons from an area of 803 thousand hectare (Anon, 2014) [3]. The enormous Indian population also constitutes the potential consumers of processed foods (Roy *et al.*, 2000) [34]. However, this abundance of production is not fully utilized and about 25-30% of wastages occur at various stages of fruit handling and distribution (Patil and Rawale, 2009) [28]. Therefore, it is needless to say that food processing sector in general and fruit processing industry in particular is still a sunrise area which holds tremendous potential both for revenue generation and for employment opportunity (Tripathi and Anju, 2000) [44]. The several processing technologies for value added banana products have been developed at National Research Center for Banana, Trichy, Tamil Nadu. In modern days value addition has become one of the most important ideas especially in horticulture to protect physiological losses of fruit and vegetables.

### 2. Uses of different parts of banana

Almost all parts of banana plant are used in different aspects. Whole banana plant is useful in food, feed, pharmaceutical, packaging, and many other industrial applications. The ancient Egyptians used banana leaves, fruits and flowering sheaths as a wound dressing, often mashing the fruit and applying it as a poultice over rashes, infected scratches, grazes and burns, covered by either the skin or the leaf which was warmed in hot water (Robets, 1999) [33]. Banana flowers are used as a vegetable in South Asian and Southeast Asian cuisine, either raw or steamed with dipor cooked as soups, curries and fried foods. Both the fleshy part of the bracts and the heart are edible. Banana leaves are large, flexible, and waterproof. They are often used as ecofriendly disposable food containers or as "plates" in South Asia and several Southeast Asian countries. Especially in the South Indian states of Tamil Nadu, Karnataka, Andhra Pradesh and Kerala in every occasion the food must be served in a banana leaf and as a part of the food a banana is served. Steamed with dishes they impart a subtle sweet flavor. They often serve as a wrapping for grilling food.

The tender core of the banana plant's trunk is also used in South Asian and Southeast Asian cuisine. Banana shoots produce fibers of varying degrees of softness, yielding yarns and textiles with differing qualities for specific uses. The outermost fibers of the shoots, the coarsest, are suitable for table cloths and the softest innermost fibers are desirable for kimono and Kamishim. Fiber obtained from banana pseudo-stem can be utilized as biodegradable binding ropes. Pith can be used as colour absorber and food after properly processed. Tamil Nadu, a South Indian state, after harvesting fruit the trunk is made into fine thread used in making of flower garlands. Banana fiber is used in the production of banana paper. The water extract of ash of pseudo-stem, peel and the corm of banana, commonly known as "kolakhar" in Assam, a type of food additive, is widely used in Assam particularly by the rural folk (Deka and Talukdar, 2007)<sup>[10]</sup>. In ancient Assam *kolakhar* was widely used as soaps and detergents for washing cloths and shampooing hair. It is used to prevent bacterial attack on freshly cut injuries and it accelerates the healing process.

### 3. Medicinal properties of banana

In India, banana is considered as a holy fruit and are distributed as consecrated food. It is not only used as a favorite fruit but also used in treating a variety of health conditions. They act as a fine tonic as well as an instant source of energy being a favorite for athletes too. They are a boon for thin people who wish to gain weight. Banana also contains a wide array of nutrients in good amounts. Banana has a mild laxative property. Banana is a store house of minerals, vitamins and carbohydrates. It contains potassium, calcium, magnesium, iron, zinc etc. Vitamins A, B, C, B-6 etc. are all available in plenty. Presence of iron in banana helps to boost the production of haemoglobin. This helps persons who suffer from anemia. Banana contains plenty of potassium. This helps to balance sodium potassium level and reduce hypertension or high blood pressure. This fruit help to supply required vitamins and minerals to smokers who are trying to quit smoking. The craving for nicotine is reduced by consumption of this wonderful fruit (Suri, 2012)<sup>[40]</sup>. Banana calms nervous system, reduces stress and depression. According a survey, people suffering from depression, many felt much better after eating a banana. This happens because banana contains tryptophan, a type of protein that the body converts into serotonin, known to make relaxed, improve mood and generally make feel happier. According to Japanese Scientific Research, full ripe banana with dark patches on yellow skin produces a substance called TNF (Tumor Necrosis Factor) which has the ability to combat abnormal cells. The more dark patches it has, the higher will be its immunity enhancement quality; hence, the riper the banana means the better the anticancer quality in banana. Yellow skin banana with dark spots on it is 8 times more effective in enhancing the property of white blood cells than green skin version. As a banana ripens and turns yellow, its level of antioxidants increases. These antioxidants in ripe banana protect our body against cancer and heart diseases. Research done on ripening banana has proved that the levels of TNF- $\alpha$  induction increased markedly with dark spots on skin before the entire banana peel turned brown. Flavonoid leucocyanidin ingredient was extracted from unripe plantain banana by solvent fractionation and it shows a significant ( $p < 0.05$ ) protective activity against aspirin-induced erosions in gastric mucosa (Lewis *et al.*, 1999)<sup>[22]</sup>. Bananas are rich in

