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STARCH PROPERTIES AND MORPHOLOGICAL DIFFERENCES OF *ORYZA SATIVA* MUTANTS, MR219-4 AND UPMTC1

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PENGESAHAN

Dengan ini adalah disahkan bahawa tesis projek yang bertajuk "Starch properties and morphological differences of *Oryza sativa* mutants, MR219-4 and UPMTC1" telah disiapkan serta dikemukakan kepada Jabatan Biokimia oleh Yong Wai Shin (164038) sebagai syarat untuk kursus BCH4999 Projek.

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ABSTRACT

Rice represents the staple food for nearly half of the world's population. Efforts have been taken to produce rice cultivars with high yielding capacities and resistant to abiotic stresses to cope with the increased demand of rice. Previous studies showed that MR219-4, a Malaysian *indica* rice has good tissue culture responses. It also has enhanced tolerance towards drought and submergence as compared to MR219. UPMTC1, which was derived from MR219-4 had exhibited enhanced salt tolerant property than MR219-4. This study was carried out to determine the starch properties and morphological differences between MR219-4 and UPMTC1, which included morphological traits, soluble sugar content, starch content, apparent amylose content (AAC), starch disintegration properties, protein concentration and determination of starch synthase activity. Results showed that there were significant differences between plant height of MR219-4 (107.9cm) and UPMTC1 (79.3cm), and panicle length between MR219-4 (26.4cm) and UPMTC1 (22.3cm) at day 110; however; there were no significant differences between the number of tillers, flat length length and width, culm length, days to maturity and weight of 500 grains of MR219-4 and UPMTC1. The decrease in starch content of MR219-4 and UPMTC1 at germination day seven were 45.0% and 11.2% respectively. The apparent amylose content of MR219-4 and UPMTC1 were 22.19% and 25.37% respectively. UPMTC1 which has higher AAC may be suitable to be used as low glycemic diet for type two diabetic patients. Both MR219-4 and UPMTC1 exhibited resistant to starch disintegration towards alkali solution, suggesting both have high gelatinization temperature. However, further studies need to be carried out towards MR219-4 and UPMTC1 as both rice cultivars have the potential to be planted on a commercial scale.

ABSTRAK

Beras merupakan makanan ruji bagi hampir setengah populasi dunia. Setakat ini, pelbagai penyelidikan telah dijalankan untuk menghasilkan kultivar padi yang berdaya hasil tinggi dan lebih tahan terhadap tekanan abiotik untuk memenuhi peningkatan permintaan beras. Kajian lepas melaporkan bahawa varieti padi *indica* tempatan, MR219-4 mempunyai prestasi tisu kultur yan baik dan lebih bertoleransi terhadap tekanan kemarau dan tenggelam jika berbanding dengan MR219. UPMTC1, varieti padi baru derivasi MR219-4 pula mempunyai kemampuan untuk bertolerasi terhadap tekanan saliniti. Kajian ini dijalankan untuk menentukan ciri-ciri kanji dan perbezaan morfologi antara MR219-4 dengan UPMTC1, termasuk ciri-ciri morfologi tumbuhan padi, kandungan gula larut, kandungan kanji, kandungan amilosa ketara (AAC), ciri disintegrasi kanji dalam larutan alkali, kepekatan protein dan penentuan aktiviti kanji sintase. Kajian terhadap morfologi tumbuhan mendapati bahawa ketinggian tumbuhan antara MR219-4 (107.9cm) dengan UPMTC1 (79.3cm), dan panjang panikel antara MR219-4 (26.4cm) dengan UPMC1 (22.3cm) mempunyai perbezaan yang signifikan, manakala parameter lain seperti bilangan anak padi, panjang dan lebar daun bendera, hari untuk mencapai kematangan serta keberatan 500 biji benih tidak mempunyai perbezaan yang signifikan antara MR219-4 dengan UPMTC1. Kandungan kanji benih MR219-4 dan UPMTC1 berkurang sebanyak 45.0% dan 11.2% selepas percambahan hari ketujuh. AAC bagi MR219-4 dan UPMTC1 ialah 22.19% dan 25.37%. UPMTC1 yang mempunyai AAC yang lebih tinggi mungkin sesuai untuk dijadikan diet indeks glisemia rendah bagi pesakit diabetes jenis dua. Kedua-dua MR219-4 dan UPMTC1 tidak mudah disintegrasi dalam larutan alkali dan mungkin mempunyai suhu penggelatinan yang tinggi. Walau bagaimanapun, kajian lanjut mengenai MR219-4 dan UPMTC1 perlu dijalankan kerana kedua-dua kultivar padi ini berpotensi untuk ditanam secara komersial.

