

## **Banana-beyond it's nutritional value; A comprehensive review for the prospects of its phytochemicals and healthcare procurement**

**Abstract:** This study is based on some *Musa* varieties which are used traditionally by villagers and tribal Communities of India for the food and health care potential. Almost all the parts of banana plants are having effectiveness towards nutritional and medicinal value. Many Pharmacological investigation with animal models and clinical platforms has suggested that the different parts of banana are evidenced to have potency as food medicines in the ailment of some diseases such as hypertension, diabetes, cancer, diarrhoea, Alzheimer's urolithiasis, infertility and ulcers etc. Cultivation of banana plant is the oldest practice in cultivators for the dietary and medicinal value. Tropical as well as subtropical area is mostly suitable for the growth of banana across the Globe and act as staple food to people. The bioactive components of banana like Carbohydrates, phenolic compounds, carotenoids, flavonoids, biogenic sterols, amines, which imparts bananas into a perfect nutrition for improvement of health. Present study will be helpful to explore and focused on identification, isolation and purification of various compounds in banana and also by biofortification techniques to empower its modern medicinal, vitamins or minerals properties.

**Keywords:** Banana, varieties, bioactive compounds, food and medicine, ethnic communities, India.

**Introduction:** Indian states are extremely rich in greenery with varieties of plants and herbs species having high medicinal value. The optimal climates facilitate the appropriate growth of plant, the average rainfall annually found to be 211.76 cm. with an optimal temperature and humidity [1]. *Musa* is considered as largest herb worldwide, the developing countries also found to be expertise in cultivation of banana plants due to its high energy sourced contents [2]. The fruits banana is consumed basically as fresh or cooked food stuff. As per nutritional analyst's banana have found to possess huge benefits for implication to the sport persons. Thus it is essentially incorporated for the manufacturing purpose of energy drinks for the athletes. Moreover, banana is highly rich in some vitamins and minerals like potassium and magnesium so it can regulate better muscular contraction in athletes [3]. The various like roots, seeds, fruits pseudo stems, flowers, stems and leaves are widely found to be used as local medicines in ethnic people. These are good sources for folk medicine used in the country

like India, Pakistan as well as few more southeast countries [4]. Banana is traditionally used to treat the diseases like diabetes, cardiovascular disease, ulcerative colitis, dysentery, diarrhea, nephritis, uremia, gout, hypertension, snakebite, in sprue, inflammation and pain, the juice of banana stems are also found to potent for the treatment of otalgia, cholera and haemoptysis [5].

- Nutritional Value of Banana 100 grams of ripe banana provides approximately 116 Kcal energy that makes it a supplementary staple food, although cooked or ripe banana are easily digested
- Banana is considered as a fair source for Vitamins, Calcium and many other nutraceuticals
- Banana contains almost 20% of sugar moiety [6].

Banana fibers are also involved in the emerging bio-economy, recently millions tones of banana pseudo stems are been dumped to the firming area the accumulation of such pseudo stems create problem for the farmers. Therefore effective measures for reducing such environmental problem and to extract those valuable fibers from pseudo stems may influence the bio-economy [7]. Microcrystalline cellulose obtained by extraction from banana plants pseudo stems are essential for the industrial purpose such as pharmaceutical industries, health products for animal, in bakery and beverages [8].

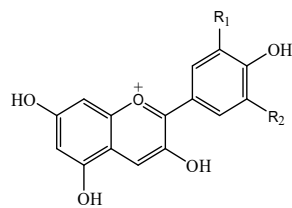
Researchers through the phytochemical investigation has reported to be the presence of a variety of phytochemical constituents for different banana parts. The flowering parts of *Musa paradisiaca* has been found to contain saponins, sterols, sugars as reducing as well as non-reducing, tannins, and triterpenes. It is also found to contains syringing, hemiterpenoid glucoside, and benzyl alcohol glucoside in the flower [9]. Moreover, the banana bracts were evaluated as a potent source for natural coloring agents. The anthocyanin consists of about 32.30 mg/100 g. In addition, 3-rutinoside derivatives of peonidin, pelargonidin, delphinidin, and malvidin are also reported anthocyanin contents [10].

