Standardization of Prepackaging Materials and Storage Environment on Post Harvest Shelf Life of Bitter Gourd (Momordica charantia L.)

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Abstract

An investigation was carried out to study the effect of prepackaging materials on post harvest shelf life of Bitter gourd cultivars C1 - Roma, C2 - CO 1, C3 - MAHY 101, C4 - US 6214 and C5 - Palee. There were six treatments in factor one Viz., T1- Perforated poly bag (200 gauge + 1 % ventilation), T2- Unperforated poly bag (200 gauge), T3 - Wetted gunny bag, T4 - Wetted cloth bag, T5 - CFB box (1% ventilation) and T6- Control (without any packing) and two treatments in factor two Viz., Refrigerated condition (S1) and Ambient condition (S2). The results revealed that, the treatment T1- Perforated poly bag (200 gauge + 1 % ventilation) showed significantly lowest physiological loss in weight (PLW per cent), highest fruit firmness (Kg cm-1), highest percentage of sound fruits (Per cent) and longest shelf life (days) were recorded in the fruits stored under refrigerated condition (S1).

Keywords
Bitter gourd, Cultivars, Packaging, Shelf life, Storage

Introduction

The bitter gourd (Momordica charantia L.) is cultivated throughout India as a vegetable crop during the warm seasons of the year. The nutritive value is high in proteins, minerals and vitamins. It has immense medicinal properties due to the presence of beneficial phytochemicals which are known to have antibiotic, antimitagentic, antioxidant, antiviral, antidiabetic and immunity enhancing properties (Grover and Yadav, 2004). A compound known as momordin and charantin present in the bitter gourd is used in the treatment of diabetes in reducing blood sugar level (Lotlikar et al., 1966). The perishable nature of bitter gourd is a definite risk to the traders.

Pre and postharvest technologies are employed to reduce the spoilage or postharvest losses and also to increase the storability of the produce. Good prepackaging, transport and storage are especially important for bitter gourd because of their perishability (Talukder et al., 2004). The postharvest loss of vegetables in developing countries is 20-50 per cent and 5-25 per cent in developed countries (Amiruzzaman, 2000). Packaging has a great
significance in reducing wastage of fresh fruits and vegetables. Hence, experiments were conducted to study the influence of pre packaging materials and storage environment on shelf life of bitter gourd.

Materials and Methods

The laboratory experiment was conducted during 2014 at PG laboratory, Department of Horticulture, Agricultural College and Research Institute, TNAU, Madurai to standardize the suitable prepackaging material and storage environment on shelf life of Bitter gourd cultivars C1 - Roma, C2- CO 1, C3- MAHY 101, C4- US 6214 and C5- Palee. The experiment was laid out in Factorial Completely Randomized Design with six treatments in factor one, T1- Perforated poly bag (200 gauge + 1 % ventilation), T2 -Un perforated poly bag (200 gauge), T3 - Wetted gunny bag, T4 - Wetted cloth bag, T5 - CFB box (1% ventilation) and T6 - Control (without any packing) and two treatments in factor two, Refrigerated condition (S1) and Ambient condition (S2). The data were analyzed statistically and interpreted.

Results and Discussion

Bitter gourd, because of its high moisture content is inherently more liable to deteriorate under tropical conditions. Like any other horticultural crop even after harvest they are biologically active and carryout transpiration, respiration, ripening and other biochemical changes, which deteriorate the quality of the produce.

All the three factors viz., different packaging materials (P), cultivars (C) and storage environment (S) and their interaction effect differed significantly in physiological loss in weight of bitter gourd. Among the different packaging materials P1 (Perforated poly bag - 200 gauge with 1 % ventilation) recorded the lowest physiological loss in weight of (10.38 per cent). The highest physiological weight was registered in P6 (Control - without any packing) with (21.96 per cent). Among the different cultivars treatment C2 (CO1) registered the lowest physiological loss in weight of (13.14 per cent). The highest physiological loss in weight was registered in C4 (US 6214) (17.92 per cent). It could be due to, bitter gourds are packed with polyethylene bags records less moisture loss due to maintenance of high humidity surrounding bitter gourds, which in turn lower rate of transpiration. These results are in conformity with the results of Viraktamath et al., (1963) in brinjal and Adamicki, (1985) in cucumber. Among the different storage conditions S1 (Refrigerated condition) registered the lowest physiological loss of (7.74 per cent). The highest physiological loss was registered in S2 (Ambient condition) (23.59 per cent). Modified atmosphere packaging is used in storage of fresh fruits and vegetables; the term refers to their storage in plastic films, which restrict the transmission of respiratory gases. This results in the accumulation of carbon dioxide and depletion of oxygen around the crop, which may increase the storage life (Kader et al., 1989).