dopamine which is an anti-oxidant (Kanazawa and Sakakibara, 2000<sup>[21]</sup> and Alothman *et al.*, 2009)<sup>[11]</sup>. Elliott and Heward (1976)<sup>[13]</sup> reported that banana can significantly reduce gastric ulcers. Dried unripe plantain banana was found to be anti-ulcerogenic against aspirin induced ulceration in the rat and were effective equally as a prophylactic treatment and in curing ulcers already induced by aspirin (Best *et al.*, 1984)<sup>[7]</sup>. Along with other fruits and vegetables, consumption of banana may be associated with a reduced risk of colorectal cancer (Deneo-Pellegrini, *et al.*, 1996)<sup>[11]</sup> and in women, breast cancer (Zhang, 2009)<sup>[47]</sup> and renal cell carcinoma (Rashidkhani *et al.*, 2005)<sup>[32]</sup>. Banana ingestion may affect dopamine production in people deficient in the amino acid tyrosine, a dopamine precursor present in banana (Jerry, 2011)<sup>[20]</sup>. Individuals with a latex allergy may experience a reaction to banana (Taylor and Erkek, 2004)<sup>[41]</sup>.

Along with dietary fibers, proteins and unsaturated fatty acids, banana flowers are also rich in vitamin E and flavonoids. They possess immense medicinal value. Ethanol-based extracts of banana flowers inhibit the growth of pathogenic bacteria such as *Bacillus subtilis*, *Bacillus cereus*, and *Escherichia coli* in the laboratory and may help to heal wounds and prevent infections (Mumtaz, 2010)<sup>[24]</sup>. Pari and Umamaheswari (2000)<sup>[27]</sup> studied that chloroform extract of the *Musa sapientum* flowers for 30 days resulted in a significant reduction in blood glucose and glycosylated haemoglobin and an increase in total haemoglobin. Banana flowers possess antioxidant properties and thereby neutralize the free radicals formed as a result of various metabolic processes in the body. If the free radicals are not neutralized, their unstable electrons react with the DNA and proteins of human cells and alter their properties. This can lead to several chronic conditions, including cancer and heart disease (Nataraj, 2010)<sup>[26]</sup>. In the case of excessive bleeding during menstruation, consuming one cooked banana flower with one cup of curd is the most effective treatment (Anonymous)<sup>[2]</sup>. The banana leaves are not only the food of elephant and other animal but also it has an incredible medicinal value for the human being. Banana leaves in their young stage can be made into a poultice for treating burns. Banana leaves are effective for preventing the growth of ulcers and are a suitable diarrhea treatment. The astringent ashes of the unripe peel and of the leaves are taken in dysentery and diarrhea and used for treating malignant ulcers. The juice of banana leaf is very useful in case of cough & cold, breathing problem, dropsy constipation, dysentery, acidity, high BP, blood disorder or poisoning and liver problem. The extract of half cup of green leaf banana juice without sweet and salt taken in every morning will prevent various diseases. The banana leaves contains chlorophyll which can protect from intestinal ulcer, leukemia and any kind of skin disease. The green leaf juice purifies the blood and used as topical for chest pains. Pseudostem has fiber and is very beneficial for those on a weight-loss program. It is also a rich source of potassium and vitamin B6 which helps in the production of insulin and hemoglobin. The extract of core of the pseudo-stem is considered to be useful in dissolving the stones in the kidney and urinary bladder and in reducing the weight (Prasad *et al.*, 1993)<sup>[30]</sup>. Houghton and Skari (1992)<sup>[16]</sup> have also reported that stem juice of banana plant has the antivenom action. South Indians use to eat banana trunk for recovery of health disorders like constipation, diabetes and detoxification of human system. This is due to its diuretic effect in eliminating waste body fluids. Water extract of banana pseudo-stem or

