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RESEARCH ARTICLE

FUTURE PROSPECTIVE: TRADITIONAL RICE (ORYZA SATIVA L.) OF EASTERN INDIA

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Abstract

Rice was one of the most important field crop grown by farmers in different geographies in the World. It was grown due to its different unique with climatic, water, soil, genetic diversity, climatic – weather variance, dietary typical unique importance, cultural and rituals on food behavior among the growers. Rice is the major food energy source but on the other hand also meet the expectation of different valuable nutritive sources with unique nutritive qualities for different health benefit with essentials nutrients, vitamins, minerals, proteins, carbohydrate, protein and fat etc. Rice was used by the different tribal people with their unique knowledge with respect to the traditional varieties those were being cultivated over a decade with very good understanding of the varieties with respect to ecological adoptability, seasonal suitability, cultivation and management practices, rice grain, farm produces, grain and grains' by product with different unique health benefit and culturally adopted with different dices and preparations due to different health benefit and remedies. All the traditional rice cultivar was to be found very unique due to their unique qualitative identity found in the knowledge domain of the indigenous farmers and people. The traditional cultivars was the own self, it unique identity due natural or farmer's selection process and consumer preparation consumption prefer ability in brief. Cultivation of traditional cultivar, it ecological adaptiveness with respect to biological traits and genes on the other hand availability of different quality traits like, medicinal, aromatic, puffing, glutinous, kernel elongation, richness with protein, Zn, Fe, antioxidants and vitamins etc. A few leading traditional rice were popular among farmers in the region, Tulaipanji, Gobindabhog, Pajjam, Kalonunia, Tulsibhog, Pioli, Aghoni, Aghoni Bora, Bora, Bao, PioJoha, Jasua, Kalojira, Bhadui, Kalirai, Ramtulasi, Magusal, Jhingasal, Musisal, Rabansal, Motichur, Parijat, Agar, Ganga, Kuajoli, Nagraikalam, Chenga, Sasimahan, Binni Dhan, Dudheswar, Radhatilak, Soni Bhadui, Murisal, Balabhat, Brahmabalak, Sitabhog, Kalo Khasa, Khasa, Ponha, Khegurchori, Begun Bichi, Kotki, Kamal, Sada Nunia and Boka Kamol etc.

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Introduction:-

Rice (*Oryza sativa* L.) was the second most important cereal in the world and it was the staple food for most Asians and over 90% of the world's rice is produced and consumed in Asia. India was the second-largest rice-producing country in the world and the crop contributes over 42% to the annual food grain production of the country (Vijayakumar et al., 2021a).

Rice is the crop in east India by nature, not by choice, due to the richness of natural resources, climatic suitability and cultural adoption with the rice farming system. Water resource availability, topography of land and richness of the natural diversity existed in the rice germplasm, virgin soils of the Gangetic plain and culture evolution with different food from rice recopies evolved in the region. East India geographically, may be marked from Odisha, West Bengal and Bihar including Sikkim. The region was also remark as the centre origin of rice (*Oryza sativa* L.). Rice crop cultivated in different seasons with direct seeded or transplanting system of cultivation. Traditional cultivar or landraces were naturally evolved by means of natural evolution in the rice farming system in the sub-centre of origin, rice (*Oryza sativa* L.). Traditional cultivars were naturally evolved in the region so called native to the origin. The Genetic or varietal diversity also very rich in the region existed due to close involvement of the people of the region and the understanding the nature of rice varieties with their daily life. In the very early, people grew various crop in their field and meet their healthy food requirement. After the development of high yielding varieties people focus on the yield, rather than diversity and quality with nutri-rich food. Farmers were started to grow vertically, more high yielding varieties and gradually loosed the interest on old typical cultivars due to not growing all the different varieties/seeds. After, the green revolution due to growing high yielding varieties loosed the old varieties. Gradually lost the valuable vital seed materials by the farmers in the region, but still many unique rice cultivars were available and growing by the farmers due to their specials quality not for yield. Traditional cultivar were the important source of different nutritive substitutes and on the other hand source of biotic and abiotic tolerance for raising a good crop. Earlier days, rice diversity was rich, but day by day loosing the seed and due to climatic change nature forcing to the grower to adopt or grow the multi-stress tolerance cultivars. According to global sustainable development goal (SDG) conservation and maintenance of natural diversity by means of germplasm were important. Looking to the SDG (FAO, 2019), local seed bank or gene bank development was developed and sharing among the farmers to improve the seed availability and healthy diet to the growers with nutritious dices and food for all and zero hunger. Looking to the importance of traditional varieties, government emphasizing the cultivation, commercialization and value added product development and exploration were going on traditional cultivars. Base on the above strategies, synthesized to look after the traditional varieties of Eastern India.

