INTRODUCTION
1. INTRODUCTION

Post-harvest losses of fruits and vegetables are a matter of concern for all those countries whose economy is based on agriculture. As this happens in almost every developing country that fruits and vegetables are extremely perishable product that require to be dealt with much care to reduce losses. Because of its high moisture content horticultural crops are inherently more susceptible to deterioration especially under higher temperature conditions. They are biologically active and carry out transpiration, respiration, ripening and other biochemical activities, which result in quality deterioration. The tomato (*Lycopersicum esculentum* Mill.) is a globally known vegetable, belongs to Solanaceae family.

Tomato is one of the very perishable fruit. It changes continuously after harvesting. Depending on the humidity and temperature it ripens very soon, ultimately resulted in poor quality as the fruit become soft and unacceptable. The quality of tomato is determined by color, appearance flavor and firmness. Color of tomato is very important in determining its quality. The post harvest losses of fresh fruits and vegetables including tomatoes are estimated to be 5 to 25% in developed and 20 to 50% in developing countries (*Kader and Morriss, 1985*). When the fresh fruits and vegetables arrive in the market at its peak season due to its abundant availability the prices of all the products come down to such a level that the farmers instead of profit loose money. In such cases the need for proper storage and product preparation is very much needed. In developing the production may not be linked with the market that how much of such fruits are vegetable will be needed to properly process and utilized in fresh form. In such cases if the production is more there is no facility for its proper storage transportation packaging and handling the surplus product, so automatically going to be wasted. The post harvest handling of tomatoes is important because of perishable nature. As such they continue to undergo both desirable and undesirable changes during handling. Post harvest losses in tomatoes cannot be eliminated, but can be reduced within certain limits by applying appropriate post harvest technology. Extending the shelf life of tomatoes is very important for domestic and export marketing. Generally shelf life of tomatoes is extended by low temperature storage. Many fruits and vegetables can be kept for several weeks at low temperature. Storage at 13°C was more favorable as compared to 24°C for prolonged shelf life and increasing vitamin C content of fruits (*Mustafa and Al-Mughrabi 1994*). Post harvest changes in tomatoes cannot be controlled or eliminated, but reduced within certain limits by applying post harvest handling
techniques. However, extension of the shelf life by slowing of ripening tomatoes at low temperature accompanied by treatment with CaCl₂ can be achieved to some extent. (Bhattarai and Gautam, 2006) reported that the least cumulative physiological weight loss (12.14%) was exhibited by 1% calcium chloride treatment. Calcium is a critical nutrient for the growth, quality and shelf life of tomatoes. It is, therefore, needed for both pre and post harvest applications to tomatoes. Calcium has a desirable effect on reducing respiration, delaying ripening and resultantly extends shelf life of fresh fruit and vegetables. Mature green yellowish tomatoes were treated with CaCl₂. Initially in the pretest tomatoes were treated with 2%, 5% and 8%. In these test 2% CaCl₂ treatment proved to decrease the weight loss as well as reduced shrinkage. Some studies have conducted on Modified and controlled storage of Tomato with the combination of different storage temperature but the MAP study using the different polymeric films was not conducted.

A modified atmosphere 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 length and quality of food/produce (Moleyar and Narasimham 1994, Phillips 1996). Modified atmosphere packaging is used in the 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 their storage life (Kader et al., 1989). The objective of controlled or modified atmosphere (CA or MA, respectively) is to extend the shelf life of fresh products. Designing modified atmosphere packaging (MAP) for fresh products is a complicated task. Many factors should be taken into account: film characteristics (O₂, CO₂, and N₂ permeability, thickness, surface area, and so on), temperature and free volume inside the package, product weight, and respiratory parameters. Passive modified atmosphere packaