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Accessment on Drying and Quality Characteristics of Tray and Microwave Dried Guava Fruit

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ABSTRACT: *An experiment was carried out to study the drying and quality characteristic of tray and microwave dried guava slices. Unblanched, blanched and blanched with KMS samples were dried at three different powers (20W, 40W, 60W). Dried samples were evaluated for quality attributes, viz. Vitamin C content, rehydration ratio, moisture content and drying rate. The samples were heat sealed in high density polyethylene bags and stored at room temperature. The samples were analysed for quality attributes after drying. Results indicated that the initial average moisture content of guava slices was 1389.08% (db). The initial moisture content of pre-treated samples had highest at 20, 40 and 60 W. Drying rate of KMS blanched sample had highest at 20 and 60 W but at 40 W drying rate of blanched sample had highest. Moisture loss increased from guava with increased in power of microwave and time of drying. The pre-treated samples were taken shorter drying time than unblanched sample. Rehydration ratio was found acceptable those samples which were dried at 40W with KMS blanched sample. Rehydration ratio of KMS blanched samples was found 5.056,7.622 and 5.566 at 20, 40 and 60W respectively. Ascorbic acid content was found acceptable at 20W KMS blanched sample had highest ascorbic acid content 200mg/100g. At 40 and 60W the ascorbic acid content of KMS blanched samples were 143.33 and 116.66mg/100g respectively with desirability factor of 0.50.*

Keywords: *Guava, Drying, Vitamin C, Rehydration ratio, Drying rate and Moisture content*

INTRODUCTION

Guava (*Psidium guajava L.*) is considered to be an excellent trade fruit. It is quite hard, multi-breeding, fruiting and even higher fruitful without more care. The higher water content of most fruits makes them highly perishable and is responsible for postharvest losses in storage, handling and transportation, resulting in economic losses. Transformation to a stable product is thus necessary either by canning, freezing or drying.

The removal of moisture by MW-drying has five advantages over convective drying: fast and volumetric heating, higher drying rate, shorter drying time, and higher quality of the product and reduced energy consumption. It implies better fruit quality due to a lower growth of microorganisms. Lower temperature and shorter drying times are usually required for a high quality product. Microwave-drying combined with vacuum has potential for high quality product due to a deeper penetration of microwaves into tissues and a higher preference for water molecules. However, the microwave-drying process can have very high capital costs. Several studies have shown that using pre-treatment prior to microwave drying could decrease drying time and thus drying costs.

The microwaves vacuum dehydration was first used for concentration of citrus juice [1]. In the food industry, the microwave-vacuum drying is used for drying pastas, powders, and porous materials. McDonnell Company has built a microwave-vacuum-drying system to dry grains, but it was not commercially successful due to economics.

The microwave oven was further modified such that combined microwave and convectional drying can be accommodated. The system performance was evaluated which included calibration of the maximum microwave output power, determination of the microwave distribution in the cavity, establishment of the relations between the output power and the input voltage for the phase-controlled power regulator. It was observed that phase-controlled

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power regulator could be successfully used for quasi-continuous (fast-switching) power regulation with the maximization of power efficiency. The degradation of output microwave power was recorded and the non-uniform distribution of microwave field in the cavity was also verified. The application of microwaves has been increasing interest in processing of foods and bio-commodities over past two decades. During microwave drying process local pressure and temperature rise continuously even though the loss factor of treated materials decrease with the reduction of moisture content. Although these increases of pressure and temperature can speed up the drying process, they may cause side effects such as bio-value degradation, physical damages, and non-uniform temperature distribution in treated materials. In microwave heating or drying, microwave-emitted radiation is confined within the cavity and there is hardly heat loss by conduction or convection so that energy is mainly absorbed by a wet material placed in the cavity. Furthermore, this energy is principally absorbed by water in the material, causing temperature to raise, some water to be evaporated, and moisture level to be reduced. A domestic microwave oven works by passing microwave radiation, usually at a frequency of 2450 MHz (a wavelength of 12.24 cm), through the food. Water, fat, and sugar molecules in the food absorb energy from the microwave beam in a process called dielectric heating. Many molecules (such as water) are electric dipoles, meaning that they have a positive charge at one end and a negative charge at the other, and therefore rotate as they try to align themselves with the alternating electric field induced by the microwave beam. This molecular movement creates heat by friction as the rotating molecules hit other molecules and put them into motion. Guava (*Psidium guajava L.*) is cultivated and consumed widely in India [2]. The ultimate objective of this present experient is to study the drying and quality characteristic of tray and microwave dried guava slices.

MATERIALS METHODS

Fresh and good quality of guava were purchased and procured from the local market in Allahabad on daily basis prior to each set of experiment. The fruits have good physiological maturity. Guava was cleaned, sliced, washed and blanched. Then tray dryer and microwave oven was used for the dehydration of guava slices. After drying the sample was packed in HDPE bags and stored at room temperature.

Table 1
Details of variables/ parameters, their level and descriptions

S. No.	*Parameter*	*Level*	*Description*	*Quality parameters*
1	Raw material	1	Guava	PhysiochemicalParameter , moisture content, Drying rate, Rehydration ratio
2	Replication	3		
3.	Thickness of Guava slices		Uniform size	
4.	Drying air temperature for tray dryer	3	55,60 and 65ºC	
5.	Microwave for microwave drying	3	20,40 and 60W	vitamin C
6.	Pre-treatment	3	Unblanched, Hot water blanching and blanched with potassium metaBisulphate	
7.	Packaging	1	HDPE 500 guage bags	
8.	Storage condition	1	Ambient Temperature	

Process for dehydration of guava

Selection of guava
↓
Washing
↓
Slicing
↓
Scooping out of seed
↓
Drying in tray drier & microwave drier
↓
Cooling to room temperature
↓
Packaging and Storage

Selection of raw materials

Good quality fresh guava was purchased from local market in Allahabad damage and immature pieces of guava was removed manually by visual inspection and experiment was conduct in the department of Food Process Engineering lab-1 and lab-2, Vaugh School of Agricultural Engineering and Technology, Sam Higginbottom Institute of Agriculture, Technology and sciences, (formerly Allahabad Agricultural Institute- Deemed University), Allahabad during the year 2014-2015.

Pre-treatment of guava

After the slicing guava was washed in hot water and the sample was drained to remove the excess water for unblanched sample.

Blanching pre-treatment

After washed the sliced guava pieces were blanched by tying them in muslin cloth and dipping the sample in boiling water for 5 minutes. The blanched samples were cooled immediately by keeping them under flowing water to prevent overcooking of the sample and drained to remove the excess water for blanched sample.

Chemical pre-treatment

After washed the sliced guava pieces were blanched with KMS by tying them in muslin cloth and dipping the sample in boiling water for 5 minutes. The blanched with KMS samples were cooled immediately by keeping them under flowing water to prevent overcooking of the sample and drained to remove the excess water for blanched with KMS(1% solution of potassium Meta bisulphate) sample.

Drying

(a) ***Tray drying:*** The dried slices were obtained after tray drying. The experiment for the samples was carried out until constant weight was achieved using inlet hot air temperature 55, 60 and 65°C.

(b) ***Microwave power drying:*** The pre-treated guava slices were dried in a microwave dryer. Drying was carried out at three different microwave generation power being 20,40 and 60W and two pre-treatment. The sample of guava design was dried simultaneously, in order to ensure uniform drying conditions. After the dried guava slices were analyzed for different physicochemical analysis. Three replication of each pre-treated samples were performed according to a preset microwave output power.

Physico-chemical Analysis

1. Determination of moisture content:

Initial moisture content

A standardization procedure of AOAC (1980) was followed to estimate the moisture content of food.

Principle

Sample was heated at specified temperature for specified period of time and loss in weight was recorded after every one hour for moisture content of sample.

Procedure

Five gram of the sample was weighted and taken in a tear porcelain dish (1 g). Dish was placed in hot air oven maintained at 105æ% C ± 20 and dried for at least two hours. Dish was cooled in desiccators at weighed. The process of heating, cooling and weighing was repeated until the difference between two successive weighing was not more than 0.002 g.

Observation

- Tear weight of dish (W g.)
- Weight of dish with sample (W_1 g).
- Weight of dish + sample after keeping in oven (W_2 g).

CALCULATION

$$Percent\ Moisture\ content = \frac{Loss\ in\ Weight}{Initial\ weight\ of\ the\ sample} \times 100$$

$$= \frac{W_1 - W_2}{W_1 - W} \times 100 \text{ .... 3.1}$$

Where,

M.C. = moisture content of sample (% w.b. and d.b.)

M_1 = wt. of sample before drying (g)

M_2 = wt. of sample after drying (g)

Moisture content of sample during drying: Moisture content of sample during drying was computed through mass balance. For this purpose, weight of the sample during drying was recorded every five minute for one hour after that ten minute for one hour after two hour readings were taken after twenty minute until dehydrated it. Reading was noted after above time interval the following formula was used to calculate moisture content.

