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Standardization of drying temperature in tray drier for wild bittergourd (*Momordica charantia* var. *muricata*)

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Abstract
Wild bitter gourd (*Momordica charantia* var. *muricata*) was dehydrated using four different temperature *viz.*, T_1 (40 °C), T_2 (50 °C), T_3 (60 °C) and T_4 (70 °C) in tray dryer. The T_1(40 °C) dehydration temperature was found to be the best method for dehydration of wild bitter gourd rings because of better retention of nutrients like ascorbic acid, total chlorophyll, total carotenoid, total sugar, reducing sugar, total alkaloid and rehydration ratio. However, the moisture content and drying ratio and faster drying rate was found to be maximum in T_4 (70 °C) as compared to other methods of drying.

Keywords: Drying temperature, tray drier, wild bittergourd (*Momordica charantia* var. *muricata*)

Introduction

Small bittergourd (*Momordica* charantia var. muricata) is a wild type vegetable cultivated in India during rainy season. It is a member of the Cucurbitaceae family and native to India or China. Momordica charantia *var.* muricata (wild), which develops small and round fruits with tubercles, more or less tapering at each end (chakravarty, 1990) [1]. It is rich in protein, carbohydrates, iron, calcium. It has good demand due to its special culinary taste and it is also considered to be a good source of dietary fibers (Gopalan *et al*., 2000) [4]. Small bittergourd is available for short period of time, i.e. during rainy season and especially in the months of August and September. During these months, there is no plentiful sunshine available, so drying of bittergourd is difficult and the quality of the dried product is poor. Therefore, drying by using tray drier can be the best substitute for sun drying. However, drying is an important unit operation in post harvest processing of agriculture produce and dates back to the beginning of civilization. Its purpose is to remove moisture to a certain level which is good enough to avoid microbial growth and slows down the action of enzymes, leading to an extension of self-life while maintaining product quality. However, blanching of vegetable prior to drying is required for protecting their colour, texture, nutrients and to inactivate the harmful enzymes. Manimegalai and Ramah (1998) **[9]** worked on effect of pretreatments on the quality characteristics of dehydrated bittergourd rings. They observed that the samples treated with blanching in water and soaking in solution containing 0.3% KMS, 0.1% MgO and 0.1% $NaHCO_3$ had higher retention of chlorophyll and consumer acceptability. Therefore, keeping in view the present experiment was conducted to assess the different temperature for drying small bittergourd in cabinet dryer.

Materials and Methods

The experiment was carried out in the Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur (Raj.) during the year August, 2017 to December, 2017. Small bitter gourd fruits (*Momordica charantina* var. *muricata* L.) were procured from Chittorgadh Mandi (Rajasthan). All the fruits were washed with running water under tap to remove adhering dust and reduce the surface micro-flora. The small bitter gourds were cut into 1.5 cm thick rings with the help of sharp stainless steel knife. The prepared rings of small bitter gourd were blanched in boiling water for 3 minutes and soaked in. 2% potassium meta-bi-sulphite solution for 15 minutes to inactivate the peroxidase enzymes. The pre-treated small bittergourd rings were spread on a wire net tray @ 1.5 kg/sq m for tray drier (model). The drying was carried out with the cross flow of constant hot air flow rate of 1(+_0.1) m/s at 40 ºC, 50 ºC, 60 ºC, 70 ºC temperature respectively till the moisture content in fined product is 4-5%. Drying ratio was calculated as net dry weight obtained from fresh weight of the material (Ranganna, 2002) [11].

$$\text{Drying ratio} = \frac{\text{Fresh weight of the material}}{\text{Net dry weight obtained}}$$

Five gram of dehydrated sample was taken into a beaker and 50 ml of warm (60 °C) water was added into it. After one and half hour the drained weight of the rehydrated material was taken. Rehydration ratio was calculated as:

$$\text{Rehydration ratio} = \frac{\text{Drained weight of rehydrated sample (g)}}{\text{Weight of dehydrated sample (g)}}$$

Ascorbic acid by 2,6-dichlorophenol – indophenols dye method and acidity content of pulp was determined by diluting the known volume of pulp with distilled water and titrating the same against standard N/10 sodium hydroxide solution, using phenolphthalein as an indicator. Reducing sugars was measured by following "DNS Method". Total Sugar was estimated by using "Anthrone Method" (Dubois *et al.*, 1951) [2], Reducing Sugar (percent) by dintrosalicylic acid method (Miller, 1972) [10], Total Carotenoid (µmg $100g^{-1}$) was extracted by acetone method. Total Chlorophyll (mg $100g^{-1}$) was estimated by acetone @ OD 660nm (Ranganna, 2002) [11]. The data obtained in the present study were subjected to Completely Randomized Design with 5 replication for statistical analysis as suggested by Gomez and Gomez (1984) [3]. The critical difference CD (*P*=0.01) value at. 01% level probability was compared for making the comparison among different treatments.

