



### POTENTIAL OF *BAJRA* [*PENNISETUM GLAUCUM* (L.) R. BR.] IN HEALTH AND DISEASE

Kavya.N<sup>1\*</sup>, Kavya.B<sup>2</sup>, Rama Rao V<sup>3</sup>, Kishore Kumar R<sup>4</sup>, Shubhashree MN<sup>4</sup>, Shiddamallayya N<sup>5</sup>, Sulochana Bhat<sup>6</sup>

\*<sup>1</sup>Senior Research Fellow (Ayurveda), <sup>2</sup>Junior Research Fellow (Botany), <sup>3</sup>Research Officer (Botany), <sup>4</sup>Research Officer (Ayurveda), <sup>5</sup>Asst.Research Officer (Botany), <sup>6</sup>Research officer, Scientist - 3 (Ayurveda), Regional Ayurveda Research Institute for Metabolic Disorders G.C.P.Annexe, Ashoka Pillar, Jayangar, Bengaluru, Karnataka, India.

#### ABSTRACT

Bajra, also known as pearl millet, African millet or spiked millet, originated in Northern-Central Sahel of West Africa, was introduced 2500 years ago into Indian subcontinent. However, it is mentioned in Ayurvedic texts from 14<sup>th</sup> Century AD onwards as '*Nali*' under *Truna dhanya* or *Kudhanya vargas*. It is considered as a major source of Gluten free diet and is used in the management of Coeliac disease and other gluten allergy conditions worldwide. Indians are also including millet into their day to day diet in accordance with the global trend. However the conditions of Gluten allergy and Coeliac disease are not common in Southern India. Hence, the necessity of Gluten free diet in South Indian Population is under question. It is hypothesized that excessive millet usage could be a reason behind thyroid dysfunction and goitre. Regular millet only diet may also lead to a nutrition deprived state in people who are not gluten sensitive. Ayurveda also emphasizes on avoidance of regular use of *Kudhanyas*. This review comprises different aspects of dietary inclusion of Bajra. The properties and usability of Bajra as a gluten free diet, utility of Bajra in populations which are not gluten allergic and the effects of Bajra on health and disease form the core of this review.

**KEYWORDS:** *Bajra*, *Nali*, *Pennisetum glaucum*, Diet, Ayurveda, Gluten, Thyroid.

#### INTRODUCTION

*Bajra*, botanically known as *Pennisetum glaucum* (L.) R. Br., is a potential millet grain cultivated in arid and semi-arid regions of India. It is the second most cultivated and consumed millet of the country. It is a major cereal crop in West Africa and also widely grown in Eastern and Southern Africa. The oldest archaeological evidence of pearl millet cultivation was found in Mali and dated at around 4,500 BP. Race *typhoides* includes relics of the oldest cultivated pearl millets. It was the progenitor of the West African cultivated races, became widely distributed across the semi-arid tropics of Africa, and probably reaching India some 2500 years ago. Pearl millet is the staple food for over 100 million people in parts of tropical Africa and India. Pearl millet is rich in several nutrients and also in non-nutrients such as phenols. It has high energy, has less starch, high fiber and is gluten free<sup>[1]</sup>.

Gluten free diet has been advocated particularly to patients of Coeliac disease as they are more susceptible to gluten in commonly used cereals such as Wheat and Barley. Millets have gained importance in diet as they are nutritional, gluten free and also economical. The nutritional aspects of *Bajra* are being explored extensively and in recent years, the millet is widely used as a prime gluten free dietary article.

However Ayurveda does not advocate regular usage of millets as food. Millets are included under *Kudhanyas*, the very word is derived from *Kutsita dhanya* meaning that which is contemptible. Hence a need to explore the benefits and ill-effects of usage of *Bajra* in health and disease arises.

#### TAXONOMIC CLASSIFICATION

Kingdom	: Plantae
Subkingdom	: Viridiaeplantae
Infra-kingdom	: Streptophyta
Super-division	: Embryophyta
Division	: Tracheophyta
Subdivision	: Spermatophytina
Class	: Magnoliopsida
Subclass	: Commelinidae
Super order	: Lilianae
Order	: Poales
Family	: Poaceae (Grass Family)
Genus	: <i>Pennisetum</i> L.
Species	: <i>Pennisetum glaucum</i> (L.) R.Br.

