# REDUCTION IN POSTHARVEST LOSS OF CAULIFLOWER BY ADAPTING APPROPRIATE HANDLING TECHNOLOGY

D.M. Gautam[1], R. Naupaney[2], K.M Tripathi[1], A.L. Acedo Jr.[3], W. Easdown[3], J.A. Hughes[4] and J.D.H. Keatinge[4]

[1] *Agriculture and Forestry University, Chitwan, Nepal*

[2] *Nepal Polytechnic Institute, Chitwan, Nepal*

[3] *AVRDC – The World Vegetable Center South Asia, Hyderabad, India*

[4] *AVRDC – The World Vegetable Center Headquarters, Shanhua, Tainan, Taiwan*

**ABSTRACT**

*Postharvest loss of cauliflower in Nepal is very high due to improper harvesting, handling, packaging and transportation. Farmers usually harvest cauliflowers with 5-6 leaves and transport to the market, which constitute 35% of weight. A study was carried out to find out the effect of different packaging material on transportation loss and thereafter shelf life of cauliflower at ambient storage condition (30.1 ± 0.9oC and 79.5 ± 9.5 % RH). Cauliflowers var. 'Snow Mystique' at commercially matured, tight curd stage were harvested from the farmers field by usual practice and grouped into; retention of 5-6 leaves (farmer's practice), removal of all leaves, and removal of all leaves followed by news print wrapping. Each group of curd samples were further divided into four subgroups packaging methods: nylon net bag, general plastic bag, plastic crate with newsprint liner and 50μ low-density polyethylene bag (LDPE) (modified atmosphere packaging or MAP technique developed earlier). Five packages of produce at 10 kg each were used for each treatment; each pack representing a replicate. They were then transported in pick-up van from a farm in Kavre to Chitwan, about 200 km distance. Water droplets accumulated inside the MAP bag; bulging of the bag was noticed; and temperatures inside the bag were slightly higher than that in the other packaging treatments. Weight loss during transportation was highest in nylon bag (4%), followed by plastic crate and lowest in plastic bag. No weight loss was recorded in sealed 50 LDPE. During subsequent ambient storage, curds packed in plastic crates had the longest shelf life (10 days) while those in the MAP, the shortest (<6 days). Thus, complete sealing in MAP was not beneficial. Cauliflower with 5-6 leaves exhibited more weight loss however the shelf life or retention of quality was at par with the cauliflower wrapped in news print. Wrapping by news paper minimizes the cost of transportation without affecting the transportation loss and quality of cauliflower.*

**Key words:** *LDPE, MAP, Postharvest loss, Transportation loss, Harvest stage.*

## Introduction

Tomato (Lycopersicon esculentum Mill.), is one of the most important vegetable crop grown all over the world which supplement human diet as a major sources of minerals, vitamins and antioxidants (Raiola et.al., 2014; Anonymous 2015; Nasrin et al., 2008; ).

In Nepal tomato is an important vegetable crop grown throughout the country. It is a winter crop in the terai area of Nepal and can be successfully grown during summer in the hills which is off season in terai. The production and productivity of its fruit is increasing each year as a result of increasing demand and efforts made by various government and non government organization to boost up its production (FFT, 2010-11; ABBMDD, 2013;PACT, 2014). During winter tomatoes are supplied to the hills from terai, while during summer it is just reverse. The economy of the hill people can be uplifted by commercial production of tomato during summer. In the off season the price is two to three times higher than normal season tomato. There is a potential scope to supply off season tomato to India and Bangladesh from the hills of Nepal. Studies have been carried out to increase production and productivity of tomato (FFT, 2010; 2011). In the past few years both production and productivity of tomato has been increased (MOAD, 2014) but existing postharvest losses are very high (ANSAB, 2015). The losses are mainly due to in appropriate harvesting and handling practices. Farmers usually harvest tomato fruits at red ripe stage as demanded by the consumers and transport in conical bamboo basket and plastic crate to the market. Because of ripe condition of fruits and improper handling practices losses during transportation and marketing are very high Transportation and postharvest loss can be minimized by harvesting tomato a turning and hard stage (Gautam. and Khatiwada, 2003). A very few research have been carried out in Nepal on postharvest handling of vegetables. If suitable guidelines are provided for harvesting and handling of tomato large amount of produce can reach to distance market with minimization of postharvest loss. If tomato fruits are harvested before full ripe stage and properly packed they can easily reach to the distance market. There is need to provide guidelines for appropriate stage of maturity to harvest and suitable packaging method to increase shelf life of tomatoes.

