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Dynamic of Matrix Component Interactions and its Effects on Physico-chemical Properties of Rice During Ageing

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Previous studies on the physicochemical changes associated with rice storage (Zhou *et al*., 2010) have demonstrated that ageing alters the structural properties of rice, resulting in reduced hydration and swelling capacity and increased resistance to hydrothermal disruption during starch gelatinization. However, the presence of other ingredients in rice would have a notable impact on the heat and starch pasting capabilities. Particularly, the differences between fresh rice and stored rice can be attributed to the chemical changes in other rice components that happened during storage. Rice's physical and cooking qualities are influenced by starch and its interactions with other endosperm components like lipids, proteins, and water (Fitzgerald, 2004).

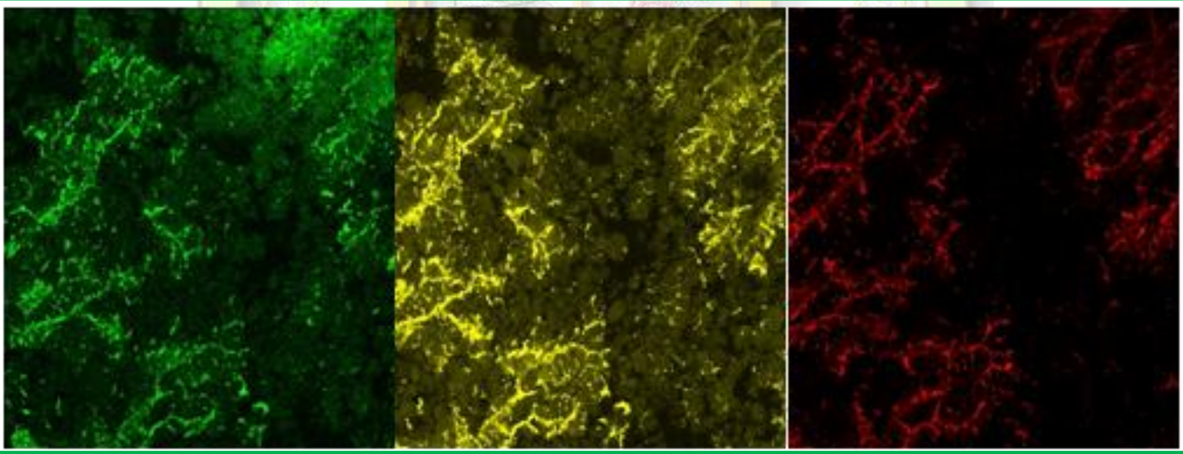

Fig 1: Representative confocal micrograph of rice visualized using Fluoresceine Isothiocyanate (FITC), Rhodamine B and Nile Blue (NB)

Shibuya *et al.* (1977) study has also been used to draw a distinction between the ageing of rice flour and rice starch, demonstrating that while the pasting properties of fresh and aged rice flours varied, those of the equivalent starches did not. Additionally, they claimed that endo-breakdown xylanases of the cell wall during storage caused alterations in the amylograms of rice flours. There are still many unanswered questions regarding the intricate process of rice ageing. What element(s), for instance, contribute to or control these changes? The answers to these queries will help disclose the mechanism of rice ageing. Two key strategies are now being used to attempt to find answers to these questions:

1) Rice starch was separated from fresh and aged rice, respectively, and the variations in pasting and thermal characteristics between the two isolated starches were further investigated in order to determine the difference in starch properties after storage.
2) Chemical and enzymatic treatments were used to examine the relationship between starch and non-starch components on rice pasting and thermal properties. There were no observable differences in the viscograms and thermograms of the two extracted starches, and the viscograms and thermograms of the starch isolated from aged rice grains closely resembled those of fresh rice, according to studies of the pasting and thermal properties of isolated starch from fresh and aged rice grains (Zhou *et al*., 2010).