The interaction effect of different packaging materials and cultivars P1 C2 (Perforated poly bag - 200 gauge with 1 % ventilation + CO1) registered the lowest physiological loss in weight of (8.49 per cent) and the highest physiological loss in weight was registered in P6C4 (Control - without any packing + US 6214) (23.34 per cent). The interaction effect of different cultivars and storage conditions C2S1 (CO1 +Refrigerated condition) registered the lowest physiological loss in weight of (6.92 percent) and the highest physiological loss was registered in C4S2 (US 6214 + Ambient condition) (27.22 per cent). The interaction effect of different packaging
materials and storage conditions P₁S₁
(Perforated poly bag -200 gauge with 1 % ventilation+ Refrigerated condition)
registered the lowest physiological loss in weight of (4.78 per cent) and the highest
physiological loss in weight was registered in P₆S₂ (Control - without any packing + Ambient condition) (30.99 per cent). Patil et al., (2010) reported that, the physiological
loss in weight during storage occurs continuously due to moisture loss; thereby the
fruits lose their freshness. In the present study the transpiration and respiration could have
caused loss of turgor in the fruits of bitter gourd. The rate of deterioration varied widely
depending upon the commodity and storage conditions as observed earlier by various
workers. In the case of bitter gourd, the fruits stored well up to 3-5 days (Sankaran, 1999).
Jayaraman and Raju (1992) and Perkins Veazie and Collins (1992) observed similar
results in bhendi.

Regarding the interaction effect of different packaging materials + cultivars + storage
conditions P₁S₁C₂ (Perforated poly bag -200 gauge with 1 % ventilation + Refrigerated condition + CO1) registered the lowest physiological loss in weight of (4.28 per cent)
and the highest physiological loss in weight was registered in P₆S₂C₄ (Control - without any packing + Ambient condition + US 6214) (32.30 per cent). The reduction in
physiological loss in weight of gherkin stored in ventilated polythene bags arrest moisture
loss and maintained turgidity. However, oxygen depletion, CO₂ accumulation occurred
in polythene bags resulting in low rate of respiration (Bindiya and Srihari, 2013).
Similar results were observed by Atri et al., (2002) in chilli and Mangal et al., (2001) in
brinjal. High CO₂ can inhibit ethylene action as well as autocatalytic production of ethylene
in climacteric fruits. Modified atmospheres can be defined as one that is created by
altering the normal composition of air (78 % nitrogen, 21 % oxygen, 0.03 % carbon
dioxide and traces of noble gases) to provide an optimum atmosphere for increasing the
storage period and maintaining the quality of produce (Table 1).

Among the different packaging materials P₁ (Perforated poly bag - 200 gauge with 1 %
ventilation) recorded the significantly highest fruit firmness of 4.88 (kg cm⁻¹). The lowest
fruit firmness was registered in P₆ (Control - without any Packing) with the value of
2.74 (kg cm⁻¹). The different storage conditions S₁ (Refrigerated condition)
registered significantly highest fruit firmness of 4.54 (kg cm⁻¹) and the lowest fruit firmness
was registered in S₂ (Ambient condition) 3.41 (kg cm⁻¹). The interaction effect of
different packaging materials and cultivars P₁C₂ (Perforated poly bag - 200 gauge with 1
% ventilation + CO1) registered significantly highest fruit firmness of 5.22 (kg cm⁻¹) and the
lowest fruit firmness was registered in P₆C₄ (Control - without any packing + US 6214)
2.15 (kg cm⁻¹). The extended shelf life observed with ventilated bags may be due to
optimum level of humidity and modified gaseous composition inside the bags which
did not favour the growth of fungus, but in polyethylene bags without ventilation, which
favours fungal growth leading to reduced storage life. These results are in confirmation
with the results obtained by earlier workers Anandaswamy et al., (1989) in capsicum,
Lingaiah et al., (1983) in bell pepper, Badgujar et al., (1987) and Viraktamath et al.,
(1963) in brinjal, Saimbhi and Ranohawa, (1983) in okra.