Results and Discussion

Temperature and blanching methods effect have a reasonable impact on the rehydration ratio of the samples dried at 40 °C, 50 °C, 60 °C and 70 °C respectively. Among the four drying temperatures the highest rehydration ratio (5.69) was reported in T_1 (40 °C) samples and lowest (4.93) in sample dried at 70 °C soaked in hot water for 90 minutes.

Table 1: physio-chemical parameters of fresh wild bitter gourd (wet weight basis)

Moisture (%)	:85.40
Total chlorophyll (mg/100g)	:11.23
Ascorbic acid (mg/100g)	:78.06
Total Sugar (%)	:0.48
Reducing Sugar (%)	:0.40
Total carotenoid (mg $100g^{-1}$)	:2.86
Total alkaloid (mg AE/g)	:0.12

Table 2: Effect of different dehydration temperature on physio-chemical properties of bittergourd (*Momordica charantia* var. *murcata*)

Treatments	Moisture (%)	Ascorbic acid (mg $100g^{-1}$)	Total chlorophyll (mg $100g^{-1}$)	Total carotenoid (mg $100g^{-1}$)	Total Sugar (%)	Reducing sugar (%)	Rehydration ratio
T_1 (40 °C)	5.14	54.53	11.86	2.88	3.26	2.95	5.69
T_2 (50 °C)	5.08	50.63	11.25	2.18	3.03	2.85	5.31
T_3 (60 °C)	5.01	47.76	11.12	1.88	2.80	2.76	5.01
T_4 (70 °C)	4.96	45.20	10.93	1.78	2.77	2.71	4.93
SE(m)±	0.03	0.13	0.04	0.02	0.02	0.01	0.02
CD(P=0.01)	0.08	0.39	0.16	0.06	0.07	0.02	0.07

Treatments	Hunter colour value (L*)	Hunter colour value (a*)	Hunter colour value (b*)	Drying ratio	Total alkaloid (mg AE/g)
T_1(40 °C)	42.12	2.54	26.83	10.34	1.17
T_2(50 °C)	40.26	3.51	23.15	10.86	1.03
T_3(60 °C)	27.87	6.67	20.70	11.72	0.98
T_4(70 °C)	25.36	7.35	20.05	13.76	0.96
SE(m)±	0.13	0.17	0.08	0.02	0.02
CD(P=0.01)	0.39	0.50	0.25	0.07	0.06

