The Andhra Agric. J 63 (4):936-940, 2016

Effect of Inlet Air Temperature on Quality of Spray-Dried Bitter Gourd Powder

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ABSTRACT

A study was conducted to select a suitable inlet air temperature in a spray dryer for getting high yield and quality of bittergourd powder. Juice was extracted from bitter gourd and concentrated by adding 10% maltodextrin as carrier agent and fed in to a spray drier at an inlet air temperatures of 130, 140 and 150°C and at feed flow rate of 15 ml/min. The dried bittergourd powders were analyzed for water activity, WSI, WAI, chlorophyll, ascorbic acid and reducing sugars. The yield recovery of bittergourd was highest at 150°C inlet air temperature followed by 140 and 130°C inlet air temperatures. As inlet air temperature increased, the water activity, WAI, ascorbic acid and chlorophyll content decreased and WSI, reducing sugars decreased. The quality of bittergourd was good at lower inlet air temperature compared to 140 and 150°C temperature.

Key words: Bittergourd powder, Inlet air temperature, Maltodextrin, Spray Drying.

Momordica charantia Linn. (Karela) commonly known as Bitter melon or Bitter gourd is tropical and subtropical climber of the family Cucurbitaceae. Bitter gourd *(Momordica charantia)* is grown extensively throughout India. In terms of area and production, Andhra Pradesh ranks first followed by Odisha. The total area of this crop during 2012-13 was 83 thousand hectares and the production was about 940 thousand metric tonnes (Hand Book of Horticulture, 2014). Bittergourd has some medicinal properties and is recommended for curing blood diseases, rheumatism, diabetes and asthma. It is relatively highly nutritive and high in proteins, vitamins and minerals. Lectins from the bitter gourd have shown significant anti-lipolytic and lipogenic activities. It is rich in iron, beta-carotene and potassium, vitamins A, B_1, B_2, B_3 and C, phosphorous and fiber. The fruits have long been used in India as a folk "remedy for diabetes mellitus".

As it is a seasonal vegetable, steps should be taken to preserve them to make them available for consumption in off season as well. This could be achieved by extending the shelf life in fresh form or in the processed form. Much of the work is done for preservation of bitter gourd by different methods such as steeping preservation, processing of bitter gourd into rings, sun drying and dehydration of bitter gourd, hot air drying of bitter gourd slices etc.

Spray drying is widely used in the industry for conversion of a suspension or solution into a dry powder product. In spray drying the suspension or solution feed is atomized and the droplet formed comes into contact with a hot gas. When the droplets and the heated gas come into contact, the solvent in the droplets evaporate, leaving a dry powdered product. Spray drying is presently one of the most exciting technologies for the pharmaceutical industry. It is an ideal process where the end products meet the precise quality standards regarding particle size distribution, residual moisture/solvent content, bulk density and morphology (Masters, 2002). The physicochemical properties of the final product mainly depend on inlet temperature, air flow rate, feed flow rate, atomizer speed, types of carrier agent and their concentration. Hence, the present study is taken up to select a suitable inlet air temperature for spray drying of bittergourd juice.

MATERIALS AND METHODS

Selection of raw material:

Freshly harvested bitter gourds used for the study were procured from vegetable market, Bapatla, Guntur District. The good healthy and unripe (green color) fruits which were harvested a day before were selected for the study. The fruits were cleaned with water to remove all dirt adhering and the pesticide residues.

Extraction of juice:

The selected fruits were washed and the fruit was sliced into ± 5 mm thick, then the seeds and pith were removed from the fruits. The sliced fruits were then pretreated with salt of 8% w/w. The pretreated samples were then washed with mineral water and then subjected to blanching with hot water at 60°C for 15 min to minimize the microbial load, deactivate the enzymatic activity and to prevent the browning reaction (Kulkarmi et al. (2005)). From the blanched bitter gourd slices, juice was extracted by using juicer.

