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RESEARCH ARTICLE

MUSA PARADISIACA (KADALI) PSEUDOSTEM AS A POTENT NUTRACEUTICAL IN KIDNEY DISORDERS- A REVIEW

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Abstract

Musa paradisiaca, is a tropical plant widely recognized for its nutritional and medicinal properties. While the fruit is celebrated for its carbohydrate-rich composition and essential vitamins, the pseudostem—often treated as agricultural waste—has garnered attention for its remarkable therapeutic potential. This review compiles and critically analyzes current evidence on the pharmacological effects of the banana pseudostem, emphasizing its role as a nutraceutical in managing diseases such as urolithiasis, diabetes, and nephropathy. The pseudostem exhibits anti-inflammatory, diuretic, anti-urolithiatic, and nephroprotective properties, with studies demonstrating its ability to reduce stone-forming markers, such as glycollic acid oxidase and lactate dehydrogenase, while preventing kidney stone deposition. In diabetes management, the pseudostem shows anti-hyperglycemic effects by modulating advanced glycation end-products and improving kidney function, positioning it as a potential plant-based alternative for diabetic nephropathy. Furthermore, its nutraceutical applications extend to the development of functional foods and supplements, leveraging its rich nutritional profile of carbohydrates, fiber, protein, and essential minerals. By transforming the pseudostem from an underutilized byproduct into a valuable resource, Musa paradisiaca offers sustainable solutions for healthcare and agriculture. This review underscores the pseudostem's potential in Ayurveda medicine, advocating its inclusion in dietary regimens and therapeutic formulations to address chronic conditions effectively.

Introduction:-

Musa paradisiaca, commonly referred to as the banana plant, is a tropical herb known for its diverse nutritional and medicinal properties, which are valued across many cultures. While the fruit is popular for its high carbohydrate content and essential vitamins, other parts of the plant, such as the pseudostem and peel, have gained considerable interest due to their therapeutic benefits. These often-overlooked components, typically regarded as agricultural byproducts, are now being studied for their pharmacological properties, revealing promising possibilities for their use in modern medicine and healthcare. Recent studies have highlighted the potential of Musa paradisiaca pseudostem as a natural remedy, owing to its anti-inflammatory, diuretic, anti-urolithiatic, and nephroprotective properties.

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Methodology:-

This review aims to compile and critically analyze the current evidence on the pharmacological effects of the banana pseudostem, focusing on its role as a potent nutraceutical in the prevention and management of diseases.

Results:-Musa paradisiaca, a member of the **Musaceae** family, is a large, perennial herb widely grown in tropical and subtropical regions[1]. Its true stem remains underground as a rhizome, while the visible pseudostem is formed by densely packed leaf sheaths. The plant typically reaches heights of 2 to 9 meters[1]. The leaves are large, simple, oblong, and spirally arranged, with a sheathing base, prominent midrib, and parallel venation. The inflorescence is branched spadix.

- The flowers are protected by large, brightly coloured, spirally arranged, boat shaped bracts called spathes.
- When the flowers open, the spathes roll back and finally fall off.
- The flowers are polygamous i.e. staminate flowers, pistillate flowers and bisexual flowers are present in the same plant.

Cultivated forms of fruits are usually seedless, whereas wild varieties may contain small, hard seeds. Edible bananas form through vegetative parthenocarpy, a process in which the ovary develops into an edible fruit without requiring fertilization or pollination. This results in seedless bananas. A bunch of bananas consists of multiple clusters called "hands," with each fruit within a cluster known as a "finger." Botanically classified as a berry, the banana features a leathery outer skin (epicarp), a somewhat fibrous middle layer (mesocarp), and a soft, fleshy inner layer (endocarp). Propagation occurs vegetatively through suckers or rhizome segments, making it an essential agricultural crop and a vital source of food and economic value worldwide.

Nutritional profile[2]:

A study conducted in Sarawak, Malaysia, evaluated the pseudostems of six common banana cultivars and found that, on average, the pseudostem core contains approximately 50% carbohydrates, 19% crude fiber, and 13% protein per 100 grams of edible portion. It is also rich in minerals, with around 8.0% potassium, 0.4% each of phosphorus, magnesium, and calcium, as well as 335 ppm of iron, 200 ppm of manganese, and 46 ppm of zinc. These values surpass the nutritional content typically found in banana fruits, highlighting the pseudostem's potential as a valuable nutritional resource. This discovery opens avenues for further research into its sustainable use in food, health, and pharmaceutical industries.

