COMPARISON OF CALCIUM HYDROXIDE TREATED AND UNTREATED PUMPKIN FLESH AT DIFFERENT DEHYDRATION TEMPERATURE

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ABSTRACT

Pumpkin is widely planted worldwide, including Malaysia. Some regions have the limitation of oversupply or limited supply for fresh pumpkin. This has raised the urge to produce pumpkin derived products to avoid spoilage and wastage of fresh pumpkin and to cater the high demand from consumers due to its known health benefits. Dehydration is one of food preservation method. Starting from food dehydrating directly under sunlight to developing time saving and cost effective technologies with the aim to improve the quality of dehydrated products. Food dehydrator is a practical technology that can be used to dehydrate pumpkins. It could be used to dehydrate foods at different temperatures with a good air aeration to accelerate the dehydrating process. Four temperatures (50°C, 60°C, 70°C and 80°C) had been tested to dehydrate pumpkin flesh in the present study. The pumpkin flesh was treated with calcium hydroxide ($Ca(OH)_2$) for better dehydration and food preservation. The dried pumpkins were then ground into powder for storage. The quality of pumpkin products was proven by extracting bioactive components from dried pumpkin using ethanol extraction. The good quality of dried pumpkins was also determined for its biochemical compounds such as ß-carotene, riboflavin, caffeic acid, and quercetin by HPLC. The antimicrobial activities of the extracts towards four microorganisms (*Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumonia*) were also analysed using disc diffusion method. Dehydration of pumpkin flesh was found to exhibit falling rate pattern, which is common in the dehydration of agricultural products. The treated pumpkin flesh that dehydrated at 70°C was able to produce the highest extraction yield (73.54%). However, the degradation of bioactive compounds could be happened during the process of pre-treatment, dehydration, extraction and storage. The explanation was given to the observation in the present study because the assigned compounds could not be detected and no significant inhibition was observed for the selected pathogenic microorganisms. Although dehydration was successfully carried out, the quality of dried pumpkin was not satisfied. Therefore, it is recommended to improve the pre-treatment and extraction techniques to ensure high quality of dehydrated pumpkin flesh for human consumption.

ABSTRAK

Labu ditanam secara meluas di seluruh dunia, termasuk Malaysia. Sesetengah wilayah mempunyai had lebihan bekalan atau bekalan terhad untuk labu segar. Ini telah menimbulkan keinginan untuk menghasilkan produk labu bagi mengelakkan kerosakan dan pembaziran labu segar dan untuk memenuhi permintaan tinggi daripada pengguna kerana manfaat kesihatannya. Dehidrasi adalah salah satu kaedah pengawetan makanan. Bermula daripada penyahhidratan makanan secara langsung di bawah cahaya matahari kepada membangunkan teknologi penjimatan masa dan kos efektif dengan tujuan untuk meningkatkan kualiti produk dehidrasi. Dehidrator makanan adalah teknologi praktikal yang boleh digunakan untuk menyahhidrat labu. Ia boleh digunakan untuk menyahhidrat makanan pada suhu yang berbeza dengan pengudaraan udara yang baik untuk mempercepatkan proses penyahhidratan. Empat suhu (50°C, 60°C, 70°C dan 80°C) telah diuji untuk mengeringkan isi labu dalam kajian ini. Isi labu telah dirawat dengan kalsium hidroksida ($Ca(OH)_2$) untuk dehidrasi dan pengawetan makanan yang lebih baik. Labu kering kemudiannya dikisar menjadi serbuk untuk disimpan. Kualiti produk labu telah dibuktikan dengan mengekstrak komponen bioaktif daripada labu kering menggunakan pengekstrakan etanol. Kualiti baik labu kering juga ditentukan untuk sebatian biokimianya seperti ß-karotena, riboflavin, asid kafeik, dan kuersetin oleh HPLC. Aktiviti antimikrob bagi ekstrak terhadap empat mikroorganisma (*Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, dan *Klebsiella pneumonia*) turut dianalisis menggunakan kaedah resapan cakera. Dehidrasi isi labu didapati menunjukkan corak kadar kejatuhan, yang biasa berlaku dalam dehidrasi produk pertanian. Isi labu yang dirawat yang mengalami dehidrasi pada suhu 70°C mampu menghasilkan hasil perahan yang paling tinggi (73.54%). Bagaimanapun, degradasi sebatian bioaktif boleh berlaku semasa proses pra-rawatan, dehidrasi, pengekstrakan dan penyimpanan. Penjelasan diberikan kepada pemerhatian dalam kajian ini kerana sebatian yang ditetapkan tidak dapat dikesan dan tiada perencatan yang ketara diperhatikan untuk mikroorganisma patogenik terpilih. Walaupun dehidrasi berjaya dijalankan, kualiti labu kering tidak memuaskan. Oleh itu, adalah disyorkan untuk menambah baik teknik pra-rawatan dan pengekstrakan bagi memastikan isi labu dehidrasi yang berkualiti tinggi untuk kegunaan manusia.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

