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CHANGES IN TOTAL SUGAR AND PROTEIN CONTENT IN GERMINATING RICE SEEDS UNDER SALINITY STRESS

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PENGESAHAN

Dengan ini adalah disahkan bahawa projek yang bertajuk "Changes in Total Sugar and Protein Content in Germinating Rice Seeds under Salinity Stress" telah disiapkan serta dikemukakan kepada Jabatan Biokimia oleh Yap Mei Kee (163278) sebagai syarat untuk kursus BCH 4999 projek.

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ABSTRACT

Rice (*Oryza sativa* L.) is the main staple food for more than half of the world's population. It is a salt sensitive species and susceptible to salinity stress condition. Some of the irrigated lands in Malaysia are salt-affected and rice grown in these areas was reported to have reduced yield. In this study, the effect of salinity on the germination of two Malaysian rice cultivars MR219-9 and MR253 was investigated. The cultivars are commercially grown in Malaysia. The rice seeds were germinated *in vitro* and the germination capacity was observed for six days. The salt-stressed seeds were treated with 150mM NaCl and the control did not contain NaCl. The germinated seeds were analysed for soluble sugar and protein content. The results showed that the presence of 150mM NaCl caused significant reduction in all the growth parameters measured as well as the soluble sugar and protein content for both cultivars. For MR219-9, the 150mM NaCl decreased the percentage of germination by 22.5% and reduced the rate of germination by 68.31%. The plumule length was decreased by 66.99% and the radicle length by 56.66%. Similarly, the soluble sugar and protein content of the germinating seeds were drastically reduced. A similar trend was observed for MR253 cultivar, however the effects were not as severe as compared to MR219-9. Thus, it was concluded that salinity stress significantly affected the seed germination and reduced the soluble sugar and protein content of two Malaysian rice cultivars MR219-9 and MR253.

ABSTRAK

Beras adalah makanan ruji utama bagi lebih separuh daripada penduduk dunia. Ia adalah satu spesies yang sensitif terhadap garam dan terdedah kepada keadaan tekanan garam yang berlebihan. Sebahagian daripada tanah-tanah sawah di Malaysia terjejas dengan garam yang berlebihan dan padi yang ditanam di kawasan-kawasan ini dilaporkan telah kekurangan hasil tanaman. Dalam kajian ini, kesan kepekatan garam kepada dua kultivar padi Malaysia MR219-9 dan MR253 telah dikaji. Kultivar padi telah ditanam secara komersial di Malaysia. Benih padi telah dicambah *in vitro* dan keupayaan percambahan diperhatikan selama enam hari. Benih-benih telah diberi tekanan dengan kepekatan garam sebanyak 150mM NaCl dan benih kawalan tidak mengandungi NaCl. Benih bercambah dianalisis untuk kandungan gula larut dan kandungan protein. Hasil kajian menunjukkan pengurangan ketara untuk kedua-dua kultivar dalam semua parameter pertumbuhan yang diukur begitu juga kandungan gula larut dan kandungan protein apabila dirawat dengan 150mM NaCl. Untuk MR219-9, 150mM NaCl menyebabkan penurunan peratusan percambahan sebanyak 22.5% dan mengurangkan kadar percambahan 68.31%. Panjang *plumule* telah menurun sebanyak 66.99% dan panjang radikal sebanyak 56.66%. Begitu juga, kandungan gula larut dan kandungan protein benih bercambah telah berkurangan secara drastik. Trend yang sama diperhatikan bagi MR253 kultivar, namun kesannya tidak begitu teruk berbanding MR219-9. Kesimpulannya, tekanan garam telah memberi impak besar dalam mempengaruhi percambahan benih dan mengurangkan kandungan gula larut dan kandungan protein pada kedua-dua kultivar padi Malaysia MR219-9 dan MR253.

