‘गथुवान’ चावल का प्रतिरक्षात्मक गुणधर्म

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भारतीय स्वदेशी चावल ‘गथुवान’ के प्रतिरक्षा-संशोधक गुणधर्मों का लक्षण-निर्धारण और उसका कृषि-विज्ञान सुधार

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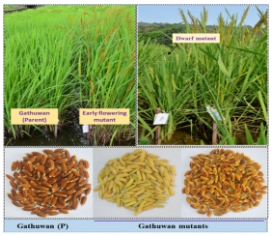

गथुवान की कृषि विशेषता में सुधार के लिए उत्परिवर्तन प्रजनन।

सारांश

स्वास्थ्य और रोगों के प्रबंधन में वर्तमान और संभावित चुनौतियों के वैश्विक परिदृश्य के कारण पौधों के खाद्य भागों में आनुवंशिक विविधता की खोज और उपयोग की आवश्यकता है। चावल की फसल विशिष्ट परिस्थितियों में उनके विकास के परिणामस्वरूप अनाज आकृति विज्ञान और संरचना की एक विशाल विविधता प्रदान करती है। छत्तीसगढ़ का एक देशी चावल, गथुवान, स्थानीय रूप से संधिशोथ के प्रबंधन के लिए उपयोगी रहा है। हालांकि, वैज्ञानिक आधार की कमी और सीमित कृषि विशेषताओं ने इसकी खेती को सीमित कर दिया है और इस पारंपरिक चावल का मूल्य अभी भी अज्ञात है। अध्ययन का उद्देश्य मानव स्वास्थ्य में अपनी कार्यात्मक भूमिकाओं को स्थापित करना और ऐसे आनुवंशिक संसाधनों के मूल्यांकन और संरक्षण की दिशा में एक दृष्टिकोण के रूप में इसके कृषि संबंधी लक्षणों में सुधार करना है।

Immunomodulatory Property of ‘Gathuwan’ Rice

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Characterization of Immune-modulatory Properties of an Indian Indigenous Rice ‘Gathuwan’ and its Agronomic Improvement

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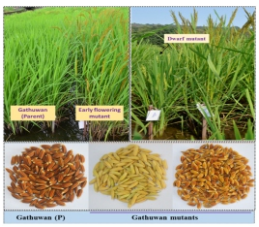

Mutation breeding for agronomic trait improvement of Gathuwan

ABSTRACT

The global scenario of current and potential challenges in the management of health and diseases necessitates exploration and utilization of genetic diversity in edible parts of plants. Rice crop offers a vast diversity of grain morphology and composition resulting from their evolution in specific conditions. Gathuwan, a native rice of Chhattisgarh, has locally been useful for the management of rheumatic arthritis. However, lack of scientific base and limiting agronomic traits have confined its cultivation and the value of this traditional rice remains unrecognized. The study aims to establish its functional roles in human health and improve its agronomic traits, as an approach towards valuation and conservation of such genetic resources.

KEYWORDS: *Immune-suppressive, Traditional rice, Gathuwan, Mutation breeding, Metabolomics*

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Introduction

The global challenges posed by increased burden of non-communicable diseases, limitations associated with the treatment of several disorders and sudden emergence of novel health threats have accelerated the adoption of 'food as medicine'. Rice is a major food crop with abundant diversity in plant and grain characters and hence, grown and consumed over wide geographical dimensions. Diversity in rice forms suiting different purposes has also been acknowledged in traditional medicine systems, including Indian *Ayurveda*. These traditional rice landraces/ farmers' varieties have acquired the specialty as a result of evolution over a long period of time in particular agroclimatic conditions. They constitute enriched genetic resources for bio-active compounds, which help in achieving better state of health and genes for resistance to biotic and abiotic stresses, thereby, serving as valuable assets in breeding programmes. However, lack of adequate scientific data supporting their biological effects has been a major limitation in the wider recognition of their values. Also, their non-sustenance in present times, is a result of inferior yield related traits. Scientific validation of their functional roles in human health, along with subtle changes leading to improved agronomic traits, is an effective approach to address both these concerns. Gathuwan, an indigenous rice variety native to Chhattisgarh, is characterized by purple pigmentation in culm, leaf margins and reddish colour husk of bold type grains. This local landrace of rice has been considered to be effective in treating rheumatism (गठिया in Hindi). However, its tall stature, spreading plant type, high tendency to lodge at maturity and long maturity duration, makes it agronomically undesirable. Hence, these limiting traits needed to be improved along with a thorough evaluation of its medicinal property.