The interaction effect of different cultivars and storage conditions C₂S₁ (CO1 +Refrigerated condition) registered the highest fruit firmness of 4.94 (kg cm⁻¹) and
the lowest fruit firmness was registered in C₄S₂ (US 6214 + Ambient condition) 3.03 (kg
cm⁻¹). The interaction effect of different
packaging materials and storage conditions $P_1S_1$ (Perforated poly bag -200 gauge with 1 % ventilation+ Refrigerated condition) registered significantly highest fruit firmness of 5.75(kg cm$^{-1}$). The lowest fruit firmness was registered in $P_6S_2$ (Control - without any packing + Ambient condition) 2.55(kg cm$^{-1}$). The firmness of bitter gourd fruits in terms of pressure was found to be reduced with the increase in the storage period. However, fruits packed with polyethylene bags with ventilation were more firm than control. This can be attributed mainly due to more loss of moisture from the control fruits. Where packaging helped to prevent moisture stress and softening and thereby maintained a high firmness. Which were obtained by various researchers Yehoshua et al., (1979) in tomato and Yehoshua et al., (1983), Miller et al., (1986) in bell pepper and Showalter, (1973) in green capsicum.

Among the interaction effect of different packaging materials and cultivars $P_1C_2$ (Perforated poly bag -200 gauge with 1 % ventilation + CO1) registered significantly highest sound fruits of 85.51 per cent and the lowest percentage was registered in $P_6C_4$ (Control - without any packing + US 6214) 70.61 per cent. The interaction effect of different packaging materials and storage conditions $P_1S_1$ (Perforated poly bag -200 gauge with 1 % ventilation + Refrigerated storage) registered significantly highest sound fruits percentage of 89.69 per cent. The lowest percentage of sound fruits was registered in $P_6S_2$ (Control - without any packing + Ambient condition) 61.54 per cent. The modified atmosphere packaging is used in storage of fresh fruits and vegetables; the term refers to their storage in plastic films, which restrict the transmission of respiratory gases. This results in accumulation of carbon dioxide and depletion of oxygen around the crop, which may increase their storage life (Kader et al., 1989). The different packaging materials $P_1$
Perforated poly bag - 200 gauge with 1% ventilation recorded significantly highest shelf life 5.44 days and the lowest shelf life was registered in P₆ (Control - without any packing) (4.26 days).

**Table 1** Effect of prepackaging materials and storage condition on physiological loss in weight (per cent) of bitter gourd cultivars

| TREATMENTS | C₁  | C₂  | C₃  | C₄  | C₅  | MEAN |
|------------|-----|-----|-----|-----|-----|------|
| P₁         | 11.05 | 8.49 | 11.47 | 12.08 | 8.80 | 10.38 |
| P₂         | 19.44 | 18.03 | 19.46 | 20.23 | 18.56 | 19.14 |
| P₃         | 15.48 | 10.75 | 15.79 | 16.90 | 11.30 | 14.04 |
| P₄         | 16.42 | 10.82 | 17.15 | 17.74 | 11.64 | 14.75 |
| P₅         | 14.98 | 10.33 | 15.38 | 17.22 | 10.65 | 13.71 |
| P₆         | 21.83 | 20.40 | 22.54 | 23.34 | 21.70 | 21.96 |
| MEAN       | 16.53 | 13.14 | 16.96 | 17.92 | 13.77 | 15.66 |
| S₁         | 7.76  | 6.92  | 8.02  | 8.62  | 7.38  | 7.74  |
| S₂         | 25.30 | 19.35 | 25.90 | 27.22 | 20.17 | 23.59 |
| MEAN       | 16.53 | 13.14 | 16.96 | 17.92 | 13.77 | 15.66 |

**SOURCE**

| P | SEd | CD (P=0.05) |
|---|-----|-------------|
|  | 0.125 | 0.247 |
| S | 0.072 | 0.142 |
| C | 0.114 | 0.226 |
| P x S | 0.176 | 0.350 |
| S x C | 0.161 | 0.319 |
| P x C | 0.279 | 0.553 |
| P x S x C | 0.395 | 0.782 |
### Table 2: Effect of prepackaging materials and storage condition on fruit firmness (kg cm\(^{-1}\)) of bitter gourd cultivars