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LIST OF ABBREVIATIONS

%	Percent
℃	Degree Celcius
µg/ml	Microgram per milliliter
BSA	Bovine serum albumin
cm	Centimeter
DNSA	3, 5-dinitrosalicylic acid
FAO	Food and Agriculture Organization of the United Nations
g	Gram
MARDI	Malaysian Agricultural Research and Development Institute
ml	Milliliter
mm	Millimeter
mM	Millimolar
nm	Nanometer
ROS	Reactive oxygen species
SE	Standard error

CHAPTER 1

INTRODUCTION

Rice (*Oryza sativa* L.) is a monocotyledon plant belonging to Poaceae family. It is one of the most important cereal crops in the world after wheat. It is the main staple food for more than half of the world's population (Fageria, 2007). Rice is rich with carbohydrates and provide one-third of the daily calorie requirement of a person (Mar et al., 2012). According to Food and Agriculture Organization of the United Nations (FAO), rice has exceptional agricultural and economic importance as it provides the source of income and job opportunities to more than 100 million households in Asia and Africa (Juraimi et al., 2013). The production of rice in the world has increased since the past decade and the world's rice demand is expected to further increase in future due to the rapid population and economic growth (Lim et al., 2012).

Abiotic stresses such as salinity, drought, temperature, flooding, heavy metal, herbicides and radiation have destructive effects to agricultural crops. Abiotic stresses reduce the crop yields by more than 50% which strongly threaten and affect the worldwide food security (Rodriguez et al., 2005). Salinity is one of the major abiotic stresses that strongly affects the crop growth and crop production (Hakim et al., 2014). More than 800 hectares of lands in the world are salt affected and this account about 6% of the world land area (Munns and Tester, 2008). Different crops and even different species of the same crop have different salinity tolerance. Salinity causes severe effects on plant metabolism, disrupting cellular homeostasis and cause physiological and biochemical disorders (Mane et al., 2011). Low concentration of

salt will suppress the plant growth while high concentration of salt will evenly cause the plant to die (Peel et al., 2004).

Rice is a salt sensitive species and susceptible to salinity stress particularly during the seed germination and seedling growth stage (Deivanai et al., 2011). However, some of the irrigated lands in the world are salt-affected. About 20% of irrigated land are salt affected and assumed that the salinity problem will affect 100 000 hectares of rice area by year 2056 (Munns and Tester, 2008). Salinity will reduce the growth and yield of the rice crops. For example, salinity stress may result up to 50% yields loss in salinity sensitive rice cultivars (Hakim et al., 2014).

Malaysia realizes the needs to increase self-sufficiency level in rice production from 73% to 86%, so Malaysia needs to expand the rice cultivation area and also increase the yield per unit area (Eliza et al., 2014). However, some of the irrigated lands in Malaysia are salt-affected and the rice grown in these areas are reported to have reduced yield. The need for salt tolerant rice cultivars has increased in order to enhance crop production (Kandil et al., 2012). However, for example the normal rice MR 219 is saline-susceptible (Nozulaidi et al., 2015). The development of salt-tolerant rice cultivars and lines of rice through selection and breeding are responsible for increasing rice production. In addition, hybrid paddy has the potential for improved quality and increased quantity of rice production by 15 to 25% (Bernama, 2014a). In this study, MR219-9 and MR253 cultivars were chosen. Both cultivars are commercially grown in Malaysia. MR219-9 was tolerant to drought (Harun et al., 2012) while MR253 was reported to be suitable for low pH soil (Bernama, 2014a). Both cultivars are believed to have the potential to grow in salinity.

In Malaysia, direct seeding is normally used to cultivate the rice. Germination is a critical stage which will affect the plant yield and quality. Good seed germination is very important for the crops. Uneven or poor germination and subsequently uneven seedling growth can lead to great financial losses and reducing the crop production (Islam et al., 2012). The problem is that there is limited information on the effect of salinity on seed germination and biochemical changes of Malaysian rice cultivars.

Therefore, the objectives of this study are

1. To determine the effect of salinity on seed germination
2. To study the total sugar and protein changes during seed germination under salinity stress

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