Yield of juice:

The juice was separated from the pulp using muslin cloth and the percentage yield of the pulp was determined. The determination of the yield of pulp (%) was calculated as

$$Yield\ of\ juice(\%) = \frac{Weight\ of\ juice}{Weight\ of\ pulp} \times 100$$

Concentration of juice:

The bitter gourd juice contains initially 3-4°Brix. By concentrating process there was increased in solid contents thereby reducing the amount of liquids and that must be evaporated in the spray dryer. Hence, the bitter gourd juice was concentrated to get upto 6.5 °Brix by using rotary vacuum evaporator at 65°C. However, caking or stickiness as one of the major degradation problems hindered the development of powders (Adhikari et al., 2007). The problem is mainly due to the existence of low molecular weight sugars with low glass transition temperatures. Maltodextrin can significantly increase the glass transition temperature and reduce the hygroscopicity of dried products (Goula and Adamopoulos, 2008). The bitter gourd juice was than being concentration using maltodextrin carrier agent for the preliminary experiments carrier agent of 10% w/v was added to the product. The concentrated bitter gourd juice was ready for the spray drying.

Spray Drying

The spray drying process was carried out in PHTC, Bapatla, using S.M.Scientech, India. The spray dryer works on the principle of co-current flow atomizes. The maximum capacity of this machine is 1.30 l/h with the nozzle fits to 1 mm particle size. The concentrated bittergourd juice was fed in to the drying chamber with feed flow rates of 15, 20 and 25 ml/min and inlet air temperatures were maintained at 130,140 and 150°C temperatures.

Powder recovery:

Process yield expressed as the weight percentage of the final product compared to the total amount of the materials sprayed (Sansone *et al.,* 2011).

$$Powder\ recovery(\%) = \frac{Obtained\ spray\ dried\ powder}{Juice\ (g) + Maltodextrin\ (g)} \times 100$$

Determination of physical properties of bitter gourd powder

Water activity:

Water activity is a measurement of the availability of water for biological reactions. It determines the ability of micro-organisms to grow. Water activity meter was used for the measurement of water activity of the prepared sample. For the water activity determination, powder was filled in the disposable cups of the water activity meter and the sample drawer knob was turned to open position and the drawer was opened. The prepared sample was then placed in the drawer. Checked the top lip of the cup to make sure that it was free from sample residue (an over filled sample cup may contaminate the chamber's sensors). After placing the sample, reading was noted on the LCD display of the water activity meter.

Water solubility (WSI) and water absorption index (WAI):

Water solubility index (WSI) was measured according to the method of Ahmed et al., (2010). Half grams of bitter gourd powder and 50 ml water under agitation in a magnetic stirrer at 700 rpm for 5 min. The dispersion was centrifuged at 3000 rpm for 5 min. The supernatant was collected in a pre-weighed Petri dish and the residue was weighed after oven drying overnight at 105°C. The amount of solids in the dried supernatant as a percent of the total dry solids in the original 0.5 g sample was an indicator of WSI.

$$\textbf{Water absorption index} = \frac{Weightofsedimentnt}{\text{Dry weight of sample}}$$

Fig.1 Effect of temperature on the yield recovery (%) of bittergourd powder.

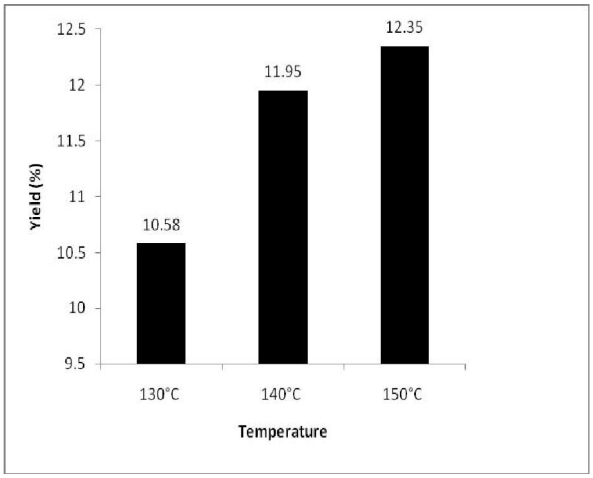


Fig.2. Effect of temperature on the water activity of bittergourd powder.