Importance of Rice germplasm in India:

Rice was the major field crops grown by the farmers in India as well as dominating in South and Eastern part of India. Rice was grown with almost 90% production share from the region. Rice was the most important crop grown by the farmers and contributes to the national economy or gross domestic product (GDP). Majority of the land was covered all most all the seasons with rice crop in eastern India. Aromatic basmati rice contribute more share in the international market but presently nutria-rich, brown rice, red rice, purple rice, black rice, aromatic non basmati, low glycemic, Fe, Mb, Zn, and protein rich rice were getting impotence among the consumers with good market price and return. Organic rice were grown so long back and presently on high demand in the market.

Farmers over generations developed different varieties and land races for different agro-climatic and socioeconomic conditions. A wealth of varieties of indigenous rice as a source of unexplored gene pool occurs naturally. These varieties have great scope for climate change adoption. However, there has also been tremendous loss of traditional knowledge associated with traditional agro-ecosystems and production practices. A report from Chhattisgarh reported that the different climate resilient characteristics of the identified varieties were low water requirement, short duration, early maturity, resistance to different biotic stress like pest and diseases etc. The major climate resilient varieties found were Chudi Dhan, Turia Kabri, Lal Dhan, Lal Chudi Dhan, Gudma Dhan, Tulsighati, Jondra-Dagd, etc. The study also suggests policy implications for identification, conservation and multiplication of seed of such varieties for making long term benefits of these materials to the farming community in climate resilience in the region (Dwivedi et al., 2017). Similarly, cultivar like Tulaipanji, Gobindabhog, Tulsibhog,

Randhanipagal, Dudheswar, Kalonunia, Kanakchur, Khasa, Kalonunia, Rampal, Joha Bora, Birein, Joha, Ketaki, Bora, Sali and Jalqouri etc all were important for different unique qualities from West Bengal and Assam.

Diversity of traditional rice varieties and their importance:

Traditional varieties were developed by natural process locally under the evolutionary force by means of natural selection. These varieties were very unique with their identity and mostly traditional varieties having their importance due to their trait and its economic importance like, protein rice, aromatic, unique taste, protein rich, iron, zinc, vitamins, malic acid, antioxidant rich or more metabolic or molecular activity with medicinal values etc. On the other hand, traditional varieties were the source of different biotic and abiotic stress tolerance source due to which some time traditional varieties performed better in adverse condition and preferably cultivated by the farmers in the respective region or spots or so called as hotspot. Sinha and Mishra, (2014) also reported the importance of rice diversity in the sustainable development. Traditional varieties were very unique with their diverse characters with respect to ecology, growing season, agro-morphological traits, grain type, grain quality and many more found in the eastern India and dominated with rice cultivation and production from the beginning due to the natural suitability on rice cultivation.

Medicinal valuable rice landraces in ancient clues:

Rice being staple food has additional qualities beyond its nutritive value with high degree of digestibility and least allergic properties compared to other cereal grains (Leena Kumary, 2004). Traditional rice landraces in India and across Asia were under serious threat of extinction due to cultivation of modern and high yielding varieties (HYVs), hybrids and genetically engineered rice (Yogesh, 2011). Rice is considered as food with high carbohydrate and some amount of protein, but has a number of unknown properties, as reported in ancient Indian Ayurvedic literature, where apart from consumption, the scientific literatures like Susrutha Samhitha and Charaka Samhitha - 1000 BC had given evidences of few rice varieties that had the "medicinal properties" and were used for treating human ailments since long time in our country, certain rice landraces are still popular even now among farming community (Mahamed and Balalaxmi, 2017).