Materials and Methods

80% Methanolic Gathuwan brown rice extract (BRE) was used for functional studies and metabolomics.

A. Murine splenic lymphocytes were used for in vitro studies. Lymphocyte activation was studied using fluorescently labelled antibodies, proliferation was studied by CFSE dye dilution method and cytokine levels were estimated using ELISA.

B. For Graft versus host disease (GvHD) induction, immunocompromised Balb/c mice were injected with lymphocytes from C57BL/6 mice. The donor cells were treated with BRE for one group of GvHD mice. A subset of each GvHD group were fed with brown rice on alternate days.

C. Nrf2 nuclear localization was studied using FITC labelled anti-Nrf2 antibody and nuclear staining using Hoechst dye.

D. Metabolomics data was obtained using Ultra-high performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) and analysed using Metaboanalyst 5.0.

E. Gathuwan paddy was mutagenised using 250 Gy gamma rays, with an objective to identify mutants with improved plant stature/maturity duration.

Results and Discussion

Rheumatoid arthritis (RA) is an autoimmune disorder, which renders body susceptible to attack by its own immune system. Self-reactive activated T cells infiltrate into the synovial fluid around the joints and activate macrophages/fibroblasts, turning them into tissue destroying effector cells[1]. The cascade of events includes activation of T cells by self-antigens presented by DCs, clonal expansion and pro-inflammatory cytokine secretion. The current treatment options suffer limitations such as variable responses among patients, drug resistance, side effects of long-term administration and thus, necessitating the use of safer alternatives with more uniform outcomes.

Immune-suppressive effects of BRE on T cell proliferation and functions

Gathuwan BRE decreased mitogen induced proliferation of T -cells (Fig.1) and prevented secretion of IL-2, IL-4, IL-6 and IFN-γ cytokines in a dose-dependent manner, and without imposing any significant cytotoxicity.

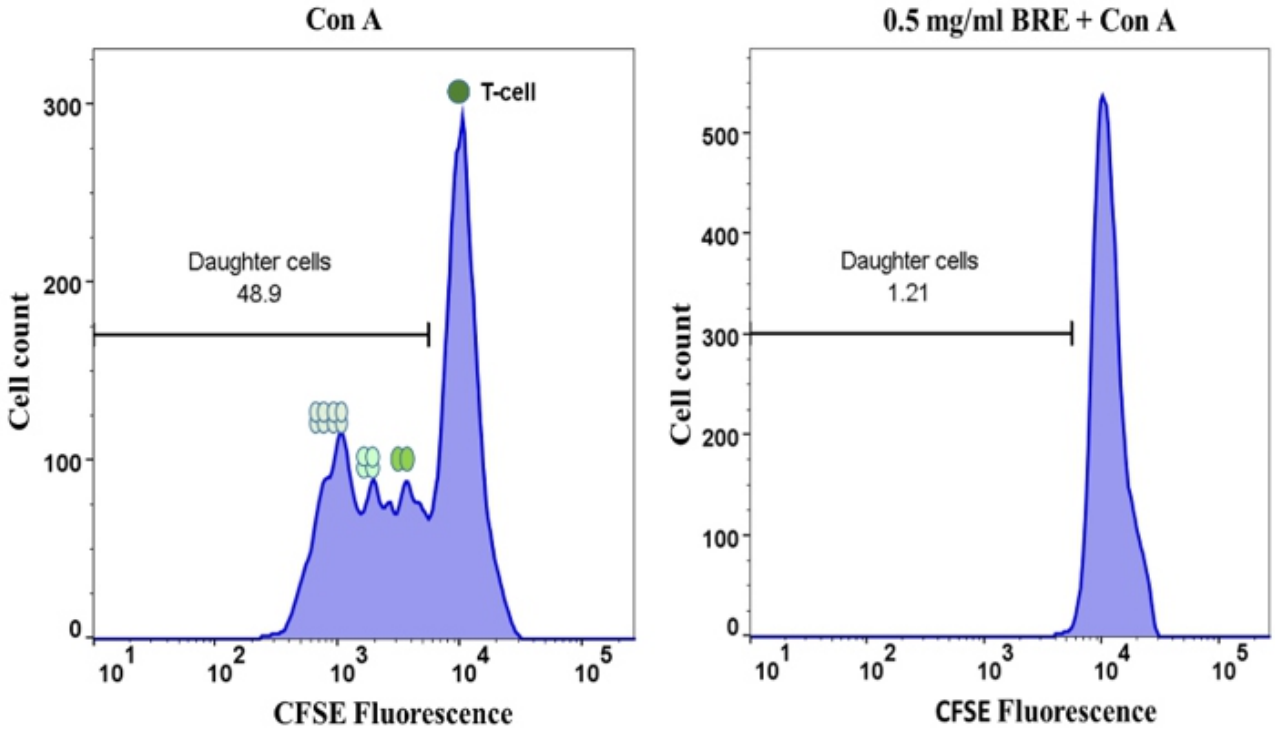

Fig.1: Effects of Gathuwan BRE on lymphocyte proliferation.