#### Botanical Description

Pearl millet belonging to the family Poaceae is a robust annual grass up to 4 m tall (Fig.1), with basal and nodal tillering. The root system is extremely profuse; sometimes the nodes at ground level produce thick, strong prop roots. The stems are slender, 1-3 cm in diameter, solid, often densely villous below the panicle with nodes prominent. Leaves are alternate and simple; leaf sheath often hairy; ligule short, membranous, with a fringe of hairs; blade linear to linear-lanceolate, up to 1.5m × 8cm, often pubescent, margins minutely toothed, somewhat rough. The inflorescence is a cylindrical, contracted, stiff and compact panicle, suggesting a spike, up to 200cm long with rachis cylindrical, bearing densely packed clusters of

1–5 spikelets, subtended by a tuft (involucres) of up to 90 bristles about as long as spikelets, but in some cultivars with a few stiff bristles up to 2cm long (Fig.2,3). The spikelets are obovate, 3–7mm long, usually 2-flowered with glumes 2, lower one c.1mm long, upper one c.2.5mm; lower floret male or sterile, upper one bisexual; lemma ovate, pubescent on margins; palea almost as long as lemma; lodicules are absent. 3 stamens are present with anthers 2–5mm long, tipped with brush-like bristles; ovary superior, obovoid, smooth, with 2 hairy stigmas, connate at the base. Fruit is a free-threshing caryopsis (grain), globose to cylindrical or conical, 2.5–6.5mm long, variously coloured, from white to pearl-coloured or yellow to grey-blue or brown, occasionally purple, hilum is marked by a distinct black dot at maturity (Fig.4).<sup>[2]</sup>

### Botanical Synonyms

*Panicum glaucum* L., *Setaria glauca* (L.) Beauv., *Pennisetum typhoideum* Rich., *Panicum indicum* Mill., *Pennisetum americanum* (L.) K. Schum., *Pennisetum spicatum* (L.) Roem. & Schult.

### Chemical and Nutritional Value

The pearl millet grains are known to contain about 12% proteins, 5% ether extractives (including fats) and 67% carbohydrates. It is said to be a rich source of minerals and vitamins of the B group. They are also rich in the minor components (anti-nutritional) such as phenolics, phospholipids and fatty oils. The total phenolics in the form of gallotannins present are about 4.08 mg/1g. All the phenolic acids present in pearl millets identified as *p*-hydroxy benzoic acid (antibacterial, anti-sickling, immunosuppressant, cancer preventive and fungistat), ferulic acid (analgesic, antiallergic, anti-inflammatory, hepatoprotective and antihepatotoxic, immunostimulant, antiallergic, arteriodilator and acts against cancer in the colon, liver and skin), *p*-coumaric acid (antibacterial, antiseptic, antitumour, antioxidant and fungicidal), vanillic acid (anthelmintic, anti-fatigue, anti-inflammatory, antilaeukemic, antiseptic and antisickling) and syringic acid (antioxidant, anti-peroxidant and anti-radicular) are known to have distinct pharmacological properties<sup>[3]</sup>.

The phospholipids present in pearl millets are lecithins and cephaelins. The flavonoids present in pearl millets are triclin (anticarcinogenic, antileukaemic, antioxidant, antitumor and estrogenic, also inhibits cyclooxygenase enzymes and attenuation modulation of cyclooxygenase-mediated prostaglandin production), 7-OMe luteolin (inhibit tumor necrosis factors) and acacetin. They are known to have a positive role in strengthening the capillary walls, thinning blood by reducing the agglutination of RBCs and even preventing cancer. The pearl millets consist of golden yellow fatty oil (5.23%),  $\alpha$ -Linoleic acid (45.6%), Oleic acid (28.5%) and Palmitic acid (20.6%); Linolenic (2.1%) and Stearic acid (1.5%) as minor fatty acids. The high amounts of oils are rich in linoleic acid - omega 6-fatty acid, is highly significant because this acid is easily converted to n-6 eicosanoids, n-6 prostaglandin and n-6 leucotriene hormones. This provides targets for drug development in arthrosclerosis (B.P), asthma, arthritis, immunity development etc. Oleic acid - omega-9 fatty acid, is also equally important having all the health benefits of linoleic acid. Linolenic acid is an essential fatty acid useful in conditions of rheumatoid

arthritis, cardiac arrhythmias, depression and reduces the risk of ischemic and thrombotic stroke<sup>[3]</sup>.