Traditional varieties were used in different type of health difficulties for remedies due to the availability of medicinal properties inherently available in the rice grain. Traditionally, rice soup were used by the tribal people for the remedy of diarrhea, rice cake in Meghalaya for better health due to richness of anti-oxidant, protein and minerals. Rice is rich in genetic diversity, with thousands of varieties grown throughout the world. Rice cultivation was the principal activity and source of income for about 100 million households in Asia and Africa. Rice had potential in a wide range of food categories and had the nutritional and medicinal benefits; the by-products of rice were equally important and beneficial. By-products from growing rice create many valuable and worthwhile products. The un-edible parts that were discarded through the milling process and the edible part could be transformed into some of the following suggested valuable products. Rice might be used to treat skin conditions specially in burn wound healing. The rice was boiled, drained and allowed to cool and mashed. The rice was made into a paste or moulded into balls and these can be applied to boils, sores, swellings and skin blemishes. Other herbs were sometimes added to the rice balls to improve their medicinal effects. Sticky glutinous rice was often taken to treat stomach upsets, heart-burn and indigestion in the form of *mar bhat*. Extracts from brown rice had been used to treat breast and stomach cancer and warts. They had also been used to treat indigestion, nausea and diarrhea (Umadevi et al., 2012). Therefore, rice had been using for the health-care from a long back in Indian history by the Indian farmers as indigenous traditional practices with unique rice varieties with different preparation.

The relationship between the wild and cultivated types:

Rice holding higher genetic diversity, with more than thousands of years and thousands of varieties grown in many parts of the world. Some of the rice varieties were reported 'bail chaudi' had 90 days duration which yields about 2500kg/ac (Saha et al., 2022). In India, among small and medium grain aromatic rice varieties, Kalanamak was one of the finest quality rice varieties. Till a decade ago Kalanamak was popular in Himalayan area adjoining Nepal, particularly in districts Siddhartha Nagar, Sent Jabir Nagar, Gorakhpur, Maharajganj, Gonda and Basti of Uttar Pradesh and in small pockets at West Champaran in Bihar (Singh et al., 2005). Mettudayam was a traditional paddy variety cultivated in the southern region of India and traditional paddy variety cultivar (*sarkar nellu*) was famous among farmers of Gudiyatham village near to Vellore in Tamil Nadu even 30 years, also rice had one of the largest ex situ germplasm collection in the world (Jackson and Juggan, 1993, Sinha and Mishra, 2015). This accessible collection of diverse cultivated and wild rice germplasm had made great contribution to rice breeding. Genetic diversity in the available gene pool was the foundation or the raw material of all plant improvement programs. The

availability of transgressive segregants in any breeding programs also depends upon the effective inclusion of parents. The selection of parents based on genetic divergence had been successfully utilized in different crop species (Das et al., 1992; Guar et al., 1978; Murty and Anand, 1966). Lead, rice worker Dr. R. Richaria was the ex-situ rice gene back developer as well as collection and cataloging, characterization, documentation and conservationist of rice germplasm in the national rice research institute (NRRI), Cuttack followed by at Indira Gandhi Krishi Viswavidhyalaya (IGKV), Raipur (C.G.) which was famous and known as Dr. Richaria's Rice Biodiversity Centre and had more than 43 thousand active rice collections with different unique trait and qualities some of them were Narialful, Jabaful, Zeeraful, Dubraj, Kali Moch, Barahshal, Do dana etc.

Nutritional qualities of pigmented rice:

Rice (*Oryza sativa* L.) was a vital agricultural produce and leading food crop of the world. Moreover it served as a staple food for more than half of the world's population who relies on rice as the major daily source of calories and protein. It contributes about 21% of global dietary energy, 14% of protein and 2% of fat (Kennedy and Burlingame, 2003).