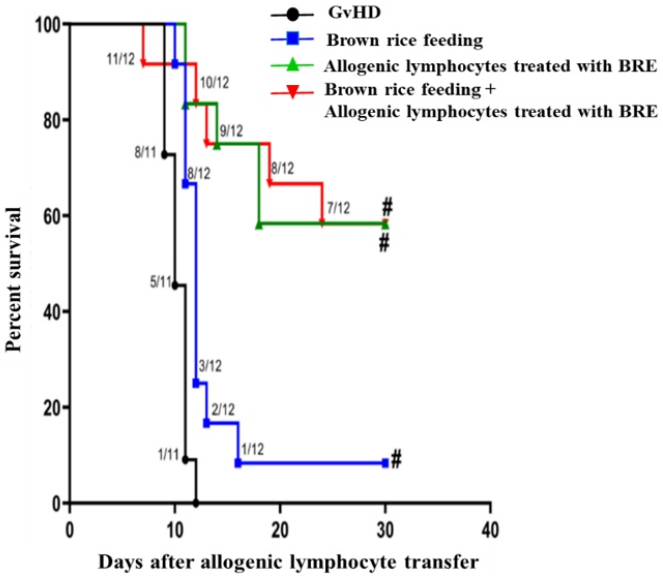

Fig.2: Effects of Gathuwan BRE on mortality in GvHD mice.

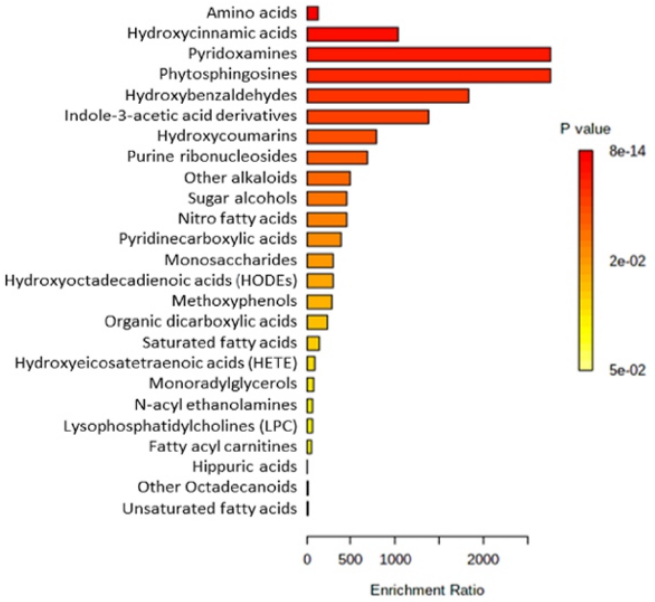

Fig.4: Nrf2 nuclear translocation induced by BRE.

In vivo activity of Gathuwan BRE

GvHDmice model represents a suitable method for in vivo assessment of immune-suppressive potential towards allograft mediated immune attack. Immunocompromised mice, when grafted with donor T-cells treated with Gathuwan BRE, showed reduced mortality compared to mice receiving untreated T cells (Fig.2).

Gathuwan BRE exerts its effects through Nrf2 signalling pathway

Nrf2 signalling pathway is a critical regulator of cellular redox homeostasis and inflammatory responses. [2].Nuclear translocation of Nrf2 and expression of Nrf2 dependent genes was found enhanced in treated lymphocytes (Fig.3). Nrf-2 dependence of the effects were further confirmed in Nrf2 knockout mice.

Metabolomic foundation of Gathuwan brown rice activity

Metabolic features determines the function of grain or other plant parts. Ultra-high performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) data of Gathuwan brown rice featured abundance of pryridoxamines, phytosphingosines, benzofurans, cyclic ketones and hydroxycinnamic acids (Fig.4). Among the many compounds that are reported to exhibit immune-modulatory or redox altering properties, more than half are known to affect Nrf2 signalling pathway[3].