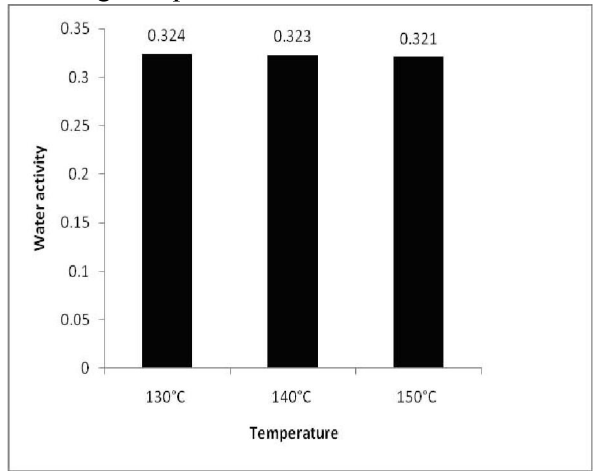


Fig.3. Effect of temperature on the WSI (%) of bittergourd powder.

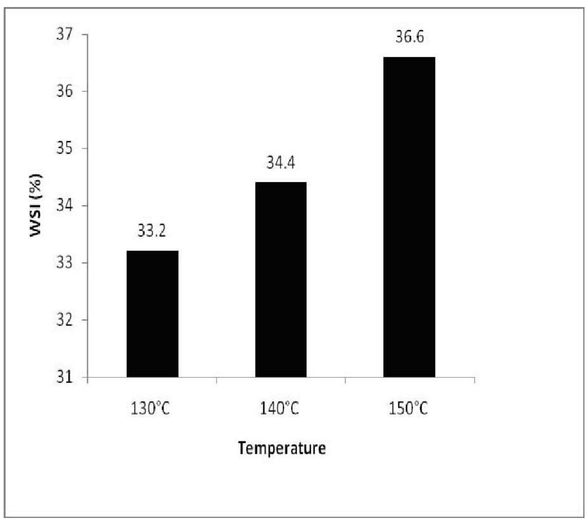


Fig.4. Effect of temperature on the WAI of bittergourd powder.

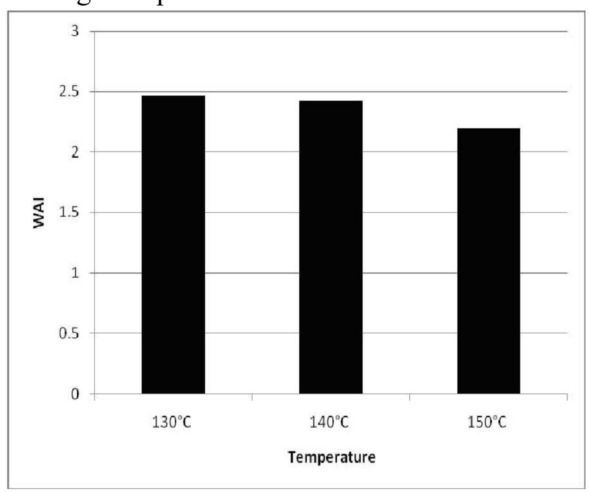


Fig.5. Effect of temperature on the Ascorbic acid (mg/100g) of bittergourd powder.

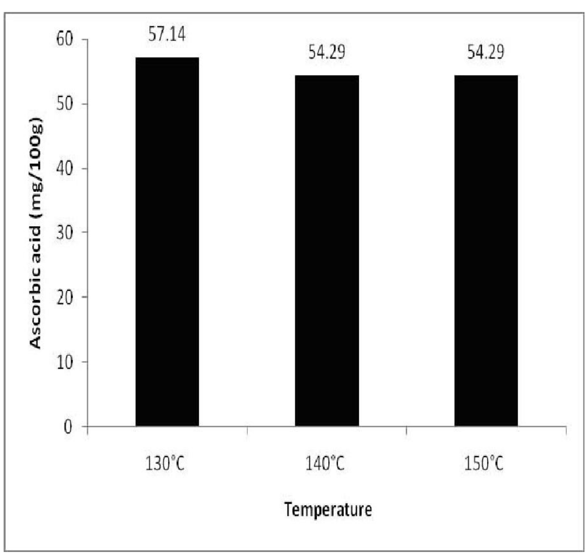


Fig.6.Effect of temperature on the Chlorophyll (mg/100g) of bittergourd powder.

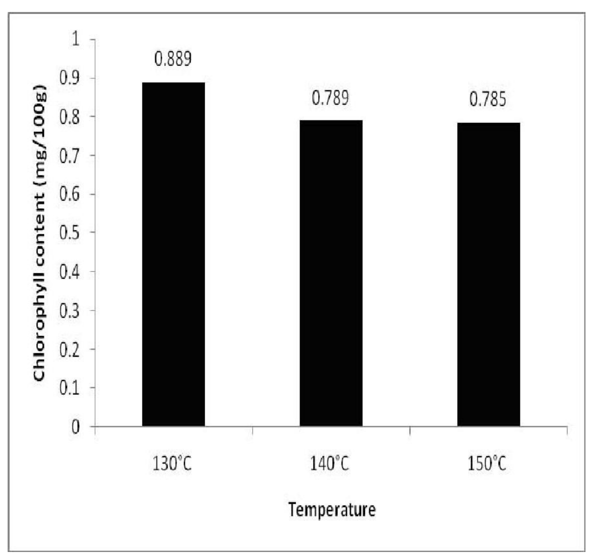
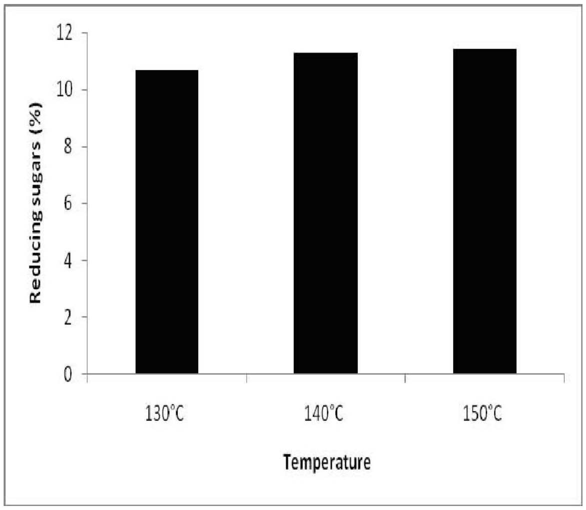


Fig.7. Effect of temperature on the Reducing sugars (mg/100g) of bittergourd powder.



$$\text{Water soluble index (\%)} = \frac{\text{Dry weight of supernatant}}{\text{Dry weight of sample}} \times 100$$

Determination of chemical properties of bitter gourd powder

Ascorbic acid content:

The ascorbic acid content of the powder was determined using 2, 6- dichloroindophenol indophenols (Ranganna, 2010).

Chlorophyll content:

Chlorophylls are extracted in 80% acetone and the absorption at 663 nm and 645 nm. The determination of chlorophylls content in the extract using a spectrophotometer absorption coefficient (Sadasivam and Manickam, 2008).

Sensory evaluation:

Sensory evaluation of bitter gourd powder was carried out for consumer acceptance and preference using 20 untrained panelists selected at random from the College of Agricultural Engineering, ANGRAU, Bapatla. Physical appearance, Aroma, texture and overall acceptability of the samples were rated using a 9-point Hedonic scale where 9 and 1 represent like extremely and dislike extremely respectively (Amerine et al.,1965).

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RESULTS AND DISCUSSIONS

Effect of inlet air temperature on yield of bittergourd powder

The highest yield recovery of 12.35% was obtained at 150°C followed by 11.95% at 140°C and 10.58% at 130°C. From fig.1, the results it was observed that as the temperature increased from 130 to 150°C the percentage yield recovery also increases. This is due to, at higher inlet temperature there is a greater temperature gradient between the atomized feed and drying air and it results the greatest driving force for water evaporation and greater efficiency of heat and mass transfer process occurring when higher inlet air temperature were used. This is accordance with the amaranthus betacyanin pigment by Cai and Corke (2000).

Effect of physical and chemical properties of bittergourd powder

Effect of water activity:

From fig.2, the lowest water activity of 0.321 was observed at 150°C followed by 0.323 at 140°C and 0.324 at 130°C. From the results, it was observed that as the temperature increased from 130 to 150°C the water activity decreases. This is due to, because at higher inlet drying temperature, the rate of heat transfer to the particle is greater, favouring the moisture evaporation (Halliday and Walker, 2001).