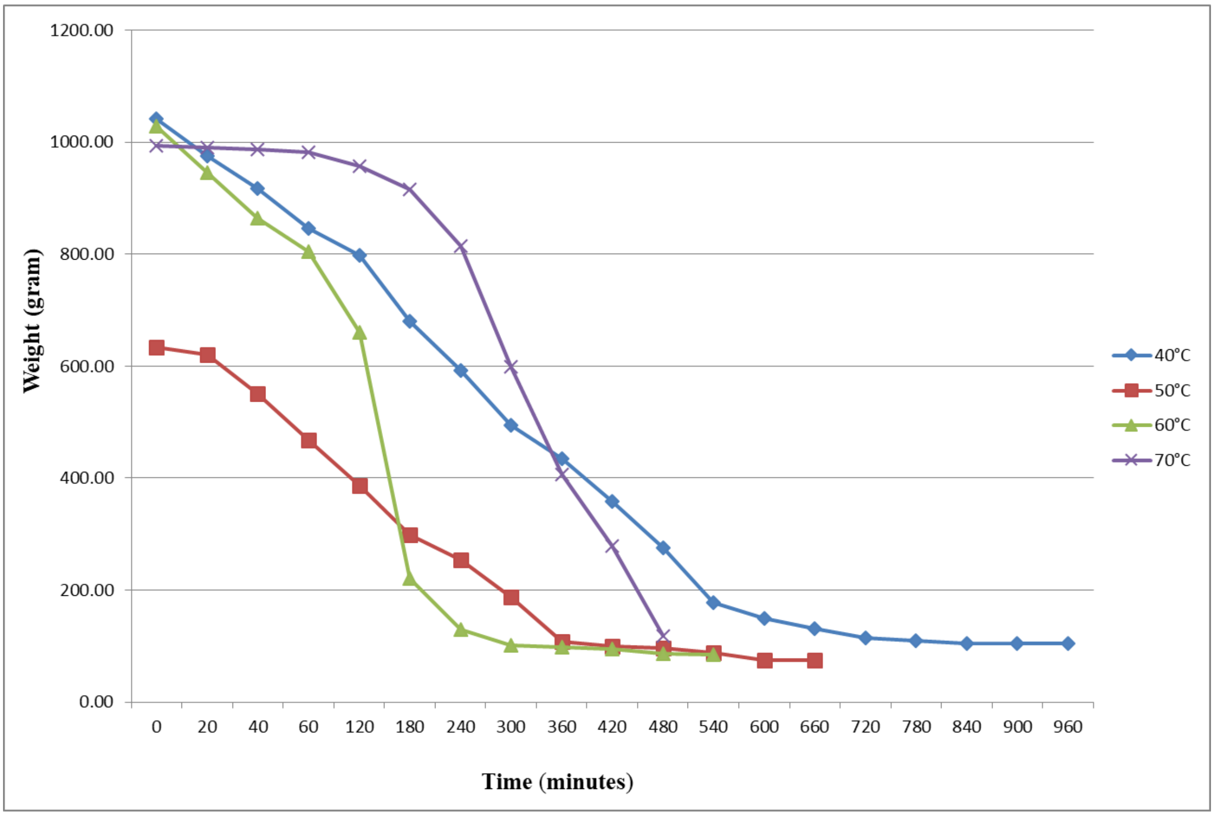

Fig 1: Drying rate

The physical and chemical constituents of fresh wild bitter gourd fruits (*Momordica charantia* var. *muricata*) used in the experiment are given in Table 1. Dehydration is the process of removing water from a product under controlled conditions of air flow, temperature and humidity which reduces the moisture in the food to such a low level that inhibits the microbial growth leading to decay and spoilage. Before drying pre treatment with KMS (0.2%) for15 minutes to inactivate the peroxides activity which causes blackening during drying. The data revels that drying rate (fig 1) was faster in T_4 (70 °C) and minimum in T_1(40 °C). Drying rates were calculated as quantity of moisture removed per unit time per unit dry solids (kg water/kg dry solids/min). The drying rate was increase with increase in temperature of tray dryer. Kar *et al.* (2003) [8] reported that the rate of drying decreased with the decrease in moisture content at all drying temperatures. Increased drying temperature from 40 to 70 ^{0}C significantly increased drying rate.

However, among the four drying temperatures in tray drier, T_1(40 °C) took 12 hour for drying to reach the constant weight and T_2(50 °C), T_3(60 °C) and T_4(70 °C) took 11, 10 and 9 hours respectively. This can be related to the fact that drying at higher temperatures provides larger driving forces for heat transfer, which increases the drying rate. Furthermore, the moisture diffusivity is also higher at a higher drying temperature. The final moisture content to which the wild bitter gourd dried under tray drier at different four temperatures varied from 4.96% and 5.14% on dry basis. The final moisture content in T_1 (40 °C) was maximum 5.14%, and T_4 (70 °C) minimum 4.96%. The difference in moisture ratio might be due to reason like shrinkage in product, non uniform distribution of initial moisture and change in product temperature during drying (Hawlader *et al.* 1991; Kannan and Bandopadhyay, 1995) [5, 7]. Ascorbic acid of dried bitter gourd decreased in all drying temperature conditions as compared to fresh one this could be clarified by a long exposure to oxygen during drying it is clear that ascorbic acid very sensitive to highest temperature and long drying operations. Vit-C content was maximum in treatment T_1 (40 °C) 54.53 mg 100g^{-1} and minimum in T_4 (70 °C) 45.20 mg 100g^{-1} treatment. This might be due to exposing pre-treated slices to the higher temperature, at high temperature, in the presence of oxygen in air, vitamin C reacts and it is oxidized. (Igwemmar *et al*, 2013) [6]. Total sugar and reducing sugar was found at maximum in 40 °C due to lower temperature. Chlorophyll content was recorded minimum in 70 °C, was due to inactivation of chlorophyllase enzyme which may be responsible for degradation of chlorophyll. Carotenoid content significantly decrease in case of 70 °C, due to long time exposure of the slices to the temperature. This is because of exposure of the material to higher temperature, leading to more oxidation of carotene.

Conclusion

Dehydrated bitter gourd rings have the potential to become an important value added product because of relatively inexpensive, easily and quickly cook-able and rich in several nutrients, which are essential for human health. Four drying temperatures in tray drier tried to find out best for drying of wild bitter gourd ring, among all the temperatures in tray drier 40 °C gave best result for retaining high content of ascorbic acid, total chlorophyll, total sugar, reducing sugar and total carotenoid, better drying and rehydration ratio and less moisture. 70 °C temperature had some advantages also as it retained comparatively less moisture in the product, higher drying rate was also occur.

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