trunk has been found to suppress the formation of oxalate associated kidney stones in the animal model, and may be a useful agent in the treatment of patients with hyperoxalaturicrolithiasis (Poonguzhali and Chegu, 1994 [29] and Sampath Kumar *et al.*, 2012) [35]. Aziah and Abdul (2011) [5] have reported that the high fibre, water holding capacity (WHC) and oil holding capacity (OHC) of native banana pseudo-stem flour (NBPF).

The aqueous (AMS) and ethanolic (EMS) extract of pseudo-stem of *Musa sapientum* Linn. possesses potential of analgesic activity (Ingale *et al.*, 2009) [18]. The pseudo-stem of *Musa sapientum* has hepatoprotective effect and probably it is due to its antioxidant property (Dikshit *et al.*, 2011) [12]. Moreover, the muscular paralysis is caused by the juice of banana trunk which may be due to presence of mono potassium oxalate (Benitez *et al.*, 1991) [6]. Roots are used to arrest hemoptysis, possess strongly astringent and anthelmintic. The root of *Musa paradisiaca* is used to manage reproductive dysfunction, especially sexual dysfunction (as an aphrodisiac. The results may explain the rationale behind the folkloric beneficial effect of the plant in the management of reproductive dysfunction (Yakubu *et al.*, 2013) [46]. Banana peels have been credited with various medicinal uses, including analgesia. Applying banana peel to the site of a pain can result in almost immediate relief. Banana peel is used for treatment of warts. It will apparently relieve the pain and swelling of insect bites and plant stings. Other complaints for which banana peel has been recommended include diarrhea, constipation, gastric ulcer, stress and anxiety, preventing cancer and heart disease, premenstrual syndrome, anaemia, hypertension, hangover, heartburn, obesity and morning sickness. Mokbel and Fumio (2005) [23] investigated the antioxidant effects of crude extracts from green banana and yellow peel and the results indicated that the extract of green peel recorded more significant antioxidant activities than that of yellow peel at other solvents extracts. Banana peel has displayed antioxidant activity *invitro*, especially from unripe extracts (Sundaram *et al.*, 2011) [37]. It can also be utilized for extraction of banana oil (Archibald, 1949) [4] (amyl acetate) that can be used for food flavoring. Banana peel is also used in wine (Faturoti *et al.*, 2006) [14] ethanol production (Tewari *et al.*, 1986 [43]; Tewari *et al.*, 1985 [42] and Castro-Gomez *et al.*, 1988) [9] as a substrate for biogas production (Ilori *et al.*, 2007) [17] and peel ash can be used as source of alkali for soap production (Udosen and Enang, 2010) [45]. The juice of the corms is used as antituberculars. The sap is vulnerary and it is used in the treatment of gonorrhoea (Quisumbing, 1978) [31]. The juice from the corm is used to help reduce effects (treat) jaundice. Hossain *et al.* (2011) [15] suggested that the MMSS could be used as a potential anti-diarrheal agent along with its antioxidant and antibacterial potentiality.

#### 4. Nutritional value of banana

Banana is highly nutritious sweet fruit and staple starch for many tropical populations. Depending upon cultivar and ripeness, the flesh can vary in taste from starchy to sweet, and texture from firm to mushy. Both the skin and inner parts are used for eating either cooked or uncooked. Banana provides exceptional nutrition and supports muscles and nerves with potassium, helps lowering bad cholesterol with soluble fiber and it is a great source of vitamin C in addition to basic vitamins and minerals. Bananas contain prebiotics that support the good bacteria in our intestine. In spite of their

sweetness they are rated low on the glycemic index, so they have only a little to cause moderate impact on blood sugar. It is an excellent source of vitamin B6, soluble fiber, and contains manganese and potassium. Bananas are also an excellent food for people who want to lose weight. Although they are rather high in calories (200 per banana) and carbs (51 gm), they are a great source of energy. A banana eaten before a workout can provide you with the necessary energy to complete a longer workout. Bananas provide you with many health benefits, but in addition to all of that, most people enjoy eating bananas as well. They can be eaten alone or combined with a fruit salad, added to jello, or made into a smoothie or a milkshake. They are one of the most affordable fruits in the marketplace and can be found year round nearly everywhere in the world.