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%	= percent
°C	= degree Celsius
BSA	= Bovine serum albumin
et al.	= and others
i. e	= *id est* (that is)
g	= gram
M	= molar
µg	= microgram
µL	= microliter
mg	= milligram
mL	= millilitre
mM	= milli molar
v/v	= volume/ volume
w/v	= weight/ volume

CHAPTER I

INTRODUCTION

Rice is one of the most important food crops and it represents the staple food for nearly half of the world's population (Redfern et al., 2012). Global rice consumption is estimated to rise to 496 million tons by 2020, driven by both population and economic growth (GRiSP, 2013). In Malaysia, efforts are being taken to meet the increased demand of rice and to heighten the country self-sufficiency level of rice production from 72% to 90% in the next ten years (Isiaka et al., 2015). Developing abiotic stress tolerant rice cultivars is one of the approaches to address the problem of dwindling rice production caused by the unfavourable growing environments or conditions, such as salinity stress, drought, submergence stress and nutrient deficiencies (Lafitte et al., 2004). Invasion of sea water towards arable lands and poor agricultural practices such as excessive application of fertilizer and poor irrigation lead to the increase in salinity in farming lands and render it less suitable for the growth of rice plants which are moderately tolerant to salinity stress (Che-Lah et al., 2015; Wassmann et al., 2009).

Besides high stress tolerance, producing rice grain with good quality is also one of the important objectives in rice breeding programs as it is the key factor in determining economic value of rice production (Cappelli et al., 2014). One of the major aspects in evaluating grain quality is cooking and eating properties, which is greatly influenced by the starch composition in rice endosperm (Pandey et al., 2012). Generally, determination of amylose content and starch disintegration properties are the two tests used to evaluate the cooking and eating properties of rice cultivars.

However, there is no single and standard definition for good cooking and eating quality since cooking and eating practices vary between regions and are highly dependent on consumers' preferences.

Starch in rice grains accounts for more than 90% of the total rice weight (Krishnan et al., 2011). Proteins, lipids, phopshorus and trace elements are minor constituents of rice (Bao and Bergman, 2004). Starch is made up of two types of molecules, that are linear amylose and highly branched amylopectin. The variation in starch composition and structure arise from the differential expression of various isoforms of starch biosynthesizing enzyme (Pandey et al., 2012). Starch synthase isoforms are the enzymes that catalyses the transfer of ADP-glucose to a growing chian of glucose residues, leading to the synthesis of amylose and amylopectin. Starch synthase I is the major enzyme involving in the synthesis of short chain length of amylopectin. Starch synthase IIa, which involves in the formation of intermediate chain length of amylopectin has a major impact on the fine structure of amylopectin and composition of starch even though it is not the major enzyme affecting the total starch synthase enzyme activity (Nakamura et al., 2005). However, Fujita et al. (2012) reported that SSIIa activity band was difficult to be detected using native PAGE and iodine staining.

A Malaysian rice cultivar, MR219 has high grain yielding capacity and good planting characteristics; however, it is relatively sensitive to the environment changes. Hence, mutants of MR219 were developed and targeted to produce rice cultivars with enhanced tolerance towards unfavourable growth conditions. MR219-4 was reported to exhibit good tissue culture response and tolerance to drought and submergence (Abdullah et al., 2009; Abdul Rahim et al., 2011). MR219-4 mutant, UPMTC1 was developed and was reported to have increased accumulation of proline under saline stress condition, suggesting that UPMTC1 may be potential salt tolerance rice cultivar.

However, information regarding the plant physical behaviour, morphological traits and starch properties is relatively scanty. Hence, in this study, MR219 mutants, MR219-4 and UPMTC1 will be further studied to meet the objectives listed below:

1. To determine the morphological differences between MR219-4 and UPMTC1.
2. To determine the starch properties of MR219-4 and UPMTC1.
3. To detect for the possible presence of starch synthase activity in MR219-4 and UPMTC1.
4. To determine apparent amylose content and starch disintegration properties of MR219-4 and UPMTC1.

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