Experimental Studies:

Anti-urolithiatic effect of Musa paradisiaca stem kernel juice[3]:

A study substantiates the anti-urolithiatic effect of Musa paradisiaca stem kernel juice through its impact on key biochemical markers associated with stone formation. In the urolithiatic rats, there was a significant increase in the activities of glycollic acid oxidase (GAO) and lactate dehydrogenase (LDH), both of which are involved in oxalate synthesis, along with elevated deposition and excretion of stone-forming constituents in the kidneys and urine. However, treatment with the Musa stem kernel extract significantly reduced the activities of these oxalate-synthesizing enzymes, as well as the level of crystalline components in both the kidneys and urine. Additionally, the extract lowered the activities of several urinary enzymes, including alkaline phosphatase, r-glutamyl transferase, inorganic pyrophosphatase, and β-glucuronidase, which are typically elevated in calculogenic conditions. Notably, no significant changes were observed in leucine amino peptidase activity, reinforcing the targeted action of the extract on specific pathways. The reduction in urinary oxalate levels, combined with decreased GAO and LDH activities, highlights the potential of Musa paradisiaca stem kernel extract as an effective anti-lithogenic agent, contributing to the prevention and management of urolithiasis.

Anti-urolithiatic effect of Herbmed Plus[4]:

Herbmed Plus, a herbal formulation from Crataeva nurvala stem bark and Musa paradisiaca stem, showed no toxicity or adverse effects on animal body weight and food intake. It improved SGPT levels and urine output (5.4 mL/24 h vs. 3.47 mL/24 h) and significantly reduced calcium oxalate crystals in both male (0.5 vs. 22) and female rats (0 vs. 22.7). The treatment lowered lactate dehydrogenase, alkaline phosphatase, and urinary phosphorus levels, while increasing urinary citrate, indicating anti-urolithiatic effects. Herbmed Plus also reduced oxalate synthesizing

enzymes, suggesting anti-urolithiatic, anti-inflammatory, and regenerative properties. The test group showed 69.7% recovery in males and 47.57% recovery in females, demonstrating significant efficacy in urolithiasis management.

Another study demonstrates that banana pseudostem (BS) mitigates diabetic nephropathy by modulating molecular changes in the kidney induced by sustained hyperglycemia.[5] Diabetes, induced in male Wistar rats through streptozotocin, led to the over-expression of glucose transporters (GLUTs 1, 2, 5, and SGLTs 1, 2), protein kinase C-α (PKC-α), and transforming growth factor-β (TGF-β), which contribute to the synthesis and accumulation of extracellular matrix (ECM) components such as laminin, fibronectin, and type-IV collagen. Diet supplementation with 5% BS significantly reduced the expression of these markers, evaluated using RT-PCR, ELISA, and immunohistochemistry, to levels comparable with aminoguanidine (a positive control). These changes resulted in a marked reduction in the accumulation of ECM components, alleviating kidney damage associated with diabetic nephropathy. The findings suggest that BS possesses a protective role at the molecular level, highlighting its potential as a dietary supplement to manage and prevent diabetic nephropathy.

Anti-diabetic effects of banana pseudostem[6]:
The study highlights the anti-diabetic effects of banana pseudostem (Musa sp. var. elakki bale), along with the flower, in managing diabetes-related symptoms and complications. Both banana flower and pseudostem were shown to have a low glycemic index and high levels of dietary fiber and antioxidants, which are beneficial for glycemic control. In diabetic rats, treatment with banana pseudostem alleviated common diabetic symptoms such as hyperglycemia, polyuria, polyphagia, polydipsia, and urine sugar and helped maintain body weight. The elevated glomerular filtration rate (GFR) in untreated diabetic rats (5.1 ± 0.22 ml/min) was significantly reduced to 3.0 ± 0.45 ml/min in the pseudostem-fed group, suggesting an improvement in kidney function. Additionally, the formation of advanced glycation end-products (AGEs), which contribute to diabetic complications, was inhibited. In diabetic kidneys, AGEs were reduced from 11.5 ± 0.64 μg/mg protein to 9.29 ± 0.24 μg/mg protein in the pseudostem-treated group, a significant decrease ($P < 0.01$). These findings support the role of banana pseudostem as a beneficial food supplement with anti-hyperglycemic and anti-AGEs properties for diabetic management.