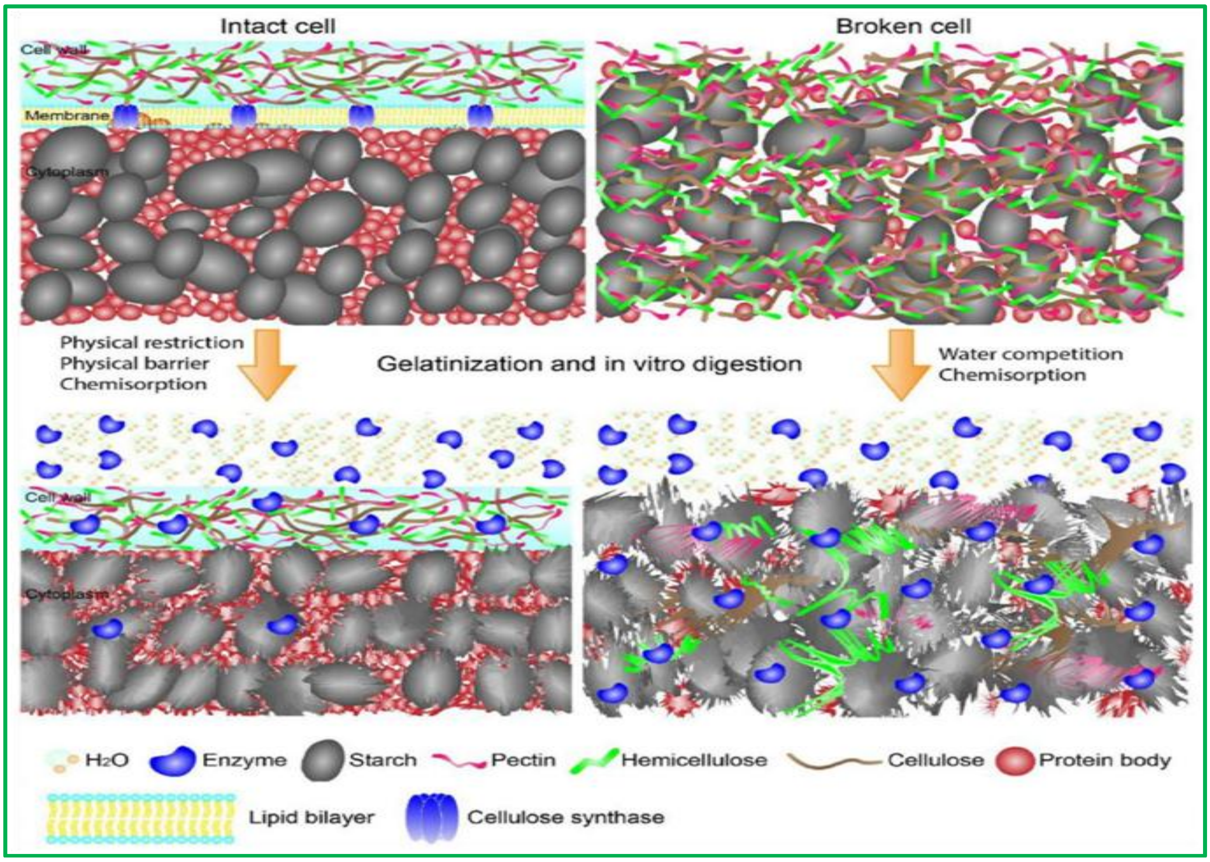

Fig: Structure of starch in intact and broken cells during gelatinization and in vitro digestion. The intact cell walls did not allow enzymes and water to go into the starch, but they allowed the starch to become gelatinous and allowed enzymes to go on the starch. (Figure is adapted from Chi et al., 2022)

These findings imply that interactions between starch and non-starch components that took place during storage were responsible for the effects of ageing on rice pasting and thermal properties (Fig 2). Adding oryzenin (rice storage proteins) to isolated starch caused pasting behaviors that mimicked those of aged rice flour, as was previously demonstrated (Teo *et al*., 2000). Despite prior study, the mechanisms governing rice ageing remain poorly understood. Ageing of rice is a complicated process, according to polynomial models. As was previously indicated, a series of tests were created and carried out to investigate the impact of the ageing process on the chemical makeup of rice as well as its pasting/thermal and cooking capabilities. Studying how starch and non-starch components interact to affect rice pasting and thermal characteristics after storage, which helped identify the key elements in the rice ageing process, was particularly interesting (Fig.1)

Interactions between starch, protein and lipid are not yet explored during ageing. The study conducted by Yang *et al*. (2019) to characterize the influence of starch-protein interactions on physico-chemical properties and starch digestibility in corn starch-whey protein isolate (WPI) blends during cooking. The results obtained by DSC and dynamic viscoelasticity revealed that the swelling process of starch granule was restricted by protein while recrystallization after cold storage was accelerated by protein addition. Studies on rheological properties showed that the interaction force was mainly through hydrogen bonds. Additionally, confocal laser scanning microscopy (CLSM) analysis indicated that whey protein formed a surrounding or encapsulation of starch granules and acted as a physical barrier toward starch digestibility following cooking. Protein molecules aid in the construction of amylose-lipid complexes (Chao *et al*., 2018; Wang *et al*., 2017; Zheng *et al*., 2018). Numerous studies have demonstrated that during food processing, ternary starch-lipid-protein complexes are formed, which alters the characteristics of starch such as gelatinization and pasting, digestion rate, and rheological behaviour (Wang *et al*., 2017; Zheng *et al*., 2018).

The study of rice food matrix interactions and their role in regulating glycemic index (GI) is rapidly evolving beyond simple starch composition. Future research should focus on understanding the dynamic interactions among starch, proteins, lipids, dietary fiber, phenolics, minerals, and the gut microbiome to develop next-generation functional rice with improved metabolic health benefits.

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