Water solubility (WSI) and water absorption index (WAI):

From fig.3, the water solubility index was highest i.e 36.6% at 150°C inlet air temperature followed by 34.4% at 140°C and at 130°C. Similarly, from fig.4 the WAI was lowest at 150°C inlet air temperature i.e 2.194 followed by 2.422 at 140°C and 2.464 at 130°C. From the above results, as the inlet air temperature increased from 130°C to 150°C, the WSI also increases but WAI decreases with increase in temperature. This may be due to the effect of inlet air temperature on residual moisture content leading to increase in the particle size and consequently decrease in the time required for the powder to dissolve (Walton, 2000).

Variation in ascorbic acid:

From fig.5, the highest ascorbic acid content was observed at 130°C i.e 57.14 mg/100g followed by 54.29 mg/100g and 54.29 mg/100g at 140 and 150°C respectively. The ascorbic acid content decreases with increase in inlet air temperature. This is because at higher temperature the loss of vitamin C occurred by chemical degradation.

Variation in cholophyll content:

From fig.6, the chlorophyll content was observed highest at 130˚C i.e 0.889 mg/100g followed by 0.789 mg/100g and 0.785 mg/100g at 140 and 150˚C respectively. The chlorophyll content decreases with increase in inlet air temperature. This is because at higher inlet air temperatures heat transfer to the particle is greater thus reducing chlorophyll content of the powder

Variation in reducing sugars:

From fig.7, the reducing sugars increases with increase in inlet air temperature. The Reducing sugar was observed highest at 130˚C i.e 10.69% followed by 11.30% and 11.41%, at 140˚C and 150˚C respectively.

CONCLUSIONS

From the results it was concluded that the highest yield recovery of 12.35% was obtained at 150˚C inlet air temperature. From the results, the water activity, WAI, ascorbic acid and chlorophyll content decreases with increasing inlet air temperatures and WSI and reducing sugars increases. Finally it was concluded that the highest yield observed at 150˚C and quality of bittergourd gourd powder was good at 130˚C inlet air temperature because loss of vitamin C occur more at higher inlet air temperatures.

LITERATURE CITED

Adhikari B, Howes T, Shrestha A K and Bhandari B R 2007 Development of stickiness of whey protein isolate and lactose droplets during convective drying. *Chemical Engineering and Processing,* 46: 420–428.

Ahmed M, Akter M S and Eun J B 2010 Peeling, drying temperatures, and sulphite-treatment affect physicochemical properties and nutritional quality of sweet potato flour. *Food Chemistr,*. 121-128.

Amerine M A, Pangborn R M and Roessler E B 1965 Principles of Sensory Evaluation of Food. *Academic Press*, New York. 350- 480.

Cai Y Z and Corke H 2000 Production and properties of spray-dried Amaranthus betacyanin pigments. *Journal of Food Science*, 65: 1248–1252.

Goula A M and Adamopoulos K G 2008 Effect of maltodextrin addition during spray drying of tomato pulp in dehumidified air: ii. Powder properties. *Drying Technology*, 26(6): 726–737.

Halliday D, Walker J 2001 Drying Technique & Process. Brisbane: John Wiley and Sons, Inc.

Hand book on Horticulture Statistics 2014 Government of India Ministry of Agriculture. Department of Agriculture and Cooperation. New Delhi. http://agricoop.nic.in/imagedefault/whatsnew/handbook2014.pdf

Kulkarni A S, Patil H B, Mundada C G 2005 Studies on effect of pretreatment on quality of dehydrated bitter gourd. *Journal of Engineering*, 2: 31-33.

Masters K 2002 Spray Drying in Practice, Gersh of Grafisk ApS

Ranganna S 2010 Proximate constituents (chap 1), Vitamins (chap 5) in Handbook of analysis and quality control for fruit and vegetable products, Published by McGraw Hill education private limited, 9-16: 105-106.

Sadasivam, S. and Manickam, A. 2008. Chlorophyll (chapter 7.3). In: *Biochemical Methods*, New Age International Publishers, 190-191.

Sansone F, Mencherini T, Picerno P, Amore M, Aquino R P and Lauro M R 2011 Maltodextrin/pectin microparticles by spray drying as carrier for nutraceutical extracts. *Journal of Food Engineering,* 105: 468-476.

Walton D E 2000 The morphology of spray-dried particles. A qualitative view. *Drying Technology*, 18:1943"1986.

(Received on 31.07.2015 and revised on 25.02.2016)