SPRAY DRYING AS THE ALTERNATIVE METHOD FOR PRODUCTION OF TROPICAL FRUIT POWDER

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Abstract

Mango puree was encapsulated with gum arabic using a laboratory scale spray dryer at inlet and outlet air temperatures ranging from 160 °C to 220 °C and 79 °C to 110 °C respectively. A preliminary drying run was done at 160 °C inlet and 106 °C exit air temperatures with a flow rate of 900 ml/hr using the laboratory scale spray dryer. The temperature and flow rate were adjusted until a high product yield with low moisture content is achieved. Optimum operating condition for spray drying of mango puree using a laboratory scale spray dryer were at a flow rate of 900 ml/hr, inlet temperature of 200 °C and outlet temperature of 134 °C. The powders were analysed for starch, vitamin C and moisture content. These data is used determine the optimum operating condition for a pilot-scale spray dryer. The optimum operating condition of a laboratory scale spray dryer was then applied to the pilot scale spray dryer. Similar analysis on the powder were conducted. This optimum operating condition was applied to a pilot scale spray dryer. From the trial runs, it was found optimum operating condition for pilot scale spray dryer was at a flow rate of 1200 ml/hr, inlet temperature of 160 °C and outlet temperature of 96 °C. The powder dried at this operating condition was found possible for commercial production of tropical fruit powder.

Introduction

Tropical fruit powder industry is new in these area of the region. A tropical climate provides ideal conditions for rapid growth of spoilage micro-organisms and for chemical reactions. Most of such reactions in fruits and fruit products are deteriorative in nature causing high respiration rates, texture softening and spoilage of fruit. This causes loss of colour, flavour and vitamins, and browning of fruit products. Therefore it is desirable to contain or protect tropical fruit powder within an edible coating, which becomes a kind of package. The edible coating suggested for this research is gum arabic as extensive research have been done on them [1-4]. Established findings from previous studies on the edible coatings gives some explanation on how the tropical fruit puree formulation should

be blended [5]. Other than the edible coating, carboxymethyl cellulose is added to decrease the viscosity of the fruit solution to be spray dried.

In production of tropical fruit powder, quality analytical methods should be established to confirm the preservation of colour, flavour and taste before and after drying process. The chemical composition and physical characteristics of the raw material is analysed prior to drying and the powder produced from the process is also analysed.

Flavour and aroma are two most important criteria to be evaluated in food processing and manufacturing. Normally flavour, colour and aroma are not retained after going through various processing units thus affecting the product quality. Certain controlling method should be established in order to have an end product that taste similar if not, equivalent to the raw material. There are several new technologies that can accomplish this. One of them is by spray drying formulation, which encapsulates volatile components, producing powders that will release these components when added with water.

A vital aspect in the selection and processing of fruit juices is the use of the volatile components. In the case of mango and pineapple, the volatile substances are obtained from the concentrated juice known as water-phase volatile. These volatile fractions of juices have long known to contain a major part of the distinctive aroma and flavour of a juice but it was not until 1944 that a successful process was developed in the United States for their recovery from the concentration process [6].

Spray dryers are designed based on the principles of heat transfer and on practical experience from the operation of pilot plant units and industrial installations. Evaporation is a physical separation process in which heat and mass transfer takes place simultaneously. The evaporation rate is controlled mainly by heat transfer and all the effort to improve it is directed towards accelerating the heat transfer rate. The deterioration of quality is a time-temperature process and, in this respect, spray dryers may be considered as chemical reactors in which operating temperature and residence time are the most important parameters.

Short residence time and low temperature are neeessary for heat-sensitive products such as mango and pineapple juice. Spray dryers suits the condition needed in tropical fruit powder processes.

Materials and Methods

Mango Puree Preparation
The preparation of mango puree to be spray dried can be summarised as in Figure 1.

Spray Drying Process
Spray dryer used in this research is from model B191 Buchi pressure nozzle spray dryer. Prepared mango puree was spray dried at a predetermined flow rate and inlet temperature.

RIPE MANGOES
⇓
WASH AND WEIGH
⇓
PEEL AND SLICE
⇓
WEIGH THE FLESH
⇓
BLANCH IN WATER BATH AT 90 °C FOR 1 - 2 MINUTES
⇓
BLEND IN BLENDER
⇓
FRUIT JUICER / PULPER
⇓
BRIX DETERMINATION
⇓
DILUTE WITH WATER (1 : 1)
⇓
BLEND
⇓
WEIGH PREPARED PULP
⇓
PREHEAT AT 50 °C FOR 30 MINUTES
⇓
SPRAY DRY
⇓
PRODUCT RECOVERY
⇓
PRODUCT ANALYSIS
⇓
PACKAGING AND FURTHER ANALYSIS

Product Analysis
The analysis done on the powder were moisture content, vitamin C and glucose.