Another study which examined the effect of Musa paradisiaca stem juice on blood glucose levels (BGL) in normal and diabetic rats[7]. A dose of 500 mg/kg body weight resulted in a notable 28.3% increase in BGL after 6 hours of oral administration in normal rats. In sub-diabetic rats, the same dose caused a 16.4% rise in BGL within 1 hour during a glucose tolerance test (GTT) and a 16% increase in fasting blood glucose levels after 4 hours in severely diabetic cases. The study states that observed hyperglycemic effect does not necessarily negate its potential antidiabetic properties in patients with type 2 diabetes mellitus. The plant may act through indirect mechanisms, such as inhibiting glucose absorption in the small intestine, similar to the action of metformin, the only plant-derived drug approved for diabetes management.

Clinical study on upper urinary-tract calculi[8]:
A clinical study shows that the Ayurvedic formulation Herbmed, which includes varuna and banana pseudostem, demonstrates significant efficacy in managing upper urinary-tract calculi, particularly renal calculi. In the study, participants in Group A who received Herbmed experienced a 33.04% reduction in calculus size, compared to a 5.13% increase in the placebo group ($p = 0.017$). Similarly, Group B showed positive results, with an 11.25% reduction in the active arm versus a 1.41% reduction in the placebo arm. Additionally, those receiving Herbmed reported substantial pain relief, as indicated by lower Visual Analogue Scale (VAS) scores at peak pain ($p = 0.008$), average pain ($p = 0.001$), and initial pain episode ($p < 0.0001$) compared to the placebo group. These findings suggest that Herbmed effectively aids in dissolving and passing renal calculi while significantly reducing pain, highlighting its therapeutic potential for renal and ureteric calculus disease. Further large-scale studies are needed to validate these initial findings.

Discussion:-

The therapeutic potential of pseudostem of Musa paradisiaca, has been extensively explored in various experimental models, demonstrating a range of beneficial effects, particularly in the areas of anti-urolithiatic, anti-diabetic, and anti-venom properties. The results from multiple studies underscore the diverse pharmacological applications of banana pseudostem and its derivatives, which hold promise for managing conditions such as urolithiasis, diabetic nephropathy, and snake venom envenomation.

The anti-urolithiatic properties of banana pseudostem and its extracts are particularly noteworthy. Studies have shown that Musa paradisiaca stem kernel juice significantly reduces markers associated with stone formation, including the activities of glycollic acid oxidase (GAO) and lactate dehydrogenase (LDH). Additionally, it reduces the deposition of stone-forming constituents in the kidneys and urine, highlighting its potential as an effective anti-lithogenic agent. Similarly, the herbal formulation Herbmed Plus, combining Musa paradisiaca with other plant ingredients, further supports its efficacy in reducing calcium oxalate crystals and restoring normal kidney function.

In the context of diabetes, banana pseudostem has demonstrated significant anti-hyperglycemic effects. Its ability to reduce advanced glycation end-products (AGEs) and modulate kidney function through molecular changes makes it a promising candidate for managing diabetic nephropathy. Furthermore, the extract's impact on glucose levels in normal and diabetic rats suggests a dual action—both direct and indirect mechanisms—that could be beneficial in managing type 2 diabetes mellitus. The observed hyperglycemic effect at higher doses does not negate its potential anti-diabetic properties, which could be leveraged through mechanisms similar to those of metformin, a plant-derived drug approved for diabetes management.

Given the wide range of therapeutic applications and the growing interest in plant-based health supplements, Musa paradisiaca pseudostem holds considerable promise for development into a nutraceutical. Its rich nutritional profile, including high levels of carbohydrates, fiber, protein, and essential minerals, makes it an excellent candidate for functional foods and dietary supplements. The health benefits demonstrated in the studies, such as its anti-urolithiatic, anti-diabetic, and anti-inflammatory properties, could form the basis for creating nutraceutical formulations aimed at managing chronic conditions like kidney stones, diabetes, and related complications. The pseudostem, often underutilized as a waste product in banana cultivation, could be processed into powder, capsules, or extracts, thereby adding value to agricultural practices while also addressing nutritional and therapeutic needs. Moreover, the plant’s ability to manage blood glucose levels and protect kidney function presents opportunities for developing targeted nutraceuticals for diabetic patients, especially those at risk of nephropathy.

Conclusion:-

In conclusion, the diverse pharmacological activities of Musa paradisiaca, particularly its anti-urolithiatic and anti-diabetic effects, highlight its potential as a valuable therapeutic agent. Its ability to modulate biochemical markers associated with kidney damage and stone formation, along with its promising effects on blood glucose regulation underscores the need for further research. The nutritional richness of banana pseudostem also makes it an attractive candidate for nutraceutical development. Future studies should focus on large-scale clinical trials to validate these initial findings, explore the full therapeutic potential of Musa paradisiaca in the management of various health conditions, and investigate its viability as a functional food or dietary supplement aimed at improving health outcomes.

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