Reusable plastic crated are generally used to hold fruits and vegetables during transport and marketing (Kitinja, 2013). In developed countries fruits and vegetables are transported in temperature controlled container (PRNewswire, 2014; PREWEB, 2014). Controlled atmosphere storage or shipping offer a moderate level of benefit. Low O2 levels (3-5%) delay ripening and the development of surface and stem-scar molds without severely impacting sensory quality for most consumers (Suslow and Cantwell, 2013). Modified atmospheric packaging (MAP) is a simple technology which works in the principle of controlled atmosphere storage (Singh, 2010; Xanthopoulos et.al.,2012). Low density polyethylene (LDPE) films are commonly used for MAP. MAPs are effectively utilized for packaging fruits and vegetables in temperature controlled transportation container. In MAP increase in carbon dioxide and decrease in oxygen is achieved as a result of respiration of the produce. Laboratory study has revealed extension of tomato shelf life in modified atmosphere storage packaging (MAP) in 50 micron thickness LDPE (Gautam et. al., 2015). There is need to test MAP technology for transportation of tomato to minimize postharvest loss and ripening behavior. Even though some research efforts have helped to increase the production of tomato to some extent, the purpose of obtaining maximum profit will be served only if the increased production is supplemented with the similar efforts to minimize the postharvest losses and enhance the shelf life. This study was carried out to find out the influence of maturity stage and packaging method on transportation loss and there after ripening behavior, quality and shelf life of tomato fruits.

## Materials and Methods

Tomato fruits of cv 'Srijana' grown under protected cultivation in farmers field were harvested at breaker (CI-1) and orange yellow stage (CI-4) and transported in ordinary plastic crate, plastic crate with news paper lining, plastic crate with polyethylene (plastic) lining and MAP inside plastic crate. Low density polyethylene (LDPE) bag having 4 micron thicknesses were used for MAP. Eight punching holes were created in each bag to avoid an anaerobic respiration during transportation. Altogether there were eight treatment combinations with three replications having about 20 kg fruits in each. Fruits were transported from Panauti, Kavre to Rampur, Chitwan about 200 km in mini truck. Damage of the fruits was assessed upon arrival at destination. About 2 kg fruits free from visual damage were selected for shelf life study. They were allowed to ripen at ambient room temperature. Temperature and relative humidity were monitored daily. Weight loss, change in fruit color were monitored in each three days intervals. Firmness, TSS, TA, pH and vitamin C were measured at 12th day during storage. and at the end of shelf life (50 % acceptability). Color rating was done using 6 point scale hedonic rating i.e., 1=Breaker, 2=Turning, 3=Pink, 4=Orange, 5=Red and 6=Deep red until the fruits were disposed.

# Results and Discussion

## Weight Loss and Damage During Transportation

Percentage weight loss and damage of the fruits during transportation are presented in Table 1. Weight loss was influenced by the method of packaging. Highest weight loss was recorded in plastic crate followed by news paper and plastic lining. Significantly lowest weight loss was exhibited the fruits held inside MAP. Reduction in weight loss inside sealed perforated MAP was mainly due to partial restriction in transpiration and also could be due to reduced rate of respiration in such condition. MAP has been reported to reduce both the rate of respiration and transpiration (Sandhya, 2010). Damage of the fruits during transportation was greatly influenced both by the stage of maturity and by the method of packaging. Damage of fruits was higher in ripe fruits and it was more in plastic crate. Damage was significantly reduced both in ripe and breaker tomatoes by MAP in perforated polyethylene bag, plastic lining and paper lining as compared to ordinary plastic crate. MAP, plastic or paper lining have minimized the friction of fruits with crate during transportation and thus have reduced the damage. Invisible damage might have occurred in such condition which are reflected during storage

## Physicochemical Characters

Analysis of firmness, TSS, TA and vitamin C content during storage did not show variation with packaging method and stage of maturity at harvest, however only firmness varied with the stage of maturity (Table.2). Fruits harvested at breaker stage fruits required greater pressure (0.85kg force) to puncture compared to ripe fruits (0.63 kg/Inch2). It revealed that loss can be minimized by harvesting fruits at breaker stage which have resistance to pressure damage during transportation..