### Bajra In Ayurveda

*Bajra* is known to have entered India around 2500 years ago. However, the millet finds its mentioning in Ayurvedic texts only since the 14<sup>th</sup> Cen. AD. It is known to be *Nali* in Sanskrit and the very first mentioning of the word *Nali* is found in Madanapala Nighantu (1374 AD)<sup>[4]</sup> under *Truna Dhanyas* (Poaceae). The author mentions the properties of the *Truna dhanyas* in common and the properties of *Nali* are not mentioned in detail. Nighantu rathnakara placed in the 18<sup>th</sup> century has given a detailed explanation of *Bajra*<sup>[5]</sup>. 19<sup>th</sup> Century works like Priya nighantu contemplate *Bajra* and its properties under the name *Vajranna*<sup>[6]</sup>. *Nali*, *Nalika*, *Nilakana*, *Nilasasya*, *Agradhanya*, *Sajjaka*, *Varjari*, *Varharika*, *Vajranna*, *Barjaree* are some of the terminologies coined for the drug *Bajra*.<sup>[7]</sup>

### Properties of Nali

The Pharmacokinetics and Pharmacodynamics of a drug are explained in Ayurveda under five attributes termed as *Rasapanchaka*. *Rasa* (Taste of the drug), *Guna* (Properties and effect it has on the body following consumption), *Veerya* (Potency of the drug, whether it has a catabolic or anabolic effect on the body), *Vipaka* (Post digestive effect on metabolism). Based on the above, the probable action of the drug can be understood in terms of its effect on the *Doshas* (Bio-forces governing the body whose equilibrium and disparity determines health and ill health).<sup>[8]</sup>

*Nali* is said to possess *Madhura rasa* (Sweet in taste), is *Ruksha* (Dry) and *Laghu* (Light), *Ushna veerya* (Hot in potency, Catabolic in nature), *Katu vipaka* (Post digestive Pungentness) and is said to vitiate *Vata* and *Pitta* as per Madanapala nighantu<sup>[4]</sup> and Priya nighantu<sup>[6]</sup>. It also acts as *Shleshmahara* (Pacifies *Kapha dosha*). The other properties and actions ascribed to *Nali* are *Balya* (Strength promoting), *Durjara* (Difficult for digestion) *Pumstvahara* (Antaphrodisiac), *Vilekhana* (Scarifying), *Baddhanisyanda* (Dries up and accumulates the fluid tissues of the body)<sup>[5]</sup>. Nighantu rathnakara opines differently from the above authors. *Nalika* has *Katu* and *Tikta rasa* (pungent and bitter in taste), along with *Madhura*. The potency of *Bajra* is said to be *Sheetoshna* and it possesses *Teekshna guna*. *Bajra* pacifies *Vata* and *Pitta* according to Nighantu rathnakara<sup>[5]</sup> which is the contrary of the view mentioned in Priya nighantu<sup>[6]</sup>. The diseases which are said to be alleviated by *Bajra* are *Raktapitta* (Bleeding disorders), *krumi* (Worm infestation), *Visha* (Poisoning), *Shula* (GI ulcers), *Ashmari* (Calculi), *Mutrakrucchra* (Dysuria), *Raktadosha* (haematological disturbances), *Trusha* (Dyspepsia), *Kandu* (Pruritis), *Jvara* (Fever), *Vrana* (Wounds and ulcers) and *Durnama* (Haemorrhoids).<sup>[5]</sup>

### Importance of Bajra In Gluten Related Diseases

*Bajra* is considered important gluten free dietetic which is advocated to patients of celiac disease and other gluten related diseases.

Gluten is a general term used to describe a mixture of wheat storage proteins (prolamins and glutenins). Prolamins are characterized by a particular amino acid composition with domains with a high content of proline and glutamine. It has been demonstrated that

these protein domains are resistant to degradation by gastric, pancreatic and proteases in the human intestinal brush border membrane. This results in an accumulation of relatively large peptide fragments. The study of the molecular mechanisms about the toxic effect of protein fragments has demonstrated that these peptides both *in vivo* and *in vitro* induce mucosal damage and/or behave as "immunogenic" (i.e. are able to specifically stimulate HLA-DQ2 or HLA-DQ8).<sup>[9]</sup>

### Gluten Related Disease Spectrum

The three main forms of Gluten reactions are Allergic (Wheat allergy), Auto immune (Coeliac disease, dermatitis herpetiformis and gluten ataxia) and Immune mediated (Gluten sensitivity)<sup>[10]</sup>. Wheat allergy is defined as an adverse immunologic reaction to wheat proteins. Depending on the route of allergen exposure and the underlying immunologic mechanisms, it is classified into classic food allergy affecting the skin, gastrointestinal tract or respiratory tract; wheat-dependent, exercise-induced anaphylaxis (WDEIA); occupational asthma (baker's asthma) and rhinitis; and contact urticaria. IgE antibodies play a central role in the pathogenesis of these diseases<sup>[10]</sup>.