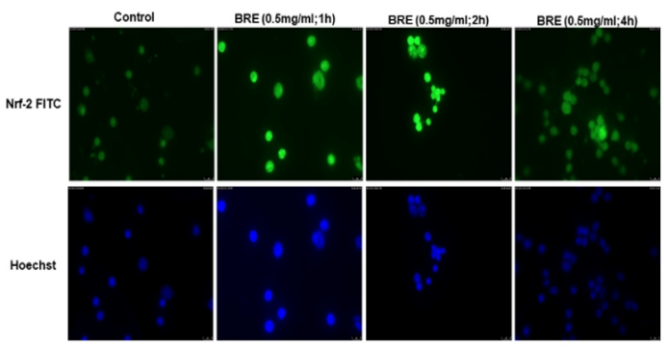

Fig.3: Nrf2 nuclear translocation induced by BRE.

Mutation breeding for improvement of plant stature and/maturity duration

Mutation breeding is a highly sought technique, in present times, to introduce novel mutations or improve few delimiting traits in otherwise highly useful genetic backgrounds. The Gathuwan parent plant attains 140-160 cm height and flowers in 130-140 days. M2 generation of Gathuwan was screened and mutants with either reduced plant height (<110 cm) and/or early maturity (20-25 days earlier than parent) were isolated, followed by homozygosity testing in subsequent generations. Some of the isolated mutants also showed changed grain type and/ husk colour. Mutants have been advanced up to M6 generations. Six mutants have been evaluated for their effects on induced cytokine production by lymphocytes. Two of these mutants have been observed to be promising in terms of bio-activity.

Conclusion

The study highlights the immune-suppressive potential of Gathuwan brown rice along with the mechanistic and biochemical basis and complements traditional knowledge.

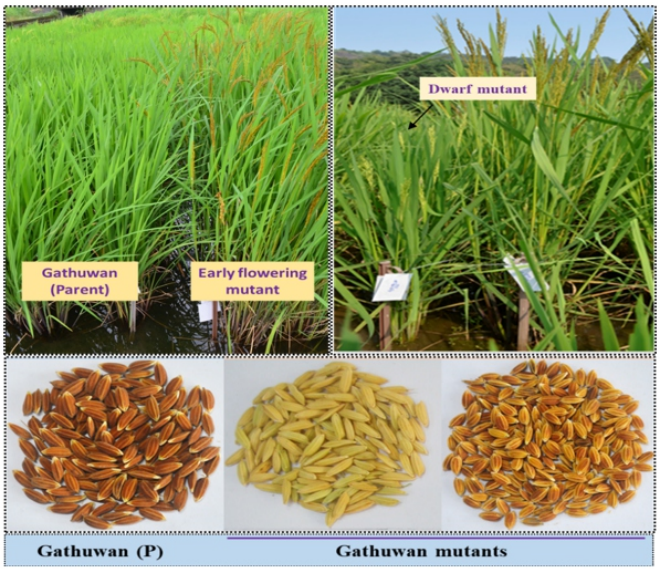

Fig.5: Mutation breeding for agronomic trait improvement of Gathuwan.

Agronomic improvement without compromising the health benefit will not only help its conservation and wider recognition, but will promote more explorations of rice germplasm.

References

[1] C. M. Weyand, J. J. Goronzy, Association of MHC and rheumatoid arthritis, HLA polymorphisms in phenotypic variants of rheumatoid arthritis, Arthritis Res 2, 2000, 212. https://doi.org/10.1186/ar90.

[2] A. Cuadrado, G. Manda, A. Hassan, M. J. Alcaraz, C. Barbas, A. Daiber, P. Ghezzi, R. León, M. G. López, B. Oliva, M. Pajares, A. I. Rojo, N. Robledinos-Antón, A. M. Valverde, E. Guney, H. H. H. W. Schmidt, Transcription Factor NRF2 as a Therapeutic Target for Chronic Diseases: A Systems Medicine Approach, Pharmacol Rev 70, 2018, 348–383. https://doi.org/10.1124/pr.117.014753.

[3] A. Chauhan, R. Checker, S. Nair, P. K. Sahu, D. Sharma, D. Sharma, B. K. Das, Indian traditional rice variety “Gathuwan” suppresses T-cell-mediated immune responses via activation of ERK/Nrf2/HO-1 signalling pathway, Food Funct., 14, 2023, 5232–5250. https://doi.org/10.1039/D3F000125C.