Calculation;

$$M.C = \frac{wt.of\ sample\ at\ any\ time - wt.of\ bone\ dry\ material}{wt.of\ sample\ at\ anytime} \times 100 \quad 3.2$$

Where,

$$Wt.of\ bone\ dried\ material = \frac{Initial\ weight\ of\ sample - initial\ M.C}{100} \quad 3.3$$

Drying rate (DR)

$$Drying\ rate = \frac{Amount\ of\ moisture\ remove(g)}{Time\ taken\ (\text{min}) \times total\ bone\ dried\ weight\ of\ sample\ in\ (g)} \quad 3.4$$

Similarly, the drying rate was approximately proportional to the difference in moisture content between the product being dried and EMC at the drying air state.

$$DR = \frac{M_{t+dt} - M_t}{dt} \quad 3.5$$

Where,

M_t = moisture content at time t (% db)

M_{t+dt} = moisture content at time t+dt (%db)

dt = time of successive measurement (min)

2. Rehydration Ratio

5 g of dehydrated sample was put into a small container and 120ml of distilled water was added. Container was cover with a watch glass and the water was brought to boil. Water was boiled gently for 15 minutes. Sample was turn out onto a white dish which surface was covered with a piece of filter paper to soak the excess water and the weight of sample was record and rehydration ratio was calculate by,

$$Rehydration\ ratio = \frac{B}{A}$$

Where,

B = weight of sample (g) after rehydration A = weight of sample (g) before rehydration

3. Determination of ascorbic acid (vitamin C)

Ascorbic acid otherwise known as vitamin C was determined by dye method. The reagents used were 4% oxalic acid, standard ascorbic acid solution in 4% oxalic acid and dye solution (42 mg of sodium bicarbonate and 52 mg of 2,6, dichloro phenol indophenol dye in 200 ml of distilled water). About 100 mg of pure dry crystalline ascorbic acid was taken and made up to 100 ml using 4% oxalic acid to get the stock solution. The working standard solution (100 ml) was prepared by diluting 10 ml stock solution using 4% oxalic acid. About 5 ml each of working standard solution and 4% oxalic acid were pipette into a conical flask and titrated against the dye solution. End point was the appearance of pale pink color which persisted for a few minutes. The titration was repeated for 3 times to get the concordant value. The amount of dye consumed (V1) was determined which was equal to the amount of ascorbic acid present in the working standard solution. Then the sample was made into powder and 10 ml of the homogenized pulp (Vs) was taken and made up to 100 ml with 4% oxalic acid solution. Then 5 ml of the made up solution was pipette out into a conical flask and titrated against the dye (V2). The quantity of ascorbic acid (mg) present in 100 g of sample was calculated as follows.

$$Ascorbic\ acid\left(\frac{mg}{100g}\right) = \left(\frac{0.5}{v1}\right) * \left(\frac{v2}{5}\right) * \left(\frac{100}{vs}\right) * 100 \quad 3.7$$

Material used for packaging

The material used for packaging of dried guava slices were HDPE (High Density Polyethylene). The dried product was packed at room temperature after cooling the products and stored at room temperature away from direct sun light.

RESULTS AND DISCUSSION

Experiments were conducted to study the Tray drying and Microwave drying characteristics of guava slices at different temperatures and power. Guava samples were packed in HDPE bags and stored at room temperature. Studies on quality were based on physicochemical characteristics (i.e., moisture content, drying rate, rehydration ratio, and ascorbic acid content) which were determined for fresh samples. The results of the study are presented and discussed in following section.

Drying rate of guava in tray dryer was affected by hot air temperature. The initial moisture content of unblanched sample was less than pre-treated samples at 55,65^{o}C. The initial moisture content of unblanched, blanched and KMS blanched sample were observed 1358.13, 1338.84 and1527.33% (d.b) at 60^{o}C in tray dryer . The initial moisture content of pre-treated samples had highest at 20, 40 and 60 W in microwave dryer. Drying rate of blanched sample had higher than other samples at 55^{o}C and 60^{o}C, and 65^{o}C drying rate of KMS blanched samples had highest in tray dryer while as in microwave the drying rate of

Table 2
Effect of pre-treatment on Ascorbic acid of guava powder prepared from unblanched, blanched and blanched with KMS at different Temperature in tray dryer

S. No	*Pre-treatment*	*Vitamin C (mg/100g) at temp 55*	*Vitamin C(mg/100g) at temp 60*	*Vitamin C(mg/100g) at temp 65*
1	unblanched	333.34	316.67	280.00
2	Blanched	306.67	290.00	256.67
3	KMS Blanched	366.67	350.00	300.00

Table 3
Effect of pre-treatment on Ascorbic acid of guava powder prepared from unblanched, blanched and blanched with KMS at different power level