| TREATMENTS | \(C_1\) | \(C_2\) | \(C_3\) | \(C_4\) | \(C_5\) | MEAN |
|------------|--------|--------|--------|--------|--------|------|
| \(P_1\)    | 4.90   | 5.22   | 4.76   | 4.50   | 5.02   | 4.88 |
| \(P_2\)    | 3.50   | 3.74   | 3.29   | 3.03   | 3.68   | 3.45 |
| \(P_3\)    | 4.13   | 4.41   | 3.90   | 3.72   | 4.24   | 4.08 |
| \(P_4\)    | 3.93   | 4.21   | 3.78   | 3.55   | 4.02   | 3.90 |
| \(P_5\)    | 4.81   | 5.06   | 4.68   | 4.41   | 4.98   | 4.79 |
| \(P_6\)    | 2.70   | 3.26   | 2.51   | 2.15   | 3.11   | 2.74 |
| MEAN       | 3.99   | 4.32   | 3.82   | 3.56   | 4.17   | 3.97 |

| SOURCE     | SEd    | CD (P=0.05) |
|------------|--------|-------------|
| \(P\)      | 0.025  | 0.050       |
| \(S\)      | 0.014  | 0.029       |
| \(C\)      | 0.023  | 0.046       |
| \(P \times S\) | 0.036 | 0.071       |
| \(S \times C\) | 0.032 | 0.065       |
| \(P \times C\) | 0.056 | 0.112       |
| \(P \times S \times C\) | 0.080 | 0.159       |
Table 3: Effect of prepackaging materials and storage condition on sound fruits (per cent) of bitter gourd cultivars

| TREATMENTS | C1  | C2  | C3  | C4  | C5  | MEAN |
|------------|-----|-----|-----|-----|-----|------|
| P1         | 82.97 | 85.51 | 82.67 | 81.71 | 85.12 | 83.59 |
| P2         | 74.44 | 76.87 | 74.47 | 73.73 | 75.94 | 75.09 |
| P3         | 78.59 | 82.85 | 78.42 | 77.10 | 82.10 | 79.81 |
| P4         | 77.03 | 82.59 | 76.68 | 76.17 | 81.99 | 78.89 |
| P5         | 79.11 | 83.51 | 78.51 | 76.83 | 83.12 | 80.22 |
| P6         | 72.05 | 73.42 | 71.30 | 70.61 | 72.42 | 71.96 |
| MEAN       | 77.36 | 80.79 | 77.01 | 76.02 | 80.11 | 78.26 |

| TREATMENTS | S1  | S2  | S3  | S4  | S5  | MEAN |
|------------|-----|-----|-----|-----|-----|------|
| P1S1       | 86.27 | 87.06 | 85.95 | 85.31 | 86.53 | 86.22 |
| P1S2       | 68.46 | 74.52 | 68.07 | 66.74 | 73.69 | 70.29 |
| MEAN       | 77.36 | 80.79 | 77.01 | 76.02 | 80.11 | 78.26 |

| TREATMENTS | P1S1 | P1S2 | P2S1 | P2S2 | P3S1 | P3S2 | P4S1 | P4S2 | P5S1 | P5S2 | P6S1 | P6S2 | MEAN |
|------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| P1S1       | 89.30 | 84.94 | 63.94 | 87.49 | 69.69 | 87.02 | 67.04 | 87.49 | 81.01 | 63.08 | 72.05 | 77.36 |
| P1S2       | 89.69 | 85.87 | 67.86 | 88.11 | 77.58 | 87.90 | 77.27 | 88.11 | 82.48 | 64.36 | 73.42 | 80.79 |
| P2S1       | 88.94 | 84.76 | 64.18 | 87.27 | 69.56 | 86.56 | 66.80 | 87.27 | 80.53 | 62.07 | 71.30 | 77.01 |
| P2S2       | 88.17 | 84.31 | 63.15 | 86.86 | 67.33 | 86.44 | 65.89 | 86.86 | 79.68 | 61.54 | 70.61 | 76.02 |
| P3S1       | 89.54 | 85.29 | 66.58 | 87.58 | 76.61 | 87.41 | 65.75 | 87.58 | 81.30 | 63.53 | 72.42 | 80.11 |
| P3S2       | 78.02 | 78.07 | 65.08 | 78.16 | 72.77 | 72.41 | 70.71 | 78.16 | 78.77 | 62.92 | 71.96 | 78.26 |
| MEAN       | 89.13 | 85.03 | 65.14 | 87.46 | 72.15 | 87.07 | 70.71 | 87.46 | 81.00 | 62.92 | 78.26 |

