UNIVERSITI TEKNOLOGI MARA

EFFECTS OF DIFFERENT DRYING PROCESS, EXTRACTION AND ENCAPSULATION AGENTS ON STABILITY OF *Alternanthera sessilis* (L.) DC. EXTRACT

SYAFIQAH BINTI SHAHARUDDIN

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Food Science and Technology)

Faculty of Applied Sciences

March 2023

ABSTRACT

There are numerous studies evaluating the effectiveness of innovative drying methods and alternative extraction methods, yet only a few reported the effect of the combination of these two. Therefore, in this study, the relationships between drying methods and extraction methods on antioxidant properties, total betalain and colour of *A. sessilis* red were displayed. Drying of *A. sessilis* red was performed through superheated-steam drying (SSD) and freeze-drying (FD) which was later followed by the extraction using conventional extraction and ultrasonic-assisted extraction (UAE). Results showed that combining SSD and UAE produced greater yield of extract (32.19%) with higher phenolic compounds (GA: 1715.75 mg/100g DS; VA: 230.41 mg/100g DS; PCA: 1559.96 mg/100g DS) and antioxidant capacity (DPPH : 39.48%; FRAP : 1015.02 mg TE/100g DS) as well as having good colour. Still, a combination of SSD (170°C; 1 hour) and UAE (30 mins; 20-kHz; 40°C) was unable to enhance the betalain content. Hence, the stability study was proceeded using FD and UAE. Yet, betalain can still undergo degradation, causing the loss of its colour. The encapsulation technique can improve the stability of the pigment but it requires the addition of carrier agents. This study focused on the effect of different carrier agents on the antioxidative properties, total betalain and colour of *A. sessilis* red powder to its powder properties. The liquid extracts of *A. sessilis* red were added with single carrier agent (maltodextrin) as well as binary carrier agents (maltodextrin+arabic gum, maltodextrin+whey protein isolate) at a percentage of 20% w/w prior to encapsulation by the spray drying. The incorporation of carrier agent yielded powder of higher yield (27.80%-34.35%) and glass transition temperature (42.50°C-55.28°C) as well as lower hygroscopicity (13.40%-17.29%), moisture content (3.20% - 4.10%) and water activity (0.37-0.26). The use of binary carrier agents also improves the morphology of the powder by reducing the formation of cracks on the microcapsules. Even so, storing the powders for two months at temperatures of 4°C, 25°C and 40°C with the exclusion of oxygen (oxygen absorber) and light (opaque aluminium packaging) still caused detrimental impacts to the antioxidant properties and betalain pigment. Combinations of maltodextrin and AG were seen to be the best carrier agent as they showed the highest retention of betalain pigment (betanin: 74.36%- 84.62%; betaxanthin: 52.94%-90.20%) and moderate retention of antioxidant capacity (DPPH: 70.70%-77.39%; FRAP: 50.00%-80.60%).

ACKNOWLEDGEMENT

First and foremost, I wish to thank Allah for giving me the opportunity to embark on my MSc journey and for providing me strength in finishing this long and challenging journey.

I would like to earnestly acknowledge the sincere efforts and valuable time given by my supervisor, Dr. Azizah Othman. Her patience, understanding and encouragement really helped me survive the tough days during my study period. Also, many thanks to her for the research funding of this project. Besides, many thanks to my co-supervisor, Prof. Datin Dr. Rohaya Ahmad for helping me in solving the problems and providing feedbacks related to the HPLC instrumentation.

I would like to extend my gratitude to Universiti Putra Malaysia especially Biotechnology Centre for allowing me to use the superheated-steam oven and other facilities there. My appreciation also goes to the Faculty of Chemical Engineering, Universiti Teknologi MARA, Shah Alam for providing the facilities and assistance for the production of *A. sessilis* red powder. Thank you Puan Suhaila and Cik Hajatun for your help. Moreover, I would also like to thank the Department of Food Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam for majority of the research facilities. Also, thanks to the lab assistants, Puan Noor Haida, Encik Ahmad Khambali, Puan Siti Marhani, Puan Roslizawati, Puan Norahiza,, Encik Zulhairy and Cik Suhada for their kindness in guiding me in using the equipment and helping me to understand well on the method that I used.

Finally, this research is dedicated to my family especially my parents, who had always given me freedom to explore my own path. Their encouragement and never-ending moral and financial supports really gave me strength to pursue my MSc till the very end.

Without them, I could never had completed my MSc. Thank you.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 Background

Nowadays, the use of natural food additives is favourable, both to consumers and the food industry. Consumers demand the use of natural compounds in food due to health concerns about synthetic food additives (Patras, 2019). Meanwhile, food manufacturers are more inclined to use natural food additives for clean labelling of the product that will attract consumers. According to Embuscado (2015), the use of additives like antioxidants from natural sources also gives another benefit where they can be readily absorbed by the body. Although the bioavailability of natural pigments like chlorophyll, carotenoid, anthocyanin and betalain is low, encapsulation process, which is common in the production of natural colourant is able to reduce the problem (Ghosh *et al.*, 2022). One of the important procedures involved in the conversion of raw natural sources to food ingredients is drying. Drying reduces deterioration in food by reducing the water content which also improves the food quality (Karam *et al.*, 2016). Buchin *et al.* (2019) added that higher biological activities were seen in heat-treated rosemary as the heat being applied resulted in various chemical changes in the food. However, conventional hot air drying caused high energy consumption, non-uniform drying, unacceptable product quality with degradation of nutrients (Sehrawat *et al.*, 2016). Although freeze drying is more common in preserving products with high volatile nutrients, setting up the equipment will incur a high initial investment cost and the process also involves high energy consumption. Sehrawat *et al.* (2016) stated that superheated-steam drying (SSD) is an innovative drying technology, which eliminates excess water from the sample by utilization of heated steam (the drying medium) beyond its boiling point. SSD can dehydrate food in a shorter period which results in lower cost. The heat may also affect the cell structure of food causing it to damage, leading to an increased antioxidant component.

Extraction is a crucial step where all the desired bioactive compounds from the plant sources are extracted into the extraction medium. A suitable extraction technique influenced the extraction yield and biological activity of the extracts (Truong *et al.*, 2019). Garcia-Vaquero *et al.* (2020) suggested that conventional extraction (CE) is a