#### 5. Traditional Uses of Banana

Bananas contain three natural sugars - sucrose, fructose and glucose combined with fiber. A banana gives an instant, sustained and substantial boost of energy. Research has proven that just two bananas provide enough energy for a strenuous 90-minute workout. No wonder the banana is the number one fruit with the world's leading athletes. But energy isn't the only way a banana can help us keep fit. It can also help overcome or prevent a substantial number of illnesses and conditions, making it a must to add to our daily diet.

#### 6. Industrial Uses

The aforementioned antifungal properties of banana pulp and peel have been successfully used to treat tomato fungus in an agricultural setting. In their home countries, locals use banana leaves for everything from umbrellas to construction materials. Banana and plantain fibers are used throughout the world to weave ropes, mats and other textiles. Tannins present in ripe banana peel act as tanning agents in leather processing.

#### 7. Cultural and Environmental Care

Bananas prefer rich, fertile soils and a sunny, sheltered location. These plants thrive under uniformly warm or hot conditions. Plant growth slows if temperatures fall below 60 degrees Fahrenheit, and irreversible freeze damage may occur below 32 degrees. High winds can cause leaf shredding and drying and may topple plants. Banana plants require ample water and will suffer if the soil dries out; however, they are not flood tolerant. Each stem only produces flowers and fruits once, so the active stem must be cut away to allow new suckers to emerge.

#### 8. By- Products from Banana:

**8.1 Chips/Crisps:** Nendran fruits of approximately 80% maturity are harvested and demanded. The fingers are peeled, treated with 0.1% potassium metabisulphite and cut into slices of 1.2-0.8 mm thickness and deep fried in suitable cooking oil, preferably coconut oil. Upon frying this will yield crisp, yellow colored chips, which are sprinkled with common salt and packed in polyethylene bags. Generally they have a storage life of 30-35 days under ambient conditions. Packing the chips in laminates with nitrogen gas can extend its life up to 4 months. Several other varieties of banana chips like flavored, sweet, sweet and sour, tomato flavored, with pepper, etc. are also catching up in the market.

**8.2 Banana Fruit Candy/Stem Candy:** Banana fruit candy made from nendran with jiggery and ginger are widely sold in

market in Kerala state. Banana stem (true stem) can also be made into candy through osmotic dehydration process followed by sun drying.

**8.3 Banana Fig:** Banana figs are dried or dehydrated banana fruits with sticky consistency and very sweet taste. Fully ripe banana fruits of variety Karpuravalli or Dwarf Cavendish are peeled, treated with 0.1% potassium metabisulphite solution and dried either in sun or oven at 50 °C. These figs are packed in polyethylene bags or any other suitable containers. They have a shelf life of about 3-4 months under ambient conditions.

**8.4 Banana Flour:** Banana flour is prepared from mature green bananas, which have a high starch content. It can be used as nutritious adjuvant in several food preparations like bread, cakes, biscuits, health drink and baby food formulations. It can also be blended with other cereal flours for making chapaties and roties. It has some medicinal property to cure ulcers. Under cool and dry conditions it can be stored up to one year without any adverse change in their composition.

**8.5 Banana Powder:** Banana powder is prepared from fully ripe banana fruits either through drum drying or spray drying process. The moisture content of final product should be around 2-4%. This product has got high market value as it is extensively used in confectionary industry, ice cream preparations and baby food making. When suitably packed it will have a shelf life of more than 6 months.