| SOURCE | SEd | CD (P=0.05) |
|--------|-----|-------------|
| P      | 0.542 | 1.073       |
| S      | 0.313 | 0.619       |
| C      | 0.495 | 0.980       |
| P x S  | 0.766 | 1.518       |
| S x C  | 0.700 | 1.386       |
| P x C  | 1.212 | NS          |
| P x S x C | 1.714 | NS          |
Table 4 Effect of prepackaging materials and storage condition on shelf life (days) of bitter gourd cultivars

| TREATMENTS | C_1 | C_2 | C_3 | C_4 | C_5 | MEAN  |
|------------|-----|-----|-----|-----|-----|-------|
| P_1        | 5.29| 5.95| 5.16| 5.01| 5.81| 5.44  |
| P_2        | 4.55| 4.76| 4.45| 4.39| 4.70| 4.57  |
| P_3        | 4.96| 5.13| 4.92| 4.78| 5.05| 4.97  |
| P_4        | 4.79| 4.90| 4.67| 3.54| 4.88| 4.55  |
| P_5        | 5.19| 5.70| 5.07| 4.97| 5.65| 5.31  |
| P_6        | 4.23| 4.53| 4.14| 4.00| 4.40| 4.26  |
| MEAN       | 4.83| 5.16| 4.73| 4.45| 5.08| 4.85  |

| SOURCE | SEd | CD (P=0.05) |
|--------|-----|-------------|
| P      | 0.036| 0.072       |
| S      | 0.021| 0.041       |
| C      | 0.033| 0.066       |
| P x S  | 0.051| 0.102       |
| S x C  | 0.047| 0.093       |
| P x C  | 0.081| 0.161       |
| P x S x C | 0.115 | 0.228     |
Cultivars treatment C₂ (CO1) registered the highest shelf life of 5.16 days and the lowest shelf life was registered in C₄ (US 6214) (4.45 days). Among the different storage conditions S₁ (Refrigerated condition) registered the significantly highest shelf life of 5.78 days. The lowest shelf life was registered in S₂ (Ambient condition) (3.92 days). The shelf life of fruits and vegetables is also enhanced at low temperature or under cold storage conditions (Dalal and Subramanyam, 1970). Roy and Khurdiya, (1983) have designed zero energy cool chambers which are reported to enhance the shelf life of vegetables by lowering the temperature and increasing the humidity inside the chambers.

The interaction effect of different packaging materials and cultivars P₁C₂ (Perforated poly bag - 200 gauge with 1 % ventilation + CO1) registered significantly highest shelf life of 5.95 days and the lowest shelf life was registered in P₆C₄ (Control - without any packing + US 6214) 4.00 days. Among the interaction effect of different cultivars and storage conditions C₂S₁ (CO1 +Refrigerated condition) registered the highest shelf life of 6.23 days and the lowest shelf life was registered in C₄S₂ (US 6214 + Ambient condition) 3.76 days.

The interaction effect of different packaging materials and storage conditions P₁S₁ (Perforated poly bag -200 gauge with 1 % ventilation+ Refrigerated condition) registered significantly highest shelf life of 6.67 days and the lowest shelf life was registered in P₆S₂ (Control - without any packing + Ambient condition) 3.58 days. Temperature plays a key role in the metabolism of fruits and vegetables (Marangoni et al., 1996). Number of chemical and physical processes takes place in vegetables during storage shelf life.
Among the interaction effect of different packaging materials + cultivars + storage conditions P₁S₁C₂ (Perforated poly bag - 200 gauge with 1% ventilation + Refrigerated condition + CO₁) registered significantly highest shelf life of 7.49 days and the lowest shelf life was registered in P₆S₂C₄ (Control - without any packing + Ambient condition + US 6214) 3.38 days. Fruits stored in polythene bags recorded lower spoilage than other packaging materials. This might be due to the high permeability of gases through the film to prevent anaerobic respiration (Chadha, 2001). The highest shelf life was recorded in fruits packed in polythene and stored in refrigerated condition, spoilage was delayed and shelf life of bitter gourds was extended. These results were in conformity with Glaahan, (2009) in cabbage and Bindiya and Srihari, (2013) in gherkin (Table 4).

In conclusion, the study results indicated that perforated poly bag (200 gauge with 1% ventilation) plays a very effective role in controlling physiological loss in weight (PLW), Fruit firmness, Sound fruits per cent and Shelf life (days) of bitter gourds fruit stored under refrigerated condition. This may be due to the combination effect of prepackaging materials and storage environment.

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