Pigmented rice was getting more popular recently and was consumed as a functional food due to the usefulness to health. Black rice contains relatively high anthocyanin in the pericarp layer which gave the dark purple color. Anthocyanin pigment was effective to reduce cholesterol in the human body (Lee et al., 2008). Black rice also contains higher levels of proteins, vitamins and minerals than common white rice. Compared to white rice, black rice was relatively richer in mineral contents such as Fe, Zn, Mn and P and had higher variability in mineral content depended upon varieties and soil types of the planting area (Qiu et al., 1993). Some pigmented varieties were like, Kalabhat, Rarhmabalak, Chenga, Sasimahan, Bora, Berein, Chak- hao etc. Traditional varieties all the very unique with respect to their grain quality and which was influence by many factor but grain pigmentation was one of important of them.

Black Rice:

Black rice also called forbidden rice because black rice was once reserved for the Chinese Emperor, for whom it was meant to ensure health and longevity. Historically, black rice was considered to be a royal delicacy and forbidden for common people in Asian countries such as China and Indonesia (Kushwaha, 2016). In China, during the imperial period, common people were not allowed to store/cultivate black rice without the approval from authorities hence it was called 'forbidden rice' or 'imperial rice' or emperor's rice or purple rice or longevity rice.

Black rice was known for its high nutritional value and was a source of iron, vitamin E, antioxidants, calcium, magnesium, zinc and contains more protein than brown rice. In India, it was grown in a large area in Manipur for a long time and was popularly known as Chak-hao, and desserts made from black rice were served as major feasts. As such, it offers several health benefits, including boosting eye and heart health, protection against certain forms of cancer, and aiding weight loss. Black rice was a healthier alternative to white rice that caught be used in all of the same ways. There were great prospects to promote black rice cultivation in major rice-growing states of India and doing so will help our country to achieve nutritional security (Saha et al., 2022). Black rice cultivation has been increased due to awareness programme on black rice as well as marketing with value added product from black rice in India.

Red Rice:

The red rice varieties with appealing red colour, had more complex taste and contains more nutrition, fibre-filled bran compared to normal rice. In the red rice, colour was confined to the bran layer, ranging from light red to dark red, a tinge of red remains even after a high degree of milling and contains polyphenols, anthocyanin and possess antioxidant properties. The inner portion of red and the normal white rice consumed was alike and white. The zinc and iron content of red rice is two to three times higher than that of white rice (Ramaiah and Rao, 1953).

Presently continuous consumption of polished white rice lead to the development of higher insulin resistance and dyslipidemia (low-high density lipoprotein) among the Asian population. Though the traditional varieties were known to be rich in dietary fibre, resistant starch, minerals, carotenoids, flavonoids, polyphenols and consumption of grains of these pigmented rice help in improving human health in attenuating the incidence of non-communicable diseases viz., cardiovascular diseases, diabetes, cancer and stroke (Vichapong et al, 2010, Hanhineva et al, 2010; Jae et al, 2010; Hudson et al, 2000; Rao et al, 2010). Some important red rice varieties were Sasi mohan, Dular, Berain, Kamol, Moti-Chur, Katarni Rice etc. those aleuronic layer was red in color.

Brown Rice:

It was the staple food for more than 65% of the country's population and also the most important source for meeting the calorie and dietary protein needs of the people. Mostly, white or brown rice was consumed in the world whereas black rice was consumed by a very small portion of people in Asia during the special occasions. It is a medium-grain, non-glutinous heirloom rice with a deep purple hue and a nutty, slightly sweet flavour. The dark colour of the grain was due to anthocyanin, a powerful antioxidant. Black rice had a deep black colour and usually turns deep purple when cooked. It was suitable for creating porridge, dessert, cake, bread, kheer, noodles and many other dishes. The Japanese researchers analyzed the genome of 21 black rice varieties and found that the specific gene that triggers the plant to produce large amounts of anthocyanin (Oikawa et al., 2015). These were the whole grain rice, recovered after the de-husking of rice grain.

