Drying Optimization and Storage Stability of Bitter Gourd (Momordica charantia L.)

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Abstract
Drying conditions of bitter gourd (Momordica charantia L.) were optimized. Adequate blanching times in tap water and alkaline solution (saturated MgO solution: 0.1% Na₂CO₃ solution = 1: 1) were 4 min and 5 min, respectively. The alkaline blanched sample preserved color and texture better compared to tap water blanched sample as judged by hedonic rating. But the latter sample retained higher concentration of ascorbic acid (AA). The alkaline blanched samples were treated with 0.2% KMS for color and AA conservation, and for preservation of dried products. Drying at 70°C and multi-stage drying retained significantly higher (p ≤ 0.05) amount of AA, color and texture compared to drying at 50° and 60°C. During four months storage of dried samples in polythylene (65 µ thickness) packages at ambient temperature moisture content increased from 5.4 to 9.9 % whilst AA decreased from 538 to 263 mg/100g dry weight. At the end of the fourth month, the stored product was still acceptable for consumption.

Keywords: Ascorbic acid, Bitter gourd, Blanching, Drying, Storage

Introduction
Bitter gourd (Momordica charantia L.) has been used as a vegetable in South Africa, Africa and Asia from the time immemorial. The fruit, though bitter, is wholesome and esteemed as a vegetable when young. It is rich in iron, calcium, phosphorus, sodium, vitamin A and ascorbic acid. Besides its food value, it has also therapeutic value. It is beneficial to consume for the patients suffering from ascites, gout, diabetes, hypertension and pain in the joints (Shivkumar et al. 1991). It is claimed that the fruit tone-up liver and spleen, relieve chronic colitis, bacillary dysentery, hemorrhoids, jaundice, rheumatism, intermittent fever, cough, menstrual disturbance and anorexia (Dewan 1994).

The fruit is succulent, perishable and warty in appearance (Snowdon 1991). It has high moisture content (89-93%) that causes rapid biochemical changes leading to yellowing and microbial spoilage. These undesirable changes are required to inhibit for the successful preservation of bitter gourd (Mohammed et al. 1993).

It has short shelf life of only 4 days at ambient conditions (Padmamaban et al. 1994). So it is required to extend its shelf life by using different methods of food preservation. It can be preserved for more than 3-4 weeks in cold storage (0-7°C) with or without polyethylene package (Mohammed et al. 1993, Kalra et al. 1988).

Canning, freezing and controlled atmosphere storage can be used for bitter gourd preservation but all these methods are expensive. Preservation in brine is cheap and easy but the fruit suffers from color, texture, and flavor defects. Kalra et al. (1983) reported drying as the best method of preservation owing to the lighter dried product weight, easier packing, storage and transportation. Therefore, an attempt is rendered to optimize drying conditions and to find storage stability of dried bitter gourd in PE packages.

Materials and Methods
Material and processing for drying: Fresh mature bitter gourds (cv long green) were purchased from the local market of Dharan. They were sorted, graded for maturity and washed. Tips were removed and cut into slices of 6±1 mm thickness. The cut slices were blanched at 98°C in tap water and alkaline solution (saturated MgO solution: 0.1 % Na₂CO₃ solution = 1: 1) for varying time periods. The samples were dipped in 0.2 % potassium metabisulphite (KMS) solution for
5, 10, 15, 20, 25 and 30 minutes. The samples were drained and dried at 50°C, 60°C, 70°C and in multi-stage dryer to a final moisture content (5.0±0.1%). Multi-stage dryer consists of initial drying at 70°C followed by at 60°C and then finally at 50°C to a required moisture level. The dried products were rehydrated for 8 h and their sensory qualities were examined. For assuring shelf life the dried products were sealed in polythylene (PE) bags with 65 μ thickness and stored for 4 months. Changes in moisture content and ascorbic acid were determined during the storage period.

Samples dipped in the KMS solution for 30 minutes retained 1530 mg SO₂/kg product. Robert and McWeeny (1972) described that retention of SO₂ should be in the range of 1500 to 2500 ppm to act as preservative. Blanching and sulphiting improve color enhance drying rate and stabilize AA (Kalra et al. 1983, Luh et al. 1975).

