Chapter 5
Emerging Microwave Technologies for Agricultural and Food Processing

Kok Yeow You
https://orcid.org/0000-0001-5214-7571
Universiti Teknologi Malaysia, Malaysia

Man Seng Sim
https://orcid.org/0000-0001-7776-2239
Universiti Teknologi Malaysia, Malaysia

Suhail Najm Abdullah
https://orcid.org/0000-0003-4897-9396
Universiti Teknologi Malaysia, Malaysia

ABSTRACT

This chapter focuses on microwave research and measurements for agricultural and food processing applications. Normally, microwave devices and components are used as a moisture detector for soil, agricultural, and food products. For instance, the moisture content in fruits normally is correlated with the maturity and sweetness of the fruits. In addition, the moisture content can be used to determine the storage period and the quality of the agricultural products after processing by an industrial factory. In this chapter, several microwave applications of agri-food products are selected to be reviewed comprehensively, such as microwave heating mechanism for several agri-food products, heating/drying, or freeze-drying process in food industry to control pathogenic and spoilage microorganisms in packaged foods, moisture soil testing, fruit moisture measurement, ripeness/storage period determination, fruit sweetness detection, microwave radiation for agricultural pest control.

DOI: 10.4018/978-1-7998-5000-7.ch005

INTRODUCTION

Microwave technology is expanding rapidly and is becoming more and more common in our daily lives, such as mobile phone and microwave oven. Microwave technology application can be divided into two groups, namely communication and non-communication applications. In this chapter, microwave non-communication applications have been described and specifically focus on the use of such technologies in agriculture/food fields. This chapter reviews the microwave applications for agricultural in this era based on a detailed literature survey and the author's experience in microwave researches.

In fact, over the past 40 years, a lot of research on microwave applications in agriculture has been conducted. Most of the research related to the field has been published in journals, such as Journal of Microwave Power and Electromagnetic Energy (Formerly Journal of Microwave Power) and Transactions of the ASAE (American Society of Agricultural Engineers). However, commercial microwave products/instruments for agricultural use are rarely found in comparison with optical-based (infrared) and acoustic-based (ultrasound) technologies. This is due to the higher price of microwave electronic components, such as monolithic microwave integrated circuit (MMIC) chips, compared to others. Foremost, microwave device components require high precision machining. Also, normally, microwave raw materials used in electronic components are the expensive synthetic materials, which materials have good thermal resistance and lossless dielectric at the high operating frequency. Besides, the design of microwave components is not easy and requires experts in the field of microwave engineering, especially in the last 30 years where it is difficult to obtain workstation computers and simulation software for microwave components/electronics design.

Nowadays, advances in the mechanized industry (industry 4.0) and electronic communication technologies, such as internet of things (IoT) and fifth-generation (5G) wireless technologies, are increasing globally. Thus, precision machining, such as computer numerical control (CNC) milling machine, high-end personal computers, and engineering simulation software are becoming common. In addition, techniques and knowledge in the production of new synthetic materials and microwave components are matured, and that information can be easily obtained from books, journal or internet. Hence, recently, the microwave component prices have reached a level nearly similar to optical and acoustic electronic components. This has provided the advantages and opportunities for more microwave technologies to be applied in agricultural / food processing.

In fact, microwave technology is capable of applying in sensors for agricultural/food processing, such as grain/soil moisture measurement, fruit ripeness/storage period determination, fruit sweetness detection, control of milk of lime, monitoring of nitrogen/phosphorus content in fertilizer. The microwave also can be used for heating/drying or freeze-drying process (sterilization/pasteurization) in the food industry to control pathogenic and spoilage microorganisms in packaged foods. Microwave applications for heating and crushing normally use high microwave power which is up to megawatts. Besides, microwave energy also has been implemented for agricultural pest control.