$Ca(OH)2$	-	Calcium Hydroxide
HPLC	-	High Performance Liquid Chromatography
COVID-19	-	SARS-CoV-2 virus
WHO	-	The World Health Organization
S. aureus	-	*Staphylococcus aureus*
USD	-	United State Dollar
¥	-	Chinese Yuan
HAD	-	Hot Air Drying
VD	-	Vacuum Drying
FD	-	Freeze Drying
FIRD	-	Far-infrared Drying
MH	-	Mueller-Hinton
SD	-	Standard Deviation
VS	-	Versus
ANOVA	-	Analysis of Variance
MIC	-	Minimal Inhibitory Concentration

LIST OF SYMBOLS

ß	-	Beta
%	-	Percentage
°C	-	Degree Celcius

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of study

High moisture content in pumpkin (*Cucurbita moschata Duchesne*), especially the local pumpkin variety in Malaysia makes it easily spoiled. Dehydration is a technique to remove or minimise water content, and is considered as a form of food preservation. Limited water will inhibit the growth of microorganisms, and thus extending its shelf life. Reduction of moisture content can prevent damage resulting from microbial contamination. This makes dehydration an excellent method to preserve pumpkin flesh. Dried pumpkins can be the main ingredients in dietetic food, traditional food, breakfast cereals, bakery products and others. However, a proper dehydration method is crucial to maintain the nutritional values of dried pumpkin (Seremet et al., 2016).

The method of processing and preservation of food may give a good or bad effect to gut microbiota (Miclotte and Van de Wiele., 2019). Dehydrated pumpkin products have high commercial potential, and pumpkins are widely planted in Malaysia. However, there is still a lack of study for products from pumpkin. This study investigated a dehydration technique to produce the optimum quality of dried pumpkin (Kamarubahrin et al., 2018). The technique is user friendly and can be carried out at home.

In this study, calcium hydroxide ($Ca(OH)_2$) treated pumpkin flesh was dehydrated at four different temperatures ranged from 50°C, 60°C, 70°C, to 80°C. The dehydration duration took about 8 hours to 13 hours. All dehydrated pumpkin flesh was extracted by alcohol and then determined for bioactive compounds such as ß-carotene, caffeic acid, riboflavin, and quercertin using HPLC. Antibacterial activities were also analyzed against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia* using disc diffusion method. Moisture content of treated and untreated pumpkin flesh, the presence of biochemical compounds, and antibacterial properties were observed and discussed in the following chapters.

1.2 Problem statement

Pumpkins are widely grown throughout Malaysia and have become one of its native plants with a large production area comparable to its high demand globally. However, the commercial production is still limited due to limited market demand compared to the consumption of fresh products. Indeed, pumpkin derived products have huge potential, mainly because of their high nutritional values. However, there is still lack of awareness, turning fresh pumpkin into valuable and convenient products. Potential of pumpkin products needs to be further investigated to explore the full potential of such amazing prophetic plants to increase their competitiveness and self-sufficiency. More than that, pumpkin is a good source of vast phytochemicals such as carotene, fibre, folate and vitamins (Aimi et. al., 2018).