### The Varieties of Indian *Musa* (banana)

**Table-1:** *Musa* biological sources, bioactive constituents and parts based potential therapeutic uses

Sl. No.	Scientific name	Family	Local name	Bioactive constituents	Parts used	Uses
1	<i>Musa velutina</i> <sup>[11]</sup>	Musaceae	Malbhog	Lignocelluloses, alkenes, esters, aromatic ketones, glycosides, lignin, alcohol	Fruits, foliage seeds	Fertility enhancer, Ornamental purposes and edible uses
2	<i>Musa. textilis</i> <sup>[12]</sup>	Musaceae	Abaca manila hemp	55–64% cellulose, hemicellulose, pectin	Leaf stem flowers	Used to treat wounds and reduce blood pressure
3	<i>Musa. Balbisiana</i> <sup>[13]</sup>	Musaceae	Colla	Lipophilic components (11.1–28.0%), isoamyl acetate (banana oil), (3-	Pseudostem inflorescence	Antihypertensive, cooling drink, antidiabetic,

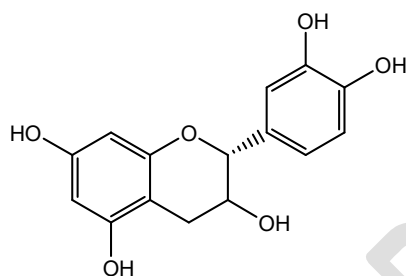
				methylbut-1-yl ethanoate)		antilipidemic
4	<i>Musa. Cavendish</i> [14]	Musaceae	Basrai	13-Phelonnin compound, polyphenol oxidase, peroxidase	Fruits peels	Antioxidant ulceration hyperglycemia, edible use, treatment of type II diabetes, dyslipidemia, nephropathy, promote wound healing
5	<i>Musa. Ornatee</i> <sup>[15]</sup>	Musaceae	Dwarf banana, Rose banana	Carbohydrates, Vitamin-C, Fibres, carotenoids	Leaf stem flowers	In treatment, the digestive ailment used as antiscorbutic (scurvy)
6	<i>Musa. sapientum</i> [16]	Musaceae	Latundam	Lipids carbohydrates and crude fibers cycloartane triterpenes, 3-epicycloeucalenol, 33-epicyclommusalent, 24-methylenopollinasttone, 28-norcyclomussalenone, beta-tocopherol	Fruits flowers	Antioxidant, antimicrobial agent, hemolysis
7	<i>Musa. Itinerans</i> [17]	Musaceae	Yunnan banana, wild forest banana	Diarylheptanoids and 4 phenylphenalenones, 2-diarylheptanoids, irelnolone, musaltinerius A and DB, 1 heterodimeric phenyl phenalenone, musanolone, hydroxyanigorufone	Fruits, young flowers, pseudostem	antimicrobial, edible use, cytotoxic activity
8	<i>Musa. Paradisiacal</i> [18]	Musaceae	Banana kela vaazhi kaelali rambha	Tannin, saponin, reducing non reducing sugars, sterols, triterpenes, starch phosphorylase, acyl steryl glycoside sitoindoside III, sitosterol myoinositol beta d-glycosole, alpha-glucan phosphorylase	Flower fruits and pseudostem	Antiulcer activity, wound healing activity, antidiabetic activity, antidote for crotalidase venoms, antiurolithiatic activity, skeletal muscle contraction
9	<i>Musa. Acuminate</i> [19]	Musaceae	Banana, dwarf plant	Contain starch, sugar, probiotics, fructooligosaccharide (inulin)	Root leaves, flower and fruits	Treat high blood pressure, ulcer and motion sickness



General structure of Anthocyanin

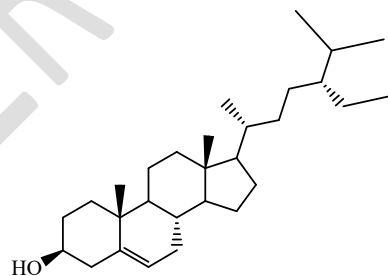
Anthocyanidin	R <sub>1</sub>	R <sub>2</sub>
Delphinidin	OH	OH
Pelargonidin	H	H
Peonidin	OCH <sub>3</sub>	H
Malvidin	OCH <sub>3</sub>	OCH <sub>3</sub>

**Figure a)** General structure of anthocyanin and its derivatives found as common in banana [20]



(+)-catechin

**Figure b)** Catechin, class of flavonoid present in banana (Flavon-3-ol) [21].



Sitosterol

**Figure c)** Structure of sitosterol [21]

### Pharmacological Potential of banana

The use of plants in healthcare has remained a trend since ancient times through the transmission of ethnic knowledge across generations. Banana fruit has high nutritional value, but beyond its nutritious properties, it also possesses various medicinal potentials. Banana is used as an antioxidant, anticancer, anti-ulcerogenic, anti-diarrheal, anti-diabetic, wound healing, antimicrobial, and anti-diarrheal agent.