**8.6 Banana Juice:** Since banana puree is very thick, juice cannot be directly obtained from it. Therefore, the puree is treated with pectolytic enzyme and clear juice is obtained through filtration or centrifugation. After pasteurization and bottling it can have a shelf life of a minimum of 6 months under ambient conditions. Fruit juices are the most common and demanding products made out of most of the fruits. Generally, juices are extracted by simple crushing and / or grinding of fruits. However, in case of banana this process results in a sticky, lumpy mass with no juice. For banana juice production, any variety of banana like Basrai '10 Gy' (developed by tissue culture at BARC), Harichal or Cavendish can be used for extraction. A process has been developed to extract almost 60 – 70% of the total soluble materials of banana as juice. This process has been patented (Surendranathan *et al.*, 2001)<sup>[38]</sup>.

Taste panel studies were conducted at Food Technology Division, FIPLY, BARC and Products evaluated included banana juice (Nair, 2000)<sup>[25]</sup>, ripe banana powder (Jayachandran, 2000)<sup>[19]</sup> and products made from ripe banana powder such as banana biscuits, banana cake (Cardoza, 1999)<sup>[8]</sup> and banana baby food (Jayachandran, 2000)<sup>[19]</sup>.

**8.7 Banana Fruit Bar:** Banana Fruit Bar is confectionary item prepared from ripe banana fruit of any variety. It is made by homogenizing banana pulp, sugar, citric acid and pectin in suitable proportions and dehydrating the mass in ghee coated tray at 70° C in an oven till sets into a sheet. It is then cut into suitable size and packed in polyethylene pouches.

**8.8 Banana Biscuits:** Banana biscuits are made by mixing 60% banana flour and 30% maida. The dough is made using flour mixture and suitable proportions of sugar, saturated fat,

baking powder, milk powder and essence. These biscuits are very tasty and highly nutritious.

**8.9 Banana Jam & Jelly:** Banana jam is made by cooking the fruit pulp with sugar along with pectin and citric acid in right proportions till gives a good set. Several varieties of banana are suitable for making jam. This is product, which has good commercial value and good market.

Banana jelly is a semi solid product prepared by boiling clear strained fruit extract free from pulp after addition of required amount of sugar, citric acid and pectin. A perfect jelly should be transparent, attractive and sparkling in color with strong flavor of fruit.

**8.10 Banana Wine:** Banana wine is produced by fermenting the enzyme treated clear banana juice with wine yeast viz. *Saccharomyces cerevisiae* var. *ellipaiswua*. The fermentation is carried out for about 3 weeks followed by filtration, clarification, and bottling. The pasteurized wine is stored in bottles for aging. The alcohol content of banana varies from 9-12%.

**8.11 Health drinks and Baby food:** A highly nutritious and tasty health drink formulations and baby food formula has been developed by NRCB using banana flour/powder after supplementing with suitable natural source of proteins, minerals, vitamins and fat. It has got a shelf life of about 6 months and suitable is for children and adults.

**8.12 Banana Fiber:** Banana fiber is extracted from the pseudostem, peduncles and dried petioles and of banana plant. The banana fiber can be used for manufacture special kind of papers, ropes, threads, baskets, toys and several fancy items. The yarn made from banana fiber is much in demand for making textiles.

**9. Conclusions:** It is quite obvious from the forgoing discussion that there is a vast scope for developing by-products of banana. The post globalization world economy gives more weightage on processing and value addition. This industry can play a vital role in the economic uplifting of the country specially the agricultural section. In fact this is going to be the second phase of green revolution. Thus, food preservation and proper low cost consumption to reduce malnutrition problem is possible through banana fruit and its by-products.

## 10. References

1. Alothman M, Bhat R, Karim AA. Anti-oxidant capacity and phenolic content of selected tropical fruits from Malayasia, extracted with with different solvents", *Food Chem.* 2009; 115:785-788.
2. Anonymous. Home Remedies to Stop Heavy Menstrual Bleeding, [http://www.ehow.com/about\\_5191887\\_home-stop-heavy-menstrualbleeding.Htm](http://www.ehow.com/about_5191887_home-stop-heavy-menstrualbleeding.Htm).
3. Anonymous. National Horticulture Board, Gurgoan Haryana, 2014.
4. Archibald JG. Nutrient composition of banana skin". *J Dairy Sci.* 1949; 32:979- 981.
5. Aziah N, Abdul A. Chemical and functional properties of the native banana (*Musa acuminata* x *balbisiana* Colla cv. Awak) pseudo-stem and pseudostem tender core flours, *Food Chemistry.* 2011; 128:748-753.
6. Benitez MA, Navarro E, Feria M, Trujillo J, Boada J.