Unique Grain Quality and Varieties:

Traditional rice varieties had an enhancing potential in wide range of neutral-ceutical and functional foods (Khush and Jeliano, 1991). Besides possessing medicinal and nutritional properties, the remaining by-products obtained from these rice varieties in various post harvest operations were equally valuable. The Traditional healers and local farmers have been using these traditional varieties in ayurveda and in curing of various kinds of ailments, such as cooling the body in ayurvedic treatments, improving vocal clarity, curing of boils, swellings and skin blemishes. Extracts of brown rice were also used as energy drink in individuals, patients and in treatment of chronic gastric problems, jaundice, dysenteric complaints and to increase lactation and nutrition to Childs. Sticky glutinous rice had been reported in treatment of stomach upsets, nausea, heart-burn and indigestion. Brown rice extracts had been reported in treatments of breast and stomach cancer and warts (Bhat and Riar, 2015).

Traditional rice varieties show a new perception with potent sources for various agronomic traits including medicinal properties, aroma as well as stress resistance. These traditional rice varieties were ignored and cultivated rarely due to introduction of high yielding, semi-dwarf rice varieties during first green revolution (Rekha et al, 2011). Hitherto was to bring back the traditional rice varieties for several advantages viz., sustainability towards adverse climatic conditions like flood, drought, therapeutic properties and nutritional value (Singh and Kalra 2002). Some traditional cultivars with unique grain qualities were Dehraduni Basmati, Kala Namak, Kalonunia, Tulaipanji, Gobindabhog, Didheswar, Nuwa, Dubraj, Jaiful, Nagri Dubraj etc. Base on the grain quality and their preparation traditionally people like to grow and grew the varieties with proper distribution as per requirement and land availability along with the ecological fitness of the varieties.

Aromatic:

Scented or aromatic rice was nature's gift to the Indian sub-continent and human kind at large (Singh et al., 2000). Aromatic rice was including all scented rice means basmati and non basmati both. Compare to other classes of rice, aromatic rice was highly demanded and get better premium price in global market due to its pleasant aroma, superfine long slender grains with delicate curvature, remarkable linear elongation and excellent flaky soft texture on cooking. However, at present, only 12-15 indigenous aromatic rice varieties (IARVs) were being cultivated in some scattered pockets of different districts in West Bengal in an unorganized manner (Adhikari et al., 2011 and 2013).

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Basmati:

The coalescence of organoleptic traits viz., pleasant aroma, cooked rice texture, and taste make aromatic rice unique and distinguished from non-aromatic rice. Aromatic rice was cultivated in every rice growing country; with each country had its own indigenous collection. International trade of rice was dominated by Indica (long grained), Japonica (short grained), aromatic rice (Basmati and Jasmine) and glutinous rice; amidst which, Basmati types from India and Pakistan; and Jasmine types from Thailand had phenomenal demand. In India all types of aromatic rice were cultivated based on Kernel length; short, medium, long and very long grained. Basmati varieties own the major market, while other types of aromatic rice besides Basmati was popular in local market only. The country inherited rich diversity of aromatic rice germplasm; with more than 300 different types, each of the rice growing states of India had its own locally popular aromatic rice varieties. India a country where two third of its population consume rice as part of their daily food; aromatic rice always remain their favorite. Basmati, by virtue of its excellent qualities it dominated both national and international market. Every year, Basmati ranks first in respect of foreign exchange earned from the export of agricultural products from India (APEDA). The phenomenal demand and export figures have augmented Basmati Breeding program. However, only few aromatic varieties were cultivated depending on their demand, and their breeding program was also limited. In India, Basmati had overshadowed other types of aromatic rice in market and in plant breeding programs too. Breeding for Basmati varieties was undertaken by prime agricultural institutions of India. The country regulates quality standards and development of Basmati varieties with the help of Export of Basmati Rice (Quality Control and Inspection) Rules 2003; Agricultural and Processed Food Products Export Development Authority (APEDA); and Basmati Export Development Foundation (BEDF). However, no such initiatives had been taken to promote the development of other aromatic rice varieties of India besides Basmati (Sharma, et al., 2021).