**Anti-diarrheal Potential:** Diarrhea is the most common disorder in children bearing the

high rate of mortality and morbidity. Banana contains pectin which has the potent resistance against the intestinal disorders. Green banana are reported to produce effectiveness against diarrhea in children [22].

### **Antioxidant activity**

Free radicals like Reactive oxygen species (ROS) having unpaired electron which involved in the pathological and physiological conditions of living systems. Antioxidants are having the ability to scavenge the radicals. Banana consists of various bio-chemicals which exert the antioxidant activity [23].

An investigation reported on *in vitro* antioxidant properties of *Musa paradisiaca*, *Musa Cavendish*, *Musa sapientum* and *Musa acuminata*, peels by radical scavenging activity and ferric reducing power activity using hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), and 2,2-diphenyl-1-picrylhydrazyl radical (DPPH). The obtained results suggested that *Musa acuminata* exhibits the maximum antioxidant potency followed by *Musa cavendish* in scavenging of DPPH radical. Similarly for ferric reducing power assay, *Musa acuminata* showed best antioxidant activity by scavenging of hydrogen peroxide as compared to other extracts. This evaluation revealed that the various species of *Musa* peels possess significant *in vitro* antioxidant property, hence, it can be concluded that the eating of banana peel and fruit would be essential by considering its effectiveness towards antioxidant property [24]. Moreover, the ethanol extracts from unripe *Musa acuminata L* peels have supreme free radical scavenging potency with an IC<sub>50</sub> of 90.28 µg/mL. The investigation ascribed with the information that banana peel is abundant with phenolic compounds, flavonoids, and tannins responsible for anti-oxidant potency [25].

### **Ant-Ulcerogenic activity**

Ulcer has been considered as a major challenge for the developing countries with their food habits. Ulcer is characterized as a lesion caused by several factors such as *Helicobacter pylori* a bacteria and an increased acid secretion. Researchers evaluated the banana against the complications involved, the report has suggested possessing significant antiulcer potential [26] by evaluating the ulcer index, pH of gastric juice, and the volume of induced ulcer in animals. The obtained data showed the preventive activity of banana peel extracts against indomethacin induced ulcer by pylorus ligation method by 43.22 ± 14.82%. The reduced volume of gastric juice and an increased in the mucus of gastric wall were observed in the peel extract-treated animal groups. Finally, this study evidenced that the extracts of banana peel were capable of preventing the ulcer by stimulating the gastric mucosa as well as reducing the gastric acids. In another investigation involving ethanol and chloroform extracts of banana, inducing ulcer by ethanol in rats, it was observed that, both the chloroform (200

mg/kg) and ethanol extracts (400 mg/kg) showed potential towards ulcer control, by significantly ( $p < 0.05$ ) with decrease in the ulcer index and number of ulcer as compared to ranitidine, a standard ant-ulcer drug [27].

### **Antimicrobial Activity**

The dehydrogenase assay against *Pseudomonas* and *Staphylococcus* species was considered for evaluation of antimicrobial activity study, it was observed that the aqueous unripe extract of banana peel showed a  $IC_{50}=143.5$  at a concentration  $183.1 \mu\text{g/mL}$  and leaves ( $IC_{50} = 401.2$  and  $594.6 \mu\text{g/mL}$ ) of banana plant *Musa paradisiacal* [28]. This evaluation highlights the leaf extract showed significant antimicrobial potential against *Staphylococcus* species of Gram-positive than *Pseudomonas* Gram negative species. The aqueous and ethanolic extract of unripe banana fruits observed to possess considerable activity against *Staphylococcus aureus*, *Escherichia coli*, *Shigella flexneri*, *Salmonella paratyphi*, *Kiebsiella Pneumoniae*, *Pseudomonas aeruginosa* and *Bacillus ubtilis* [29].