- Pharmacological study of the muscle paralyzing activity of the juice of banana trunk”, *Toxicol.* 1991; 29:(4-5):511-515.
7. Best R, Lewis DA, Nasser N. “The anti-ulcerogenic activity of the unripe plantain banana (*Musa species*)”. *Br J Pharmacol.* 1984; 82(1):107-116.
  8. Cardozo C, PG Dip. Food Technol. Project Report, Gharda Institute-BARC, 1999.
  9. Castro-Gomez RJH, Tamburini ER, Cal-Vidal J. Alcohol from tropical crop residues, *Pesquisa Agro Brasil.* 1988; 23:1151-1159.
  10. Deka DC, Talukdar NN. Chemical and spectroscopic Investigation of kolakhar and its commercial importance, *Indian J. Traditional Knowledge.* 2007; 6(1):72-78.
  11. Deneo-Pellegrini H, De Stefani E, Ronco A. Vegetables, fruits, and risk of colorectal cancer: a case-control study from Uruguay”. *Nutrition & Cancer.* 1996; 25(3):297-304.
  12. Dikshit P, Tyagi MK, Shukla K, Sharma S, Gambhir JK, Shukla R. Hepatoprotective effect of stem of *Musa sapientum* Linn in rats intoxicated with carbon tetrachloride, *Annals of hepatology,* 2011; 10(3):333-339.
  13. Elliott RC, Heward GJF. The influence of a banana supplemented diet on gastric ulcers in mice”. *Pharmacological Research Communications.* 1976; 8(2):167-172.
  14. Faturoti BO, Emah GN, Isife BI, Tenkouano A, Lemchi J. Prospects and determinants of adsorption of IITA plantain and banana based technologies in three Niger Delta States of Nigeria”, *Afric J Biotechnol.* 2006; 5:1319-1323.
  15. Hossain S, Alam B, Asadujjaman, Zahan R, Islam M, Ehsanul M et al. Antidiarrheal, Antioxidant and Antimicrobial Activities of the *Musa sapientum* Seed”, *Avicenna Journal of Medical Biotechnology.* 2011; 3(2):95-105
  16. Houghton PJ, Skari K. The effect of Indian plants used against snakebite on blood clotting. *J Pharm. Pharmacol,* 1992; 44:1054-1060.
  17. Ilori MO, Adebuseye SA, Lawal AK, Awotiwon OA. Production of biogas from banana and plantain peels”, *Adv. Environ Biol.* 2007; 1:33-38.
  18. Ingale SP, Ingale PL, Joshi AM. To study analgesic activity of stem of *Musa sapientum* Linn. *Journal of Pharmacy Research.* 2009; 2(9):1381-1382.
  19. Jayachandran T. PG Dip. Diet. Appl. Nutr. Project Report, Nirmala Niketan-BARC, 2000.
  20. Jerry W. The Pursuit of Happiness (A.K.A. It Appears That The Writer Wrote About Bananas After Eating A Few Too Many)”. *The Science Creative Quarterly,* University of British Columbia, 2011.
  21. Kanazawa K, Sakakibara H. High content of dopamine, a strong anti-oxidant, in ‘Cavendish’ banana, *J Agric Food Chem.* 2000; 48:844-848.
  22. Lewis DA, Fields WN, Shaw GP. A natural flavonoid present in unripe plantain banana pulp (*Musa sapientum* L. var. *paradisica*) protects the gastric mucosa from aspirin-induced erosions. *Journal of Ethno pharmacology.* 1999; 65(3):283-288.
  23. Mokbel MS, Fumio H. Antibacterial and Antioxidant Activities of Banana (*Musa*, AAA cv. Cavendish) Fruits Peel”. *American Journal of Biochemistry and Biotechnology,* 2005; 1(3):125-131.
  24. Mumtaz J. Concentration influence on antimicrobial activity of banana blossom extract-incorporated chitosan-polyethylene glycol (CS-PEG) blended film *Journal of Chemical and Pharmaceutical Research,* 2010; 2(5):373-378.
  25. Nair AS. BioTech Project Report, UDCTBARC, 2000.
