# ABSTRACT

Parboiling of paddy renders firmer rice kernel and improved nutritional profile due to migration of nutrient into the endosperm. Parboiling brings about improved physical integrity (hardness), which has been proved to be the major factor in withstanding physical damage and insect infestation. However, the chemical aspect pertaining to above mentioned process has got prime importance in terms of starch hydrolysis behaviour. Reduced crystallinity of parboiled rice leads to increased digestibility in its native state and favours fungal based amylolytic actions. During parboiling, rice undergoes various chemical phenomena such as gelatinization/retrogradation but slowly digestible starch and resistant starch content is not up to the mark. The probable cause of this could be the immediate drying, which limits the retrogradation phenomena and left the kernel with lower crystallinity. Lower crystallinity also exhibits higher affinity to moisture, which is primarily a contributing factor towards water activity of the kernel. Keeping above issues in mind, the present investigation was initiated by characterizing fungal damaged rice (parboiled) to understand its crystallinity and susceptibility to enzymatic hydrolysis, followed by establishing relationship between starch crystallinity of parboiled rice and moisture absorption behaviour. Subsequently, conventional parboiling process was modified and optimized to reduce the susceptibility of starch to amylolytic hydrolysis by altering its crystalline polymorph and enhancing resistant starch content. Finally, suitable hydrothermal process (Heat and Moisture Treatment-HMT) was investigated to transform the parboiled rice with low acceptability (non-issuable) into valued rice having higher crystallinity and resistant starch content.

The outcome of the investigation prompted about high moisture absorption behaviour and lower crystalline ordered starch increase of fungal damaged parboiled rice kernel. Moreover, higher susceptibility to amylolytic digestion was adjudged to be the primary intrinsic properties, which promote fungal infestation in parboiled rice. Subsequently, a model was developed to explain the relationship between starch crystallinity and moisture absorption, which can also explain the mechanism of moisture absorption by pregelatinized (parboiled) starchy matter. Further, process modification in paddy parboiling was attempted to achieve enhanced and modified crystallinity. Using numerical optimization technique, the parboiling process was optimized and soaking at low pH (3.4 for 3.5 h) followed by steaming (20 min) and cooling (5 $^{o}$C) for 1 h was found to be the best condition for crystallinity modification in parboiled rice. The optimized rice was tested for its amylolytic hydrolysis behaviour and significant reduction in glycemic index of the optimized sample was observed (GI = 42). In a subsequent study, heat and moisture treatment (HMT) was employed to enhance the starch crystallinity of parboiled rice having severe parboiling effects. Experiments at various temperature, moisture and time illustrated that, treatment of parboiled rice (with low crystallinity, 9.6%) at 120 $^{o}$C and 15% moisture content could significantly increase the crystallinity, which was comprises of major V type starch polymorph. Apart from this, HMT treated parboiled rice could exhibit around 30% of resistant starch. The mechanism of crystallinity and resistant starch enhancement was adjudged to be the increased crystal size and perfection. The crystal diffracted at $2\Theta = 13^{o}$ was found to contribute maximum towards resistant starch formation during HMT of parboiled rice starch.



**Keywords:** Crystallinity, Fungal damage, Heat and Moisture Treatment, Parboiled Rice, Starch