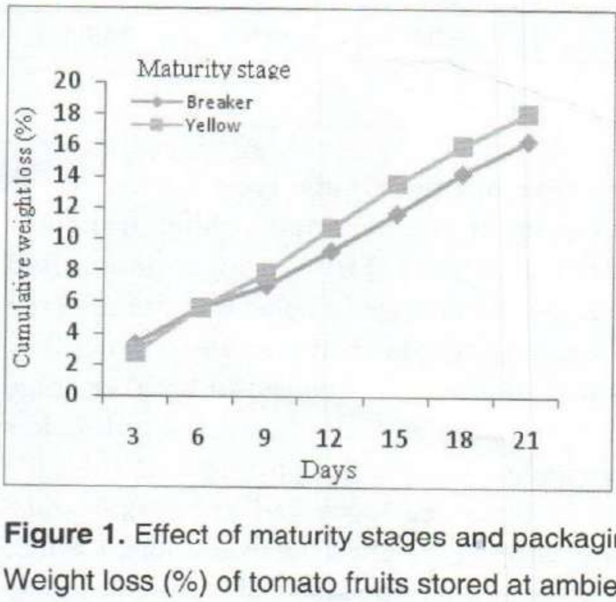
**Table 1. Tomato fruits on weight loss (%) and damage (%) during transportation from Kavre to Chitwan**

| Treatments | Weight loss (%) | Damage (%) |
|---|---|---|
| **Packaging method** | | |
| Plastic Crate | 0.56a | 11.38a |
| Newspaper lining in crate | 0.51a | 6.90b |
| Plastic lining in crate | 0.48a | 6.55b |

| | | |
|---|---|---|
| MAP with 8 punching in crate | 0.26b | 5.7b |
| SEM (±) | 0.06 | 0.80 |
| LSD0.05 | 0.19* | 2.7 ** |
| **Stage of tomato** | | |
| Breaker (CI-2) | 0.51 | 5.56b |
| Yellow (CI-4)Yellow) | 0.40 | 9.7a |
| SEM (±) | 0.05 | 0.65 |
| LSD0.05 | Ns | 2.6** |
| Mean | 0.46 | 7.64 |
| CV (%) | 33.89 | 26.83 |

## Weight Loss During Storage

Weight loss of the tomato fruits during storage at ambient room condition (29.3±2.7 0C and 85 ±7.5 % RH) is presented in Figure 1. Slightly higher weight loss was exhibited by green fruits. Packaging method used during transportation had pronounced effect on cumulative weight loss. The fruits packed in ordinary crate had highest weight loss which was followed by MAP with 8 perforations. Significantly lesser weight loss was noticed in the fruits which were held in plastic trays either with plastic lining or paper lining. Despite of lower weight loss during transportation in MAP fruits, higher loss in storage could be due to some physiological injuries to the fruits as a result of reduced oxygen and increased carbon dioxide. Higher level of carbon dioxide and lower level of oxygen has been reported harmful to the commodity (Suslow and Cantwell, 2013). The harmful effect of carbon dioxide may not be apparent immediately at the opening of MAP, but become prevalent later in storage (Ref). Lower weight loss in plastic and paper lining crates as compared to MAP with 8 perforations indicated that MAP may need more perforations for exchange of gases to facilitate aerobic respiration.



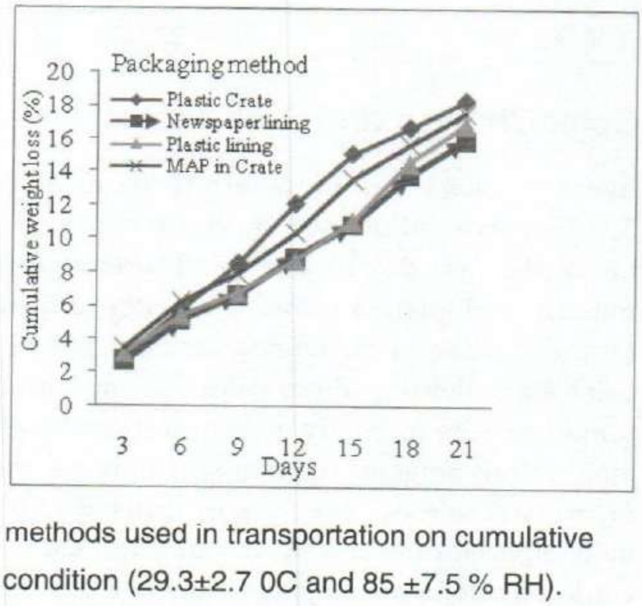




**Figure 1.** Effect of maturity stages and packaging methods used in transportation on cumulative Weight loss (%) of tomato fruits stored at ambient condition (29.3±2.7 0C and 85 ±7.5 % RH).