There are many purposes of pumpkin other than as food sources including commercial, decorative and agriculture. The popularity of pumpkin used as traditional medication has been the main attraction for researchers. Limited studies have shown the natural bioactive components of pumpkin to promote health and prevent diseases. Although different parts of pumpkin have different physiological benefits, it is still an important source to reduce the risk of consumers from getting non-communicable diseases such as tumours, diabetes, microbial infections and to promote better well-being (Dotto and Chacha, 2020). Simran et. al. (2020) stated that pumpkins are cultivated as medicine, vegetables and food products such as purees, jam, jellies and many more. This shows that pumpkins are greatly important in human life due to its benefits for health and lifestyle. For all the benefits and potential of pumpkin, Qamar et. al. (2019) and Domenico et. al. (2018) stated that further studies and awareness on the nutritional and therapeutic value of pumpkin need to be strengthened in order to make consumers realising its importance as a part of their daily meal. More than that, pumpkin has high potential to be commercially exploited for nutraceutical applications due to its benefits to human health.

According to Bartosz and Anna (2019), the development of pumpkin products from its flesh into powder is important as functional food with high health benefits. Thus far, not many food products based on pumpkin pulp have been developed and not fully examined. Not all aspects of pumpkin for its potential have been tested although it is a well-known vegetable in the world. In this study, the effect of pre-treatment and dehydration temperatures on the biochemical compounds and antibacterial activities of pumpkin flesh were analysed and interpreted.

1.3 Objective of study

The objectives of this study were:

1) To compare the moisture content between dehydrated untreated and calcium hydroxide ($Ca(OH)_2$) treated pumpkin (*Cucurbita moschata Duchesne*) flesh using a food dehydrator at four different temperatures (50°C, 60°C, 70°C and 80°C).
2) To determine the biochemical compounds from the dehydrated pumpkin flesh using ethanol extraction.
3) To characterise the antimicrobial activities against *Staphylococcus aereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *and Klebsiella pneumonia* of the dehydrated pumpkin flesh.

1.4 Scope of study

The scopes of this study were:

1) Comparison of the effects of dehydration temperature and pre-treatment on the dehydration time and moisture content of pumpkin flesh.
2) Detection of bioactive compounds such as ß-carotene, caffeic acid, riboflavin, and quercetin in the dehydrated pumpkin flesh.
3) Characterisation of antimicrobial activities against *Staphylococcus aereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumonia* of the dehydrated pumpkin flesh using the disc diffusion method.

1.5 Significance of study

Pumpkin (*Cucurbita* species) is a perfect candidate as a functional food since it is rich with nutrients and bioactive compounds. Pumpkins are commonly grown throughout Malaysia. It takes a short time to grow within two to three months, and can be stored up to six months long. Although pumpkin is a famous delicacy in Malaysia, the commercial production only depends on the market demand on the fresh fruit. The demand for pumpkin products is encouraging, this creates an oversupply issue, and farmers have difficulties to handle the large stock in their storage, which results in higher operational cost and spoiled products. Studies on simple and inexpensive technology to process pumpkin into dehydrated powder is needed to overcome the issues of reducing storage space and extending shelf life of fresh fruit. Such technologies will greatly help small-scale farmers and consumers (Yok et al., 2016).

Continuous innovation and exploration of products from pumpkin such as powder, snacks, animal feed and supplements present new opportunities in the market. Pumpkins can be diversified to make various nutritious products with such innovations. Research on the quality of products from pumpkin are important to meet the demand of consumers for more healthy products and to improve processing techniques. Daily consumption of fresh pumpkin and its products will positively influence the health of consumers. Thus, investigations on the potential of pumpkin-based products are needed to increase competitiveness of pumpkin (Kamarubahrin et al., 2018).

The importance of pumpkin in national food security has led to a progressive research on this fruit. The nutritional values and diversity of consumption has made pumpkin one of the main research interest nowadays (Jimena et. al., 2022). Since most agricultural products are not directly consumed after harvesting, dehydration can reduce the loss of valuable fresh food which prone to turning rot and foul by reducing moisture content. Dehydrated agricultural products can be produced to make instant food, vegetable snack chips, cereals, and others. Dehydration of agricultural products can adjust the supply and demand of seasonal foods. More than that, dehydration has been adapted throughout the world due to its ability to reduce waste and improve storage availability and durability (Zhihua et. al., 2022).

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