  26. Nataraj L. Antioxidant capacity and phenolic content of different solvent extracts from banana (*Musa paradisica*) and mustai (*Rivea hypocrateriformis*); *Food and Science Biotechnology.* 2010; 19(5):1251-1258.
  27. Pari L, Umamaheswari. Antihyperglycaemic activity of *Musa sapientum* flowers: effect on lipid peroxidation in alloxan diabetic rats. *Phytotherapy Research.* 2000; 14(2):136-138.
  28. Patil KB, Rawale KP. Pre and post harvest management of banana for domestic and export market, in the Proceedings of Second National Conference on Production of Healthy Planting Material in Banana, held during at Jalgaon MS, 2009.
  29. Poonguzhali PK, Chegu H. The influences of banana stem extract on urinary risk factors for stones in normal and hyperoxaluric rats. *Br J Urol.* 1994; 74(1):23- 25.
  30. Prasad KV, Bharathi K, Srinivasan KK. Evaluation of *Musa* (*Paradisica* Linn. cultivar) ‘Puttubale’ stem juice for antilithiatic activity in albino rats. *Indian J Physiol. Pharmacol.* 1993; 37:337-341.
  31. Quisumbing E. Medicinal Plants of the Philippines, Manila: Bureau of Printing, 1978, 553-554.
  32. Rashidkhani B, Lindblad P, Wolk A. Fruits, vegetables and risk of renal cell carcinoma: a prospective study of Swedish women. *International Journal of Cancer.* 2005; 113(3):451-455.
  33. Robets MJ. Edible and Medicinal Flowers, Spearhead, An imprint of New Africa Books (pty) Ltd, Garfield Road, Claremont, 1999.
  34. Roy SK, Pal RK, Sen N. Packaging Technologies for fruits, vegetables and their products, Indus Publishing Co, New Delhi, 2000.
  35. Sampath Kumar KP, Bhowmik D, Duraivel S, Umadevi M. Traditional and Medicinal Uses of Banana, *Journal of Pharmacognosy and Phytochemistry.* 2012; 1(3):57.
  36. Stover RH, Simmonds NW. Bananas (3rd ed.). Harlow, England: Longman. ISBN 978-0-582-46357-8, 1987; 5-9.
  37. Sundaram S, Anjum S, Dwivedi P, Rai GK. Antioxidant activity and protective effect of banana peel against oxidative hemolysis of human erythrocyte at different stages of ripening. *Appl Biochem Biotechnol.* 2011; 164(7):1192-206.
  38. Surendranathan KK, Ramaswamy NK, Chadha S, Mitra RK. Indian Patent, 2001, 189999.
  39. Surendranathan KK, Ramaswamy NK, Pendharkar MB. *Indian J. Biotechnol.,* 2004; 3:382-387.
  40. Suri S. Ayurveda Medicinal Properties of Banana. 2012. (<http://www.ayurhelp.com/plants/banana.htm>).
  41. Taylor JS, Erkek E. Latex allergy: diagnosis and management. *Dermatological Therapy,* 2004; 17(4):289-301.
  42. Tewari HK, Marwaha SS, Rupal K, Singh L. Production of ethyl alcohol from banana peels, *J Res Punjab Agric Univ.* 1985; 22:703-711.
  43. Tewari HK, Marwaha SS, Rupal K. Ethanol from banana peels, *Agric Wastes.* 1986; 16:135-146.
  44. Tripathi SN, Anju B. Storage system of fruits, vegetables and their products, Indus Publishing Co, New Delhi,

- 2010.
45. Udosen EO, Enang MI. Chemical composition and soaping characteristics of peels from plantain (*Musa-paradisiaca*) and banana (*Musa-sapientum*)", Global J Pure Applsci. 2010; 6:79-81.
  46. Yakubu MT, Oyeyipo TO, Quadri AL, Akanji MA. "Effects of aqueous extract of *Musa paradisiaca* root on testicular function parameters of male rats, Journal of Basic and Clinical Physiology and Pharmacology. 2013; 24(2):151-157.
  47. Zhang CX. Greater vegetable and fruit intake is associated with a lower risk of breast cancer among Chinese women. International Journal of Cancer. 2009; 125(1):181-8.