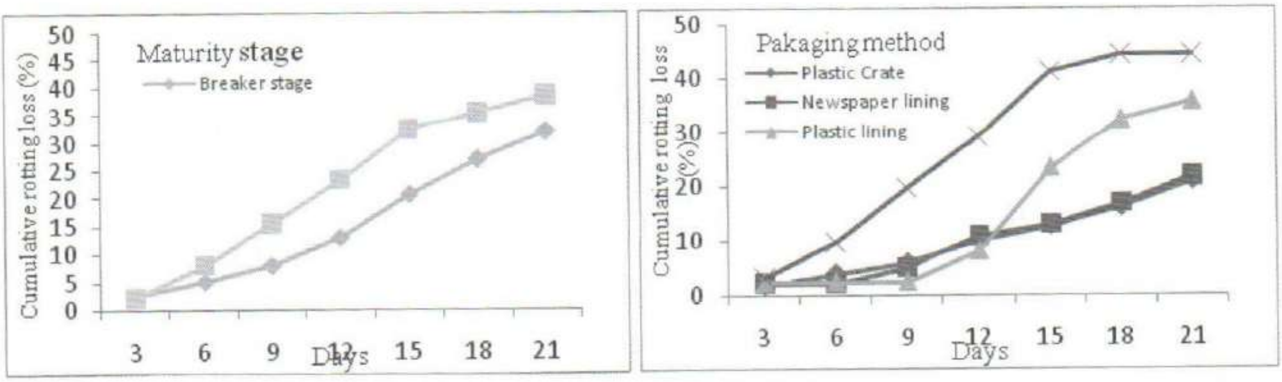



**Figure 2.** Effect of maturity stages and packaging methods used in transportation on cumulative rotting loss (%) of tomato fruits stored at ambient condition (29.3±2.7 0C and 85 ±7.5 % RH).

**Table 2. Effect of maturity stage and packaging method used in transportation on firmness, TSS, TA, pH and vitamin C content of tomato fruits after storage at ambient condition.**

| Treatments | Firmness (Kg/Inch2) | TSS (B0) | TA (%) | pH | Vitamin C (mg/100g) |
|---|---|---|---|---|---|
| **Packaging method** | | | | | |
| Plastic Crate | 0.74 | 3.57 | 0.12 | 3.97 | 24.89 |
| Newspaper lining in crate | 0.77 | 3.83 | 0.13 | 3.98 | 25.19 |
| Plastic lining in crate | 0.73 | 3.40 | 0.15 | 3.97 | 29.45 |
| MAP in Crate | 0.73 | 3.37 | 0.11 | 4.08 | 24.32 |
| SEM (±) | 0.08 | 0.13 | 0.02 | 0.05 | 1.42 |
| LSD0.05 | Ns | Ns | ns | ns | Ns |
| **Stage of tomato** | | | | | |
| Breaker (CI-2) | 0.85a | 3.57 | 0.14 | 3.96 | 25.63 |
| Yellow (CI-4) | 0.63b | 3.52 | 0.12 | 4.04 | 26.65 |
| SEM (±) | 0.04 | 0.10 | 0.01 | 0.04 | 1.14 |
| LSD0.05 | 0.15** | Ns | ns | ns | Ns |
| Mean | 0.74 | 3.54 | 0.13 | 4.00 | 26.14 |
| CV (%) | 22.84 | 8.77 | 26.04 | 3.49 | 14.51 |

## Color Change and Shelf-life

Average color index of tomato fruits at different days during storage is present in Table 3. Color was influenced by the method of packaging at the destination after transport i.e. at the first day in storage. The tomato fruits held in MAP during transportation had minimum change in color. Thereafter, during storage the change in color was not affected by the method of packaging. Irrespective of packaging method fruits harvested at yellow color stage developed red color earlier. Development of color was delayed in breaker stage tomatoes. The intensity of color did not reach to dark red in all fruits harvested at breaker stage. Both stage of the fruits at harvest and packaging method had influenced shelf-life of fruits (Table 3). Shelf-life of fruits was higher in tomatoes harvested at breaker stage as compared to yellow stage. In MAP held fruits slightly lower shelf life was noticed which could be due to physiological damage during transportation and rotting of fruits in storage (Figure 3).

From the above results is can be concluded that for distant market and holding for a few days tomato fruits should be harvested in breaker stage and should be transported in perforated MAP to reduce postharvest loss during transportation and extend shelf life..

