VISUALIZING ANTHOCYANINS: COLORIMETRIC ANALYSIS OF BLUE MAIZE

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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DEDICATION

This work is completely dedicated to my lovely parents Rosniza Binti Mohamad Nadzir, Muhammad Najib Bin Alias, and Azwan Bin Saian, who have always supported and encouraged me throughout my education journey, as well as to my beloved supervisor, Ts. Dr. Nur Fatihah Binti Azmi, who never ceases to impart knowledge and inspiration, and to my beloved siblings, who have always been there for me in good times and bad. This dissertation is also dedicated to my buddy Afif Hakim Bin Hasanudin, who helped me in finishing the project and this report.

ABSTRACT

Anthocyanins are pigments found in fruits, vegetables, grains, flowers, and other plants responsible for red, blue, and purple. It also occurs in maize. Maize or we called it corn is one of the most important grains cultivated around the world. Maize can be naturally purple, red, blue, and rainbow color. The color of corn maturity is quite challenging to recognize because of the presence of many uncontrollable factors that will affect the color of the corn. However, to assess whether the maize is ready to harvest, it is important to visualize the blue purplish anthocyanins in blue maize among the small-scale producers. Therefore, this project aims to develop a colorimeter; the MaizeMeter which can analyze the color of maize based on the blue or purplish coloration of anthocyanins. The analysis of anthocyanins coloration will be monitored in an understandable color value in real-time using IoT implementation. The proposed method involves calibrating the color sensor and designing a prototype for the MaizeMeter in order to build up a database of anthocyanins color in blue maize. Finally, it is believed that the anthocyanins' color database collected from the developed MaizeMeter will be helpful in the future for small-scale farmers and researchers in assessing the maize's maturity more efficiently and accurately.

ABSTRAK

Antosianin adalah pigmen yang terdapat dalam buah-buahan, sayur-sayuran, bijirin, bunga, dan tumbuhan lain yang bertanggungjawab untuk merah, biru, dan ungu. Ia juga berlaku pada jagung. Jagung atau kami panggil jagung adalah antara bijirin terpenting yang ditanam di seluruh dunia. Jagung boleh menjadi warna ungu, merah, biru dan pelangi secara semula jadi. Warna kematangan jagung agak mencabar untuk dikenali kerana terdapat banyak faktor tidak terkawal yang akan mempengaruhi warna jagung. Walau bagaimanapun, untuk menilai sama ada jagung bersedia untuk dituai, adalah penting untuk menggambarkan antosianin biru keunguan dalam jagung biru di kalangan pengeluar skala kecil. Oleh itu, projek ini bertujuan untuk membangunkan colorimeter, MaizeMeter yang boleh menganalisis warna jagung berdasarkan warna biru atau ungu antosianin. Analisis pewarnaan antosianin akan dipantau dalam nilai warna yang boleh difahami dalam masa nyata menggunakan pelaksanaan IoT. Kaedah yang dicadangkan melibatkan penentukuran penderia warna dan mereka bentuk prototaip untuk MaizeMeter untuk membina pangkalan data warna anthocyanin dalam jagung biru. Akhirnya, adalah dipercayai bahawa pangkalan data warna antosianin yang dikumpul daripada MaizeMeter yang dibangunkan akan membantu pada masa hadapan untuk petani dan penyelidik skala kecil dalam menilai kematangan jagung dengan lebih cekap dan tepat.

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LIST OF SYMBOLS AND ABBREVIATIONS

MS	:	Metabolic syndrome
CIE	:	Commission Internationale de l'Eclairage
RTH	:	Ready to Harvest
NRTH	:	Not Ready to Harvest
RGB	:	Red, Green, Blue
NFC	:	Near field Communication

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CHAPTER 1

INTRODUCTION

This chapter consists of a background of the project about the color measurement and anthocyanins. Besides, this chapter also states the problems statement that needs to be solved and the purpose of the research that needs to be achieving to make sure that the project success. Furthermore, this chapter also explains the scope of the project and project significant that related to the Visualizing Anthocyanins: Colorimetric Analysis of Blue Maize. Lastly, this chapter also provides an overview of each chapter in this report.

1.1 Background Project

Due to its versatility and multiple uses as a human food source, livestock feed, and a raw material for various industries, maize or we called it corn is one of the most important grains cultivated around the world[1]. Maize can be purple, red, blue, or

rainbow in color due to anthocyanin pigmentation. Anthocyanins are polyphenol pigments that are colored and water soluble. The pigments are glycosylated in some way. Fruits and vegetables contain anthocyanins, which are responsible for red, purple, and blue coloration. It can abundant in berries, currants, grapes, and also in a maize. Blue maize is a maize with grains pigmented shades of blue or purple. In purple and blue maize, the color is due to anthocyanins, polyphenolic compounds of low molecular weight that belong to the flavonoid derived from the cation 2-phenyl benzopyrylium, which are found in nature in glycosylated or acylated forms[2].

The color of the food is the very first factor that customers consider when determining its quality. In agriculture, the important matters is how well the product is received even before it is consumed[3]. The color of the maize will change when it is ready to be harvested. It is something that can only be recognized by a farmer who has been involved in the farming sector for a significant amount of time. The most important aspect of this undertaking study is to investigate, gain knowledge and educate a non-technical user (farmers) of specific crops about the color. The hue, the brightness, and the saturation of a color may all be described by human's eyes. When light is reflected off of an item, the human eye sees color in that reflection. There are three colors that are considered primary. It is yellow, red, and blue in color. Primary colors, when combined with one another, can produce secondary colors such as orange, green, and violet[4].

Maize become blue due to the anthocyanins content. The precise and exact approach to view the blue/purple anthocyanins in a blue maize among small-scale growers is vital in judging whether the maize is ready to harvest or not. There are a specifics value involved in determining the color. For a mature maize, the color will

have their own color values and it will be a standard value in determining maize's maturity. In assessing whether the corn is ready to be harvested or not, it is important to visualize the blue purplish anthocyanins in a blue maize correctly and accurately among the small-scale producers. According to [5] the agriculture drives an economic growth in these countries and contribute to overall gross domestic product. Many smallholder farmers are producing for a small-scale market. To help farmers or a small- scale producers bridge a pending food gaps, digitalizing the operations by employing IoT and in situ sensor can help them to produce and sell more into markets. This study is aim to contribute to fill above-mentioned gap. Therefore, this project's objective is to design a low-cost colorimeter to measure the anthocyanin color values and to analyze the color values via an IoT implementation. The project will help farmer to save time and efficiently in identifying maize maturity. The more accurately to recognize the maize maturity, the highest productivity a famer can make.

This project is divided into three parts. First part is the hardware development, where the colorimeter capable of detecting, measuring and visualizing the anthocyanins color values of the blue/purple maize. The color sensor works to detecting the RGB color values for blue maize. OLED LCD will show the RGB value notify farmer whether the blue maize is ready to be harvested or not. The colorimeter will be integrated with IoT for an ease of real-time monitoring process.

Lastly, this project aims are to design a low-cost colorimeter to measure the anthocyanin color values and to analyze the color values via an IoT implementation. This project is a combination of hardware, software and Internet of Things (IoT) to fill the mentioned gap in previous paragraph. Small-scale farmer can get advantages by using this device and attract young generation and new workers at the farm. This will