Coeliac disease is one of the commonest forms of Gluten related diseases and is an immune-mediated enteropathic condition triggered in genetically susceptible individuals by the ingestion of gluten<sup>[11]</sup>. The prevalence of Coeliac Disease is characterized by chronic inflammation of the intestinal mucosa, atrophy of intestinal villi and several clinical manifestations<sup>[9]</sup>. The onset of symptoms is usually gradual and characterized by a time lag of months or years after gluten introduction<sup>[10]</sup>. Coeliac disease can present with many symptoms, including typical gastrointestinal symptoms like diarrhea, weight loss, bloating, flatulence, abdominal pain and also non-gastrointestinal abnormalities like abnormal liver function tests, iron deficiency anaemia, bone disease, skin disorders, and many other protean manifestations<sup>[12]</sup>. Dermatitis herpetiformis is a skin manifestation of Coeliac disease presenting with blistering rash and pathognomonic cutaneous IgA deposits<sup>[10]</sup>. Gluten ataxia is an autoimmune disease characterized by damage to the cerebellum resulting in ataxia<sup>[10]</sup>. Non coeliac gluten sensitivity is characterized by symptoms that usually occur soon after gluten ingestion, disappear with gluten withdrawal and relapse following gluten challenge, within hours or few days. The classical presentation is a combination of IBS-like symptoms, including abdominal pain, bloating, bowel habit abnormalities (either diarrhoea or constipation), and systematic manifestations such as headache, fatigue, joint and muscular pain, leg or arm numbness, dermatitis, depression and anaemia<sup>[13]</sup>.

### Necessity Of Gluten Free Diet In India

A gluten free diet is the foremost plan in the management of Gluten related disorders. *Bajra*, in various forms, is advocated to such patients and also the people who are susceptible for Gluten related diseases.

It is essential to ponder over the necessity of incorporating gluten free millet diet in India. The gluten allergy conditions such as Coeliac disease occur majorly in the Western countries. Coeliac disease affecting adults is also now well recognized in wheat staple Northern Indian population, and in many of these individuals the

presentation is atypical, i.e. without diarrhoea or overt malabsorption. The prevalence of celiac disease in southern India is not known. Anecdotal experience of physicians and gastroenterologists in southern India suggests that it is very infrequent in southern India. Differences in celiac disease prevalence between North and South India could be ascribed to differences in dietary patterns (Rice being the staple cereal in South India) or due to differences in genetic make-up.<sup>[14]</sup>

*Bajra* is consumed quite often in northern parts of Karnataka State, India. Nevertheless, the traditional practice is such that the people never consume it during summers as it may lead to constipated bowels. They usually consume *Bajra rotis* once a week only during monsoons and winter seasons.

Hence the induction of gluten free diet does not really seem to be appropriate in Southern India. Further, regular millet-only diet leads to various nutritional deficiencies in the population. The Ayurvedic lexicons have suggested reduced or occasional use of *Kudhanya* (minor cereals) due to their properties like *Rukshata*, *Vilekhana* and *Baddha nishyanda*<sup>[6]</sup>. The very word *Kudhanya* is derived from *Kutsita dhanya* meaning that which is contemptible.<sup>[15]</sup>

Also, research proves that millets on regular consumption act on iodine metabolism. Feeding millet to rats produces histological changes in the thyroid glands of rats and distorts the thyroid hormones pattern. The super imposition of the areas where millet is cultivated and consumed in Africa and regions of high endemicity of goitre suggests that millet is a contributory factor to this endemicity.<sup>[16]</sup>

Thus, implementing the gluten free diet in people who are not gluten allergic, will harm, more than help the health of the individual. The trend of using *Bajra* on a regular basis in healthy conditions is hence not advised particularly in South Indian population.

However, there are certain benefits of *Bajra* in treatment of various diseases as mentioned by Nighantu rathnakara. The *Tikta rasa* (bitter taste) helps in purification of *Raktadhatu* (blood) and helps in alleviation of problems such as *Rakta dosha*, *Kandu*, and *Vrana*. Hepatoprotective effect of *Bajra* also acts positively in the above mentioned conditions. The anti inflammatory and antioxidant property of *Bajra* also helps in faster wound healing. The *Ruksha guna* of *Bajra* helps in haemocoagulation and thus provide relief from bleeding disorders such as *Raktapitta*. In diseases like *Jvara* caused due to microbial infections, the antimicrobial property of *p*-hydroxy benzoic acid present in *Bajra* acts towards fever relief. Thus the utility of *Bajra* in different diseases can be substantiated and brought into practical platform.