World trade of aromatic rice mostly included Basmati and Jasmine types of varieties and India was leading exporter of Basmati in International market. In year 2019–2020, India had exported 4.45 million MT of Basmati to Iran, Saudi Arab, Iraq, UAE, Kuwait (major countries which import Basmati from India), US, UK, Singapore and Malaysia; earning 4,330.68 million USD. Major export of Basmati from India was headed to Asian countries (Middle East) followed by Western Europe (Siddiq et al, 2012). Besides, milled Basmati, parboiled Basmati called as Sella Basmati rice in India and Middle East; and Cooked Basmati in United Kingdom (Bhattacharjee et al., 2002). Basmati rice was also exported from India. Nearly half of the exported Basmati to Gulf countries (Saudi Arabia, Kuwait, and UAE) as well as UK and USA, includes Sella types of Basmati (Siddiq et al, 2012). Earlier, Traditional Basmati viz., Basmati-370 and Taraori Basmati dominated the export of Basmati from India. In early 1990s, an evolved Basmati variety PB-1 replaced them and ruled Basmati export. Currently, PB1121 was the major Basmati variety exported from India; which had an exceptional kernel length (approximately 9 mm) and elongation ratio of 2.7 (Singh, et al.,2018). Cooked kernels of PB1121 attained a maximum length of 21.0 mm to 21.5 mm which maximum known in any rice germplasm. It occupies 47% of Basmati growing area, followed by PB 1509 (26%), PB-6 (9%) and PB-1 (8%); (APEDA, Basmati Survey Report, Kharif, Volume 2). All basmati rice was very unique with respect to area of production and their grain and cook rice appeal but typical on their expression on length and breadth ratio.

Low Glycemic Index (LGI):

LGI had a lower glycemic index, which was beneficial for diabetic patients and improves the production of adiponectin in the body which play a central role in the development of type 2 diabetes, obesity and cardiovascular disease in humans. To ward off the risk of diabetes and obesity, it was advised to consume whole grains instead of just refined carbohydrates.

Rice was regarded as a nutraceutical and functional food besides being a staple source of food and primary source of carbohydrate or starch. Its role of having low glycemic index in comparison to other genetically modified rice varieties, which containing complex carbohydrates and regarded as high glycemic index food provided a better novel substitute for diabetic patients. Presence of valuable mineral content, excellent starch characteristics found to be in rice. Antioxidant and anti inflammatory activity represent these unique among cereals sources (wheat, maize etc). Starch of this rice was almost completely absorbed by human body (Bhat and Riar, 2015).

According to Canadian diabetes association, glycemic index of basmati aromatic rice is lower than other rice varieties, and thus essential for those suffering from diabetes. Ayurveda supports its properties and proved it was to be a great healing food. Traditional scented rice varieties have been revealed by scientists to possess higher amount of Fe and Zn and helps in the bioavailability of iron (Chaudry and Tran, 2001).

The rice landraces, due to their adaptability to different agro climatic conditions, unique characteristics and special use are confined to only certain rice growing areas in particular season. The recent studies also recommend rice as a novel food due to its high glycemic index for lowering the incidence of certain lifestyle - related diseases such as heart attack, diabetes and cancer (Rhodes, 2008).

Consumer preference and determining factor for grain quality:

Growing black rice, which had its roots in north-east India, was becoming popular in other regions as well, among farmers. It's extensively grown in Odisha, West Bengal, Tamil Nadu, Puducherry and Jharkhand and commonly consumed in Manipur. The demand for black rice had been increasing in today's world because of its superior nutritional quality due to the presence of antioxidants and phenolic compounds. It was also rich in beneficial amino acids like lysine and tryptophan which possesses health benefits. Phenolic donate free radicle hydrogen act as singlet oxygen quenchers and protect the cell constituents against oxidative damage caused by free radical molecules (Pachauri et al., 2010). Black rice was generally consumed along with the bran due to the presence of anthocyanin and was sold as un-milled rice.

Consumer preference was based on the evaluation of quality attributes, which was determined not only by chemical and physical properties of grains but also by aspects related to the appearance of the product after cooking, such as stickiness and texture (softness or fluffiness). The cooking and textural properties were largely dependent on the chemical composition of cultivars rather than on their physical characteristics (Bal, 2006). Amylose content had been considered one of the most important characteristics in cooking behavior (Mohapatra and Bal., 2006).