### **Anti-diabetic Activity**

Diabetes, is is considered as either insulin dependent or insulin-independent results into a great threat in humanity. Elevated level of glucose in diabetic patients has often found to be counteracting by using medicinal plants including banana. Evaluation of anti-diabetic activity by oral glucose tolerance test of ethanolic extract of *Musa Cavendish*, *Musa sapientum*, *Musa. paradisiaca* and *Musa acuminata* [30]. It showed that the animals treated with extract of *Musa Cavendish* (500 and 1000 mg/ kg, p.o) and extract of *Musa acuminata* (200 and 400 mg/kg p.o) having potency towards anti-hyperglycemic activity with p-value ( $p < 0.01$ ) with a decreased sugar level in blood. An *in vitro* hypoglycemic activity was reported with peels of banana, lemon and pomegranate; it was observed that peel banana showing the highest inhibitory activity of alpha amylase (80.87% at  $1000 \mu\text{g/mL}$ ). Therefore, it has concluded that peel banana is much potent compared to other three, evidenced with maximum hypoglycemic activity. Hence, it can be considered as hypoglycemic supplement among the others [31]. The anti-diabetic activity of methanolic extract of green mature fruits of *Musa. paradisiaca* evaluated for normoglycemic and streptozotocin-induced hyperglycemic in mice. The obtained results suggested that the extract possesses anti-diabetic property, therefore it can be considered for folkloric use in type-2 diabetes mellitus management [32].

### **Wound healing activity**

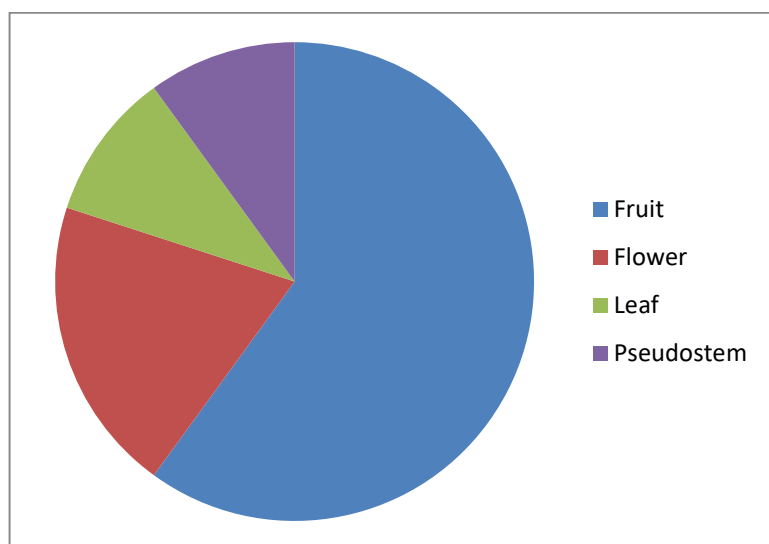
An investigation conducted with aqueous and methanolic extracts of banana Plantain which

showed wound healing potential in rats [33]. Both the aqueous and methanolic extracts found to reduce the level of glutathione, wound area, lipid peroxidation and scar area. In addition, it has also found to increase the hexuronic acid, hydroxyproline, superoxide dismutase, hexosamine, with the more strength of wound breaking.

### Anti-cancer activity

Vegetables and Fruits are always been considered to possess medicinal value, utilization of banana to decrease colorectal cancer risk [34] it also found to reduce the risk of leukemia in children, and in women breast cancer [35] and carcinoma in the renal cell [36]. The peel extract of banana is also found to be effective in the management of benign prostate hyperplasia as well as helpful to suppress the  $5\alpha$ -reductase.

**Table 2:** Showing the Musa varieties provide a series of vitamins and minerals.



Sl. No.	Nutrient Contents	Contents in Serving size: 100g
1	Vitamin B6	0.5 mg
2	Manganese	0.3 mg
3	Vitamin C	9 mg
4	Potassium	450 mg
5	Dietary Fiber	3g
6	Protein	1 g
7	Magnesium	34 mg
8	Folate	25.0 mcg
9	Riboflavin	0.1 mg
10	Niacin	0.8 mg
11	Vitamin A	81 IU
12	Iron	0.3 mg

**Figure d)** Parts used of banana

**Conclusion:** The study elucidated the rich knowledge on traditionally used Banana belongs to the genus Musa, is largely consumed as raw food and for medicinal purposes all over the world. It is the potential source of bioactive secondary metabolites. Pharmacological and phytochemical studies of banana have received much interest because of their carotenoid, amine and phenolic constituents. While going through the literature it is shown banana contains adequate amount of beneficial bioactive compounds for the maintenance of health and well-being. However there is need of utilization of these bioactive compounds from different edible and non-edible part of banana as alternative to anti-biotics with no adverse effects. It could be a possible a natural mode

of treatment for different diseases. Such study can be helpful by providing the new avenues in future pharmacological evaluation and the natural drug discovery.

