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THE EFFECTS OF GAMMA RAYS ON MORPHOLOGY, BIOCHEMICAL, AND GENETIC DIVERSITY OF *Zingiber officinale* ROSCOE

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ABSTRACT

Ginger (*Zingiber officinale* Roscoe) is an important spice crop known for its medicinal properties. The lack of genetic variability among the genotypes is one of the bottlenecks in ginger genetic improvement. In this study, gamma radiation was applied to increase genetic variability in ginger. Two varieties of ginger; Bentong and Tanjung Sepat were exposed with different doses of gamma rays (5, 7, 9, 11, 13 and 15 Gy) at dose rate of 4.31 Gy per minutes using Caesium-137 source. The lethal dose (LD_{50}) was obtained at 7.56 Gy for Bentong variety and 9.38 Gy for Tanjung Sepat variety. The parameters observed are plant survival, plant height, and number of leaves and shoots were significantly decreased with increased radiation doses. The stimulatory effect of gamma rays at low doses was also observed. The treatment at 5 Gy dose produced the highest ginger rhizome yield of 99.55g in Bentong variety and 187.0g in Tanjung Sepat variety after nine months cultivation. The crude fiber analysis was also varied in different doses of gamma rays and the effect was variety-dependent. Bentong variety at 9 Gy recorded 8.53% while Tanjung Sepat variety at 5 Gy obtained 8.70% which gave the lowest crude fiber composition. Meanwhile, the highest moisture content in Bentong variety at 7 Gy (95.73%) compared with Tanjung Sepat variety at 9 Gy (94.74%). It was also noticed that high proportions of chromosomal aberrations have been attributed to clumping, laggards and stickiness of chromosomes. The PCR based RAPD analysis showed 97.62% of polymorphisms which indicated that there were high changes in genetic sequences in irradiated ginger genotypes. Therefore, the findings of this research provide guidance in mutation induction and selection of mutant in ginger.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Towards achieving the developed nation by 2020, Malaysia government has outlined several strategic thrusts to boost the economic growth, including the establishment of the agriculture National Key Economic Areas (NKEA) in 2010 and have mapped out 16 Entry Point Projects (EPPs). One of the highlight points is focusing on herbals industry as sources of economic growth engine and as such gives promising toward a sustainable bio-economy sector (Economic, 2011). In the Malaysian scenario, ginger has been recognized as one of the 10 most popular local herbs that have high commercial potential (Globinmed, 2013).

Ginger, botanically known as *Zingiber officinale* Roscoe belongs to the family Zingiberaceae. It is a monocotyledon perennial herb consists of structure of leaves, stems and rhizomes. The commercialize plant part is the rhizome that relatively short horizontal underground stems. Ginger is one of the important tropical horticultural plants and most widely used worldwide as a spice, culinary preparation and its medicinal properties. In ancient times, ginger played a role in primary health care in China and India. Furthermore, in European medicine, ginger was among the priceless of all mild carminatives, and it was a part of various pharmaceutical preparations such as traditional treatment for curing human ailments, aid digestion system, stomach pain, diarrhea and nausea (Ravindran & Babu, 2004).

There are four main ginger varieties cultivated in Malaysia which are Bentong, Tanjung Sepat, Bara and China (Suhaimi, Mohamad, Mahamud, & Khadzir, 2012). However, local ginger production in comparison with other export crops is relatively low because of its inherent poor yields which can be attributed to lack of new varieties (Crops, 2013). Ginger plant usually propagated by vegetative means of underground rhizomes with slow multiplication rate, resulted in low variability. Breeding of ginger is limited by sterile plant reproduction system with no viable seed, poor flowering and low set of fruit and seed.