### CONCLUSION

*Bajra* being an important millet crop is consumed as a major gluten free source. However, its regular use is not advisable for South Indian population who are not susceptible to gluten allergy. Ayurveda speaks of its utility in different diseases, but does not advocate the regular use of this millet in food. Further research will be necessary to corroborate the usability of pearl millet in health and disease.



**REFERENCES**

1. De Wet JMJ, Bidinger FR, Peacock JM. Pearl millet (*Pennisetum glaucum*) - a cereal of the Sahel. Cereals Program, ICRISAT, India. 1992; 259-267.
2. Andrews DJ and Kumar KA. *Pennisetum glaucum* (L.) R.Br. In: Brink M and Belay G (Editors). PROTA 1: Cereals and pulses/Céréales et légumes secs. [CD-Rom]. PROTA, Wageningen, Netherlands. 2006.
3. Daniel M, Denni M, Chauhan D. Polyphenols, phospholipids and fixed oil composition of pearl millet [*Pennisetum glaucum* (L.) R. Br.]. Int. J. of Pharm. & Life Sci. 2012; 3(11):2098-2102.
4. Madanapala Nrupa, Madanapala Nighantu, Published by Ganga Vishnu Sri Krishnadas, Bombay, 1867., Tpg-296.
5. Nighantu rathnakara, edited by Bhashagvarya navra Krishnashastri, Published by Jawaji Vasudev, Bombay 1936, Tpg 808.
6. Sharma Priyavrat, Priya nighantu, 2nd ed, Varanasi: Choukamba surabharati prakashana; 1995, Tpg-275.
7. Gurudeva MR. Botanical and Vernacular names of South Indian Plants, India: Divyachandra Prakashana; 2001, Tpg-1004: Pp-311.
8. Kavya N, Kavya B, Ramarao V, Kishore kumar R, Venkateshwarlu G. Nutritional and therapeutic uses of Mudga [*Vigna radiata* (L.) R. Wilczek]: A potential interventional dietary component. Int. J. Res. Ayurveda Pharm. 2014; 5(2): 238-241.
9. Saturni L, Ferretti G, Bacchetti T. The Gluten Free Diet: Safety and Nutritional Quality. Nutrients. 2010; 2(1): 16-34.
10. Sapone et al. Spectrum of gluten-related disorders: consensus on new nomenclature and classification. BMC Medicine 2012; 10:13.
11. Fasano A, Berti I, Gerarduzzi T, Not T, Colletti RB, Drago S et al. Prevalence of Celiac Disease in At-Risk and Not-At-Risk Groups in the United States. A Large Multicenter Study. Arch. Intern. Med. 2003; 163(3): 286-292.
12. Rubio-Tapia A, Hill ID, Kelly CP, Calderwood AH, Murray JA. ACG Clinical Guidelines: Diagnosis and Management of Celiac Disease. Am J Gastroenterol 2013; 108:656-676.
13. Catassi C, Bai JC, Bonaz B, Bouma G, Calabro A, Carroccio A et al. Non-Celiac Gluten Sensitivity: The new frontier of Gluten related disorders. Nutrients 2013; 5(10): 3839-3853.
14. Ramakrishna BS. Coeliac disease: Can we avert the impending epidemic in India? Indian J Med. Res., 2011; 133: 5-8.
15. Williams SM, A Sanskrit-English Dictionary, Varanasi; Motilal Banarasidas publications; 1976; Tpg - 1333, Pp: 290.
16. Osman AK. Bullrush millet (*Pennisetum typhoides*) a contributory factor to the endemicity of goitre in Western Sudan. Ecology of Food and Nutrition 1981; 11(2): 121-128.

**Cite this article as:**

Kavya.N, Kavya.B, Rama Rao V, Kishore Kumar R, Shubhashree MN, Shiddamallayya N, Sulochana Bhat. Potential of Bajra [*Pennisetum Glaucum* (L.) R. Br.] In Health and Disease. International Journal of Ayurveda and Pharma Research. 2016;4(5):4-7.

**Source of support: Nil, Conflict of interest: None Declared**

**\*Address for correspondence**

**Dr Kavya.N**

Senior Research Fellow (Ayurveda),  
Regional Ayurveda Research Institute  
for Metabolic Disorders,  
G.C.P. Annexe, Ashoka Pillar,  
Jayangar, Bengaluru, 560 011.  
Phone No: 9886084305,  
Email: [dr.kavya.ayur@gmail.com](mailto:dr.kavya.ayur@gmail.com)