Results and Discussion

Optimum Operating Condition For A Laboratory Scale Spray Dryer

Results from spray drying mango puree using a laboratory scale spray dryer are as follows.

Inlet Temperature	160 °C			180 °C		
Flow Rate, ml/hr	900	1080	1260	900	1080	1260
Outlet Temperature, °C	106	109	109	106	108	107
Product, gm	16.61	16.20	15.90	7.08	14.72	10.03
Moisture Content, %	5.9	6.2	6.7	3.2	4.0	4.2
Vitamin C Content, mg/ml	14.34	14.73	15.04	16.52	14.61	14.18
Glucose, mg/ml	0.57	0.58	0.49	0.58	0.51	0.47

Inlet Temperature	200 °C			220 °C		
Flow Rate, ml/hr	900	1080	1260	900	1080	1260
Outlet Temperature, °C	134	125	130	119	141	137
Product, gram	18.52	17.08	10.08	10.22	10.03	3.79
Moisture Content, %	3.3	3.4	3.5	6.6	13.5	7.9
Vitamin C Content, mg/ml	14.43	14.61	16.02	13.55	14.08	14.43
Glucose, mg/ml	0.57	0.56	0.46	0.59	0.45	0.43

From these results, looking at the powder produced and moisture content, optimum operating condition was at a flow rate of 900 ml/hr, inlet temperature of 200 °C and outlet temperature of 134 °C. Powder produced weighed 18.52 gram with vitamin C content of 14.43 mg/ml and a trace of glucose which is 0.57 mg/ml.

Optimum Operating Condition For A Pilot Scale Spray Dryer

Initial findings from operating the laboratory scale spray dryer was applied to a pilot scale spray dryer. Later a variation of inlet temperature and flow rate is used to produce mango powder and the results are as follows.

Inlet Temperature	160 °C			170 °C		
Flow Rate, ml/hr	900	1200	6000	900	1200	6000
Outlet Temperature, °C	96	96	79	98	90	96
Product, gram	34.98	21.32	24.14	31.74	19.10	18.29
Moisture Content, %	3.4	3.8	5.7	5.6	5.8	8.5
Vitamin C Content, mg/ml	14.93	14.83	15.31	14.33	14.68	14.98
Glucose, mg/ml	0.58	0.56	0.47	0.59	0.47	0.45

Inlet Temperature	180 °C			200 °C		
Flow Rate, ml/hr	900	1200	6000	900	1200	6000
Outlet Temperature, °C	110	92	109	109	105	106
Product, gram	28.36	35.85	18.19	19.61	18.38	17.19
Moisture Content, %	4.3	4.4	5.6	7.8	8.5	9.5
Vitamin C Content, mg/ml	14.57	14.12	15.63	15.55	15.76	15.83
Glucose, mg/ml	0.59	0.56	0.49	0.49	0.45	0.44

From these results, the optimum condition for a pilot scale spray dryer is inlet temperature of 160 °C, outlet temperature of 96 °C and flow rate of 1200 ml/hr.

These differences between optimum operating condition of a laboratory scale spray dryer compared to a pilot scale spray dryer are due to variables that effects the production of mango powder. Among others differences in dimension variables such as width, height or diameter of dryer. Common simplified assumption used is not applicable in a real situation. These assumptions are:

1. A uniform feed rate, with a uniform moisture content
2. A uniform size product
3. No heat loss or heat gain through the dryer walls

Energy requirements for spray dryers depends on the heat needed for evaporation. Other parameters are feed and product temperatures, leaks, collector efficiencies, heat losses, heat source, operating pressure. Calculations alone, however, can seldom complete a design. Experience and trials play a major roles in most aspects of drying practice.

Conclusion

Under optimum operating condition the desired mango powder was obtained. The powder retains its nutritional value, colour and aroma. The data from laboratory scale spray dryer cannot be used directly for a pilot sale spray dryer due to the difference in dryer configuration. As a conclusion, spray drying of tropical fruit using laboratory and pilot scale spray dryer is capable of producing powder that retains its nutritional value, colour, aroma and suitable for commercialization.

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