S. No	*Pre-treatment*	*Vitamin C(mg/100g) at 20 Watt*	*Vitamin C (mg/100g) at 40 Watt*	*Vitamin C (mg/100g) at 60 Watt*
1	Unblanched	166.67	133.34	96.67
2	Blanched	153.33	123.33	83.33
3	Blanched with KMS	200.00	143.33	116.66

Table 4
Effect of Pre-treatment on rehydration ratio of guava samples unblanched, blanched and blanched with KMS dried at different power level in microwave dryer

Pre-treatment	*Power in (watt)*	*Initial Weight of sample (g)*	*Final Weight of Sample(g)*	*Rehydration Ratio*
Unblanched	20	5 g	23.7	4.74
Blanched	20	5 g	24.87	4.97
Blanched with KMS	20	5 g	25.28	5.056
Unblanched	40	5 g	32.68	6.536
Blanched	40	5 g	24.8	4.96
Blanched with KMS	40	5 g	38.11	7.622
Unblanched	60	5 g	27.45	5.49
Blanched	60	5 g	24.74	4.94
Blanched with KMS	60	5 g	27.83	5.566

Table 5
Effect of Pre-treatment on rehydration ratio of guava samples unblanched, blanched and blanched with KMS, dried at different temperature in tray dryer

Pre-treatment	*Temperature(^{o}C)*	*Initial Weight of sample (g)*	*Final Weight of Sample(g)*	*Rehydration Ratio*
Unblanched	55	5 g	40.12	8.024
Blanched	55	5 g	39.604	7.920
Blanched with KMS	55	5 g	36.46	7.292
Unblanched	60	5 g	38.01	7.602
Blanched	60	5 g	31.06	6.212
Blanched with KMS	60	5 g	30.42	6.084
Unblanched	65	5 g	36.72	7.344
Blanched	65	5 g	28.43	5.686
Blanched with KMS	65	5 g	28.06	5.612

KMS blanched sample had highest at 20 and 60 W but at 40 W, drying rate of blanched sample had highest. The enhancement in drying rate at high microwave power is due to the fact that higher drying power lead to higher driving forces for heat transfer. These results were good in agreement as compare to the earlier studies of various vegetables **[3].** Moisture loss increased from guava with increased in power of microwave and time of drying. It is observed that the drying time required for reducing the moisture content of pre-treated samples were taken different drying time. Thereafter, the moisture content of samples was decreased slowly with increase in drying time and attained final equilibrium moisture content. Similar results were also obtained by **[4]**. The pre-treated samples taken shorter drying time than unblanched sample. The drying rate of guava slices under tray drying decreased as the drying time progressed and finally attained zero drying rates.

Rehydration ratio was found acceptable in microwave those samples which were dried at 40W with KMS blanched sample (table 4). Rehydration ratio of KMS blanched samples were found 5.056, 7.622 and 5.566 at 20, 40 and 60W respectively. Rehydration ratio of unblanched sample was found acceptable in tray dryer that sample which was dried at 55°C (Table 5). Rehydration ratios of unblanched samples were found 8.024, 7.602 and 7.344 at 55, 60 and 65°C respectively. Rehydration ratio of dried guava slices of unblanched sample had higher rehydration ratio compared to pre-treated sample with increased temperature, power and time. Similar results were also obtained by **[5].**

Ascorbic acid content was found acceptable at 20W KMS blanched sample had highest ascorbic acid content 200mg/100g dried by microwave (Table 3). At 40 and 60W the ascorbic acid content of KMS blanched sample was 143.33 and 116.66mg/100g. In most of the cases, ascorbic acid decreased with increasing temperature, power and time. Similar results were also obtained by **[6].** Ascorbic acid content at 55°C KMS blanched sample had highest and it was acceptable. At 55, 60 and 65°C the ascorbic acid content of KMS blanched samples were 366.67,350 and 300mg/100g respectively (Table 2).

CONCLUSION

Guava slices of unblanched, blanched and blanched with KMS were dehydrated at three temperatures (55, 60, and 65°C) and power level (20, 40 and 60 watt) respectively. It was observed that slices dried by microwave dryer were removed moisture in less time than tray dryer. The ascorbic acid retention of the microwave and tray dried samples had the highest ascorbic acid retention for KMS blanched samples. There was effect on the rehydration ratio for the KMS blanched samples in tray dryer for all the three temperatures. KMS blanched sample had highest rehydration ratio in tray dryer. While as rehydration ratio of KMS blanched guava was highest at every power level of microwave dryer. And at 40W rehydration ratio was acceptable. The moisture loss increased from guava with increased in power of microwave and time of drying. The pre-treated samples were taken shorter drying time than unblanched sample in microwave.

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