EFFECT OF VARIABLES ON THE PINEAPPLE POWDER PRODUCTION USING MICROWAVE SPRAY DRYER

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I dedicate this thesis to my parents, family and siblings

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ABSTRACT

The aim of this research is to produce pineapple powder with high qualities by using microwave rig assisted spray drying (MWSD). In previous research used (MWSD) operated at atmospheric pressure to obtain pineapple powder with high inlet air temperatures. All know the effect of high temperature on the foods product especially fruits, it make thermal degradation of powder product, so the final product lose some characteristics. In this study, the drying process carried out with low inlet air temperatures. The experiments were conducted keeping constant the nozzle size, feed flow rate and maltodextrin concentration (DE12): 1mm, 25 ml/min and 25% w/w respectively. Drying was carried out by using 1000 Watt microwave power intensity and with the different inlet air temperatures (40-100 ºC). Also, drying was conducted using 80°C inlet air temperature and with the different microwave power intensities (700-1600 Watt). The product powder was analyzed for moisture content, bulk density and solubility. In two cases, moisture content and bulk density are inversely proportional to the inlet air temperature and microwave power intensity, whereas solubility proportional to the inlet air temperature and microwave power intensity. The best result when inlet air temperature 80°C and microwave power intensity 1000Watt, will produce pineapple powder with 3.91% moisture content, 0.59g/ml bulk density and 33 sec powder solubility. The results showed that the data were adequately fitted into the second order polynomial model.

ABSTRAK

Tujuan penyelidikan ini adalah untuk menghasilkan serbuk nanas dengan kualiti yang tinggi dengan menggunakan rig gelombang mikro dibantu oleh pengering sembur (MWSD). Dalam kajian sebelumnya dengan menggunakan (MWSD), ia dikendalikan pada tekanan atmosfera untuk mendapatkan serbuk nanas dengan suhu udara masuk yang tinggi. Ramai orang mengetahui pengaruh suhu yang tinggi terhadap produk makanan terutama buah-buahan, ia menyebabkan penyusutan terma bagi produk serbuk, jadi produk akhir akan kehilangan beberapa ciri. Dalam kajian ini, proses pengeringan dilakukan dengan suhu udara masuk yang rendah. Eksperimen ini dijalankan dengan menggunakan saiz muncung, kadar aliran masuk dan kepekatan maltodextrin (DE12) tetap pada nilai masing-masing: 1mm, 25 ml/minit dan 25% w/w. Pengeringan dilakukan dengan menggunakan keamatan kuasa gelombang mikro 1000 Watt dan aliran suhu udara masuk yang berbeza (40-100 °C). Selain itu, pengeringan juga dilakukan dengan menggunakan suhu aliran masukan 80°C dan dengan tenaga gelombang mikro yang berbeza (700-1600 Watt). Serbuk produk dianalisis untuk kandungan lembapan, ketumpatan pukal dan keterlarutan. Dalam dua kes, kandungan lembapan dan ketumpatan pukal adalah berkadar songsang dengan suhu udara masukan dan keamatan gelombang mikro. Keputusan yang terbaik adalah pada suhu udara masuk 80 °C dan keamatan gelombang mikro 1000Watt akan menghasilkan serbuk nanas dengan kandungan lembapan 3.91%, ketumpatan pukal 0.59g/ml dan keterlarutan serbuk 33 saat. Keputusan menunjukkan bahawa data ujikaji adalah bersesuaian dengan model polinomial turutan kedua.