**Table 3. Color rating of tomato at different days in storage (D) as effected by maturity stage and packaging method during transportation.**

| Treatments | Colour rating (1-5) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1st D | 3rd D | 6th D | 9th D | 12th D | 15th D | 18th D | 21st D |
| **Packaging method** | | | | | | | | |
| Plastic Crate | 4.35b | 4.90 | 5.18 | 5.32 | 5.45 | 5.53 | 6.00 | 6.00 |
| Newspaper lining | 4.65a | 5.27 | 5.43 | 5.57 | 5.57 | 5.75 | 6.00 | 6.00 |
| Plastic lining | 4.58a | 5.08 | 5.35 | 5.48 | 5.60 | 5.67 | 5.73 | 6.00 |
| MAP in Crate | 3.82b | 4.55 | 4.95 | 5.13 | 5.30 | 5.45 | 5.50 | 6.00 |
| SEM (±) | 0.48 | 0.40 | 0.32 | 0.29 | 0.22 | 0.18 | - | - |
| LSD0.05 | 0.51* | Ns | ns | Ns | ns | ns | - | - |
| **Stage of tomato** | | | | | | | | |
| Breaker (CI-1) | 3.32b | 4.14b | 4.57b | 4.79b | 5.05b | 5.22b | 5.41 | 5.61 |
| Yellow (CI-4) | 5.33a | 5.76a | 5.89a | 5.96a | 6.00a | 6.00a | 6.00 | 6.00 |
| Mean | 4.32 | 4.95 | 5.23 | 5.37 | 5.50 | 5.60 | - | - |
| SEM (±) | 0.17 | 0.13 | 0.10 | 0.09 | 0.07 | 0.06 | - | - |
| LSD0.05 | 0.36*** | 0.40*** | 0.33*** | 0.30*** | 0.23*** | 0.21*** | - | - |
| CV (%) | 9.52 | 9.23 | 7.29 | 6.44 | 4.78 | 4.22 | - | - |

Note: After 15 days some of the replications were spoiled and no analysis of data, only the mean of some replications are listed.

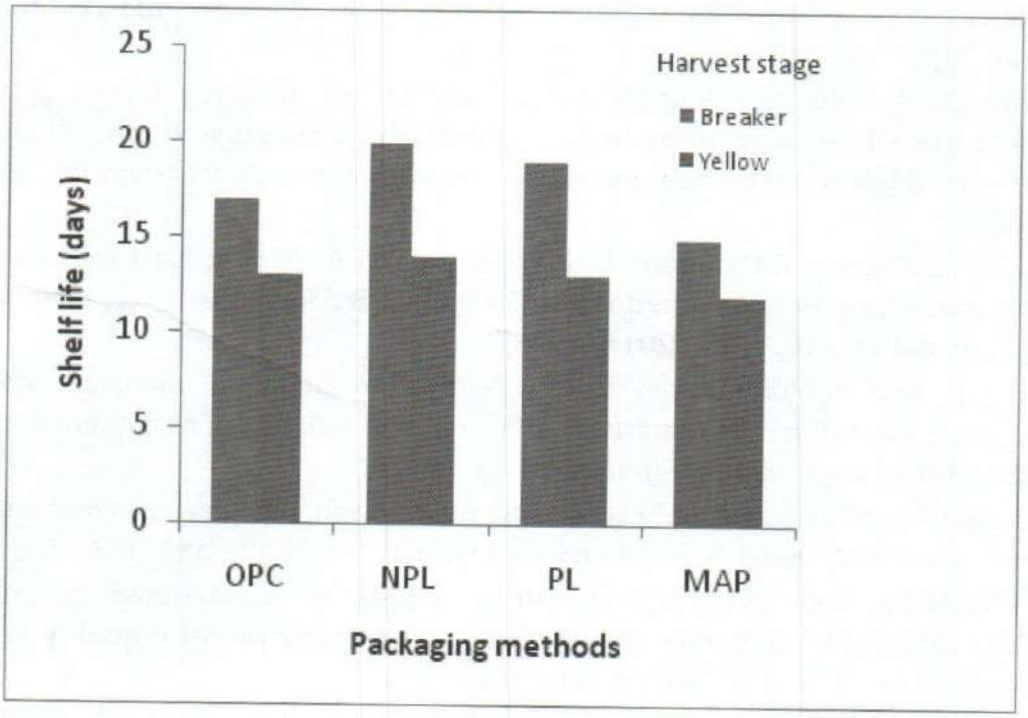



**Figure 3.** Effect of harvesting stage and packaging method used for transportation on Shelf-life of tomatoes at ambient storage condition (29.3±2.7 0C and 85 ±7.5 % RH).

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