**Table 1. Qualitative peroxidase test and AA retention of bitter gourd slices (6+1 mm thickness) in boiling (90°C) tap water and alkaline solution**

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Blanching condition</th>
<th>Blanching time (min.)</th>
<th>Avg. AA retention (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tap water</td>
<td>1</td>
<td>54.3</td>
</tr>
<tr>
<td>2</td>
<td>Tap water</td>
<td>2</td>
<td>41.0</td>
</tr>
<tr>
<td>3</td>
<td>Tap water</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Alkaline solution</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Alkaline solution</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Alkaline solution</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

*Analytical methods:* Moisture content for fresh and dried materials were determined by hot air oven method. Qualitative peroxidase test was carried out by comparing the color of the sample with the control. Sensory attributes in terms of color and texture were evaluated by using Hedonic rating test assuming point 1 for extremely disliked and point 9 for extremely liked products. Rehydration ratio was determined using procedure for dehydrated fruits and vegetables. Total sulfur dioxide was estimated by the modified Ripper titration method. Ascorbic acid was estimated by 2,6-dichlorophenol-indophenol visual titration method. All these methods of analyses are described elsewhere (Ranganna 1986). All experiments were performed in triplicate and numerical data were analyzed statistically for analysis of variance (ANOVA).

**Results and Discussion**

Blanching times in tap water and the alkaline solution were 4 and 5 minutes, respectively (Table 1). A similar blanching time was reported by Kalra et al. (1983). Both the tap water and alkaline solution blanched were dried at 65±2°C to a final moisture level of 5.0±1%. The tap water blanched sample retained 54.3 % of initial AA compared to 41.0 % in alkaline solution blanched sample. Luh (1975) reported that AA is unstable in alkaline condition. On the contrary, alkaline solution blanched samples were superior in term of color and texture as evaluated by untrained panel of judges. Alkaline blanching samples were selected because color and texture play a major role for the acceptance by consumer.

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The effect of drying temperatures on AA retention in dried samples was investigated. Samples dried at 70°C and multi-stage drying showed significantly greater amount of AA compared to dried at 50°C and 60°C (Fig. 1). It indicates that longer exposure to...
oxygen is more detrimental to AA losses than drying temperature (70°C). Goldman et al. (1983) reported that carotene losses depend on exposure to oxygen. No significant differences were observed in rehydration ratio of the different products dried at different temperatures (50°C, 60°C, 70°C and multi-stage drying) (data not shown). All samples showed maximum rehydration ratio in boiling water at 25 minutes (data not shown).

Color and texture of the product dried at 50°C and 60°C showed no significant difference (p ≥ 0.05), but they showed significant difference with 70°C and multi-stage drying. There was no significant difference between 70°C dried and multi-stage drying samples. (Fig. 2). Changes in moisture content (m.c.) and AA of the dried products packaged in 56μ polyethylene (PE) bags for the period of four months were examined (Fig. 3). Atmospheric condition of storage room was described in term of average temperature and relative humidity (Fig. 4). Moisture content was continuously increased from 5.4% to 9.9%, whilst AA was decreased from 538 to 263 mg/100 g dry weight. The destruction rate of AA during storage is affected by m.c., presence of metal ions, oxygen, enzyme, time and temperature-RH relation of storage room. AA destruction increases with increase in m.c. (Considine & Considine 1982). AA loss is reduced if in-package air is substituted with inert gas (N₂ or CO₂). The loss of AA is also affected by storage temperature. Cabbage in air lost half of its original AA in about three months at 37°C and 15 months at 15°C to 18°C. But, if in-package air is replaced by N₂ gas, these periods were extended to 9 and 24 months, respectively (Considine & Considine 1982).

Thus it can be concluded that for the successful bitter gourd drying preliminary treatments, such as, sorting, grading, washing, tipping and slicing (6 ± 1 mm thickness) should be followed by alkaline blanching in boiling solution for 4 minutes. It should be dipped in 0.2% KMS solution for 30 minutes before drying at 70°C to a final moisture content of about 5.0%. If such a product is sealed in a 65μ thickness
PE, it can be stored for 4 months or longer without appreciable changes in quality. Low temperature storage, in-package inert gas filling, use of impermeable packaging material and/or use of in-package dessicant are reported by various authors to reduce AA loss and moisture gain during storage.

References