#### Reference:

1. Baishya RA, Sarma J, Begum A. Forest-based medicinal plants rendering their services to the rural community of Assam, India. *International Journal of Medicinal Plants Research*. 2015; 4(1):314-323.
2. Aurore, G., Parfait, B., & Fahrasmane, L. Bananas, raw materials for making processed food products. *Trends in Food Science & Technology*. 2009; 20, 78–91.
3. Roubert, E. Des marchés d'avenir. *Référence INNOVATION*, 2005; 1.
4. Pari, L., & Maheswari, J. U. Hypoglycaemic effect of *Musa sapientum* L. in alloxan-induced diabetic rats. *JOURNAL of ETHNOPHARMACOLOGY*. 1999; 68, 321–325.
5. Ghani, A.. *MEDICINAL PLANTS of BANGLADESH: CHEMICAL constituents AND uses* (2nd ed.). Dhaka, Bangladesh: The Asiatic Society of Bangladesh. 2003.
6. Kumar K. P. S, Bhowmik D., Duraive S., Traditional and Medicinal Uses of Banana, *Journal of Pharmacognosy and Phytochemistry*. 2012; 1(3);51-52.
7. Muraleedharan, H. and Perumal, K. Ecofriendly handmade paper making. Booklet published from Shri AMM Murugappa Chettiar Research Centre, Taramani, Chennai. 2010.
8. Pranita P. K., Babita A. D., a review on banana plant: a boon to humankind, *World Journal of Pharmaceutical Research*. 2018; 7(13); 250-258.
9. Martin TS, Ohtani K, Kasai R, Yamasaki K. A hemiterpenoid glucoside from *Musa paradisiaca*. *Natural Medicine*. 2000; 54 (4):190-192. ISSN: 13403443. ID: 110008732052
10. Jang DS, Park EJ, Hawthorne ME, Vigo JS, Graham JG, Cabsieses F, et al. Constituents of *Musa paradisiaca* cultivar with the potential to induce the phase II enzyme, quinone reductase. *Journal of Agricultural and Food Chemistry*. 2002; 50(22):6330-6334. DOI: 10.1021/jf0206670
11. Available from: [https://www.en.m.wikipedia.org/wiki/Musa\\_velutina](https://www.en.m.wikipedia.org/wiki/Musa_velutina). [Last accessed on 2020 December 10].
12. Rio D. J. C, Gutiérrez A. Chemical composition of abaca (*Musa textilis*) leaf fibers used for manufacturing of high quality paper pulps. *J Agric Food Chem* 2006;54:4600-10.
13. Available from: [https://www.en.m.wikipedia.org/wiki/Musa\\_balbisiana](https://www.en.m.wikipedia.org/wiki/Musa_balbisiana). [Last accessed on 2020 November 13].