Geographical Indication (GI) Varieties:

GI was granted under the supervision of protection of plant varieties and farmers' right act in India under the ministry of agriculture and farmers' welfare, Govt. of India. Implementation of GI was to be field the application with the prerequisite documents along with authenticated proof and evidence on claim on the varieties to be filed under geographical indication (GI) variety. Plant varieties were to be granted GI with respect to their uniqueness or novelty and originated in an unified defined geography. Some rice varieties granted GI were Tulaipanji, Gobindabhog, Joha of Assam, Kalanamak, Kalamoch, Chakuwa, Chak-Hao, Ambemohan, Basmati, Ajara Ghanasal, **Chokuwa Rice of Assam**, Katarni Rice, **Boka Chaul**, **Navara Rice**, **Palakkadan Matta Rice**, **Kaipad Rice**, **Pokkali Rice**, **Wayanad Gandhakasala Rice**, **Wayanad Jeerakasala Rice**, etc.

Rice protein-key factor for children health:

Protein was one of the most significant factors facing in developing world. Only twenty percent of the world people were affluent enough to have access to a nutritious diet. Protein-energy malnutrition (basic hunger or under-nutrition) affects 850 million people worldwide. Most of people eat rice and rice-based products, so improve the protein content in rice was the most important target. It was estimated that under-nutrition was the cause of half of all the cases of child mortality. In India, over 50% of all children receive insufficient calories every day to meet their potential growth and development requirements (Mahendra et al., 2004). Oko et al. (2012) reported that about eighty percent (80%) of all malnourished children in developing countries that boasted food surpluses. With more than seventy percent of the world's malnourished children, South Asia was expected to remain "Black Spots" of child malnutrition in 2020. A substantial decrease in the availability of legumes over three decades, from an average of 64.4 g during the Pre-Green Revolution decade to about 33.6 g per capita per day from 1996 to 2002 in our country had been largely responsible for protein malnutrition. The quality of a rice protein was always determined by its amino acid profile. Studies conducted in the 1950s and 1960s on children recovering from protein-energy malnutrition demonstrated that essential amino acids like lysine and tryptophan were important in improving nitrogen retention when cereals like wheat, rice or corn was the staple food (Pellett and Ghosh, 2004). Nowadays, the rice grain was usually further processed by additionally removing the bran layer from the endosperm to obtain milled rice. Riza et al. (2004) studied the precision of the study that showed that protein content of tested rice varieties ranged from 5.8 to 8.8 percent for parboiled rice and 5.5 to 7.5 percent for unparboiled rice and also found that protein variations from 6.30 to 9.10 percent in 438 rice cultivars, while rice germplasm lines of core collections had 5.00 to 9.50 percent variation for protein in milled grains. Deepa et al. (2008) reported that Njavara, a medicinal landrace of rice had higher protein when compared with Jyothi and IR64. They also stated that protein ranged from 4.30 to 18.20 percent in different polished white rice samples. Some protein rich varieties had been evaluated and released as high protein rice like Nabin from National Rice Research Institute (NRRI), Cuttack.

Conclusion:-

Rice was the staple food crop in our country. Promoting black rice cultivation and its consumption will improve the nutritional status of poor farming communities. Research on black rice should be initiated in major institutions to improve its genetic potential. Also, the best package of production technology should be developed for each variety under different ecosystems. The state governments, where rice cultivation was a major enterprise, should take initiative to promote black rice or quality rice cultivation. A niche market caught to be established primarily for export purposes also. Accordingly, strategies to encourage brown rice consumption over that of polished rice, to improve consumer health were unlikely to be successful at the population level, whereas a more effective approach may be to reduce the glycaemic impact of polished rice through the development and introduction of suitable low GI rice varieties and reduce the cardiovascular risk and improve the nutritional benefits. Incorporating folk rice varieties and folk cultural values into development of locally-based and locally-controlled farming systems was the best means to providing “acceptable livelihoods of the poor” (Cleveland et al. 1994), which was the primary objective of sustainable agriculture. Conservation and documentation of the folk varieties were thus essential for providing the basis of sustainable economic option for poor and marginal farmers.

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