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LIST OF SYMBOLS

±a	-	redness
±b	-	yellowness
db	-	dry basis
L	-	lightness
Tg	-	glass transition temperature
%v/v	-	percentage of volume
wb	-	wet basis
%w/w	-	percentage of weight

LIST OF ABBREVIATIONS

AD	-	Air drying
ADMI	-	American Dry Milk Institute
ADVMD	-	Combination of air and vacuum microwave drying
CIE	-	Commission Internationale de L'Eclairage
DE	-	Dextrose equivalent
GA	-	Gum Arabic
IDF	-	International Dairy Federation
ISM	-	Frequencies for industrial, scientific and medical purposes
MD	-	Maltodextrin
MWSD	-	Microwave assisted Spray Drying
SD	-	Spray Drying
VMD	-	Vacuum microwave drying

CHAPTER 1

INTRODUCTION

1.1 Research Background

Pineapples (Ananas Comosus) one of the most popular tropical and subtropical fruits. It has attractive flavor and refreshing sugar-acid balance. Pineapples are largely grown in several countries such as Malaysia, Thailand, Philippines, Taiwan, Hawaii, Caribbean area, Mexico, Australia, South Africa and Kenya (Fuster et al., 1995). However only a limited quantity of pineapple products such as canned juice, canned fruit and frozen juice concentrate, is produced. Furthermore misuse the right way for harvest many quantities of pineapple can be wasted (Nicoleti et al., 2001). There are many uses of pineapple. It is used in baby foods, biscuit products, flavoring agent in ice cream, salads, dessert and bakery. Also is used in paper and medicine industries and food for livestock when the pineapple canning, drying and juice extraction.

One of the establish method of food preservation is dehydration. The objective from any drying process is reduce moisture content in foods to a level low enough to prevent undesirable biochemical reactions and microbial growth (Feng et al., 2001)

The most common method to produce powders is spray drying. During the last two decades intensive researches were made about spray drying to develop its work. The definition of spray drying is a technique change the feed from a fluid state to dried particulate. The feed can be liquid, slurry, emulsion, gel or paste. The final product may take the shape of a powder, granulate or agglomerate according to the physical and chemical properties of the feed, the final powder specification and drying characteristics. This technique involves spraying (atomizing) the feed into very hot air inside a large chamber (Patel et al., 2009). The disadvantages of this method are: large equipment, expensive, use high temperature and long drying time this may cause thermal degradation in the final products.

Microwaves have been used as a heat source since the 1940 (Mermelstein, 1997). Currently, microwave is applied in many food manufacturing and chemical processes for dehydration (drying) and finishing fruits, vegetables and herbs. As well as for sintering of ceramics, heating and reheating, thawing (melting), tempering of frozen food like meat and fish. Also, baking, sterilization, cooking and precooking, pasteurization of ready meals, blanching and phyto-extract.

In a microwave drying system, the microwave energy can easily penetrate into the material. The quick energy absorption causes rapid evaporation of water, creating an outward flux of rapidly escaping vapour, thus, both thermal gradient and moisture gradient are in the same direction (Hu et al., 2007). In conventional drying methods the directions of heat and mass transfer are opposite. The outer layer of the product becomes dry first, forms a poor heat conductor which hinders the dehydration process. As a result increase drying time.

According to Norashikin (2010), used a new technique to produce pineapple powder. She combined two methods for drying in one equipment, this new method called microwave assisted spray drying process (MWSD) operated at atmospheric pressure, and use high temperatures. In this research, the drying process use low temperatures at atmospheric pressure to produce pineapple powder by using same equipment.

1.2 Problem Statement

In conventional and combined methods use hot drying medium (usually hot air) to dry materials. All know the effect of high temperatures on the sensitive foods especially fruits, it make thermal degradation of powder product, so the final product lose some characteristics such as vitamins, flavor and color compounds. Furthermore, the hot air cause oxidation for many sensitive components. Also, increase the consumption of energy which used on heater to heat air and as a result waste money. For all these reasons prefer to apply low temperatures.

1.3 Objective of research

The objectives of this study are:

i. To study the effect of operating parameters such as inlet air temperature and microwave power intensity to the powder product.

ii. To examined the quality of the product due to moisture content, bulk density and solubility.

1.4 Scopes of research

The scopes of this research consists as below:

i. Sample preparation.
   Prepare pineapple juice from fresh pineapple. Add water and maltodextrin to this juice. Introduce the solution to drying process.

ii. Study the drying process using varies inlet air temperatures (40-100 ºC) for constant microwave power intensity (1000 Watt).

iii. Study the effect of varies microwave power intensities (700-1600 Watt) at constant inlet air temperature (80°C).

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