14. Alfredo E, Stalin S. Phenolic Compounds from the Peel of *Musa cavendish*, *Musa acuminata* and *Musa cavandanaish* 1 Universidad San Francisco de Quito. Cumbayá, Diego de Robles y Vía Interoceánica, Quito, Ecuador. P.O. Box 171200-841 2Universidad Laica Eloy Alfaro de Manabí. Avenida circunvalación, Manta, Ecuador. P.O. Box 13-05-2732.
15. Available from: [https://www.en.wikipedia.org/wiki/Musa\\_sikkimensis](https://www.en.wikipedia.org/wiki/Musa_sikkimensis). [Last accessed on 2020 July 15].
16. Imam MZ, Akter S. *Musa paradisiaca* L. and *Musa sapientum* L: A phytochemical and pharmacological review. *J App Pharm Sci* 2011;1:14-20.
17. Available from: <http://www.promusa.org/Musa+itinerans>. [Last accessed on 202 July 10].
18. Swathil B, Jyothi B, Sravanthil C. A review: Pharmacognostic studies and pharmacological actions of *Musa paradisiaca* D. *Int J Innov Pharm Res* 2011;2:122-5.
19. Available from: <http://www.medindia.net/patients/lifestyleandwellness/medicinal-properties-of-the-banana-plat.htm>. [Last accessed on 2020 August 10].
20. Ho GT, Kase ET, Wangensteen H, Barsett H. Phenolic elderberry extracts, anthocyanins, procyanidins and metabolites influence glucose and fatty acid uptake in human skeletal muscle cells. *Journal of Agricultural and Food Chemistry*. 2017;65:2677-2685. DOI: 10.1021/acs.jafc.6b05582.Epub.
21. David MP, Patricia V, José AP, Paula BA. Phenolics: From chemistry to biology. *Molecules*. 2009; 14:2202-2211. DOI: 10.3390/molecules14062202
22. Rabbani, G., Albert, M. J., Rahman, H., & Chowdhury, A. K., Short-chain fatty acids inhibit fluid and electrolyte loss induced by cholera toxin in proximal colon of rabbit in vivo. *Digestive DISEASES AND Sciences*. 1999; 44, 1547–1553.
23. Singh B, Singh JP, Kaur A, Singh N. Bioactive compounds in banana and their associated health benefits—A review. *Food Chemistry*. 2016:1-11. DOI:10.1016/j.foodchem.2016.03.033
24. Navghare VV, Dhawale SC. *In vitro* antioxidant, hypoglycemic and oral glucose tolerance test of banana peels. *Alexandria Journal of Medicine*. 2017; 53 :237-243. DOI: 10.1016/j.ajme.2016.05.003
25. Nur Nadirah R, Sayidah NH, Muhammad SM. Phytochemical screening and antioxidant activity of unripe Cavendish and Dream banana (*Musa sp*) fruits peels. *Journal of Academia UiTM Negeri Sembilan*.2018;6(1):39-44. e-ISSN:2289-6368
26. Rao US, Bashir AA, Khamsah SM, Zin T. Antiulcer activity of *Musa paradisiaca* (banana) tepal and skin extracts in ulcer induced albino mice. *Malaysian Journal of Analytical Sciences*. 2016;20(5):1203-1216. DOI:10.17576/mjas-2016-2005-27

27. Ganwar AK, Ghosh AK. To estimate the antiulcer activity of leaves of *Musa sapientum* Linn. by ethanol induced method in rats. International Journal of Pharmacognosy and Phytochemical Research. 2014;**6**(1):53-55.
28. Alisi, C., Nwanyanwu, C., Akujobi, C., & Ibegbulem, C. (2008). Inhibition of dehy- drogenase activity in pathogenic bacteria isolates by aqueous extracts of *Musa paradisiaca* (Var Sapiantum). AFRICAN JOURNAL of Biotechnology, 7.
29. Ahmad, I., & Beg, A. Z. Antimicrobial and phytochemical studies on 45 Indian medicinal plants against multi-drug resistant human pathogens. JOURNAL of ETHNOPHARMACOLOGY, 74, 113–123.
30. Navghare VV, Dhawale SC. *In vitro* antioxidant, hypoglycemic and oral glucose tolerance test of banana peels. Alexandria Journal of Medicine.2017; 53:237-243. DOI: 10.1016/j. ajme.2016.05.003
31. Pooja V, Nazia DK, Zia HK, Mular SM. *In vitro* antidiabetic activity of methanolic extract of *Citrus limon*, *Punica granatum*, *Musa acuminata* peel. International Journal of Applied Research. 2017;**3**(4):804-806. Availablefrom: www.allresearchjournal.com
32. Ojewole JA, Adewunmi CO. Hypoglycemic effect of methanolic extract of *Musa paradisiaca* (*Musaceae*) green fruits in normaland diabetic mice. Methods and Findings in Experimental and ClinicalPharmacology. 2003;**25**(6):453-456
33. Agarwal, P., Singh, A., Gaurav, K., Goel, S., Khanna, H., & Goel, R.. EVALUATION of wound HEALING ACTIVITY of EXTRACTS of PLANTAIN BANANA (*MUSA SAPIENTUM* VAR. *PARADISIACA*) in RATS. (2009).
34. Deneo-Pellegrini, H., De Stefani, E., & Ronco, A. VEGETABLES, fruits, AND risk of COLORECTAL CANCER: A CASE-CONTROL study from URUGUAY. (1996).
35. Zhang, C. X., Ho, S. C., Chen, Y. M., Fu, J. H., Cheng, S. Z., & Lin, F. Y. Greater vegetable and fruit intake is associated with a lower risk of breast cancer among Chinese women. INTERNATIONAL JOURNAL of CANCER. 2009; 125, 181–188.
36. 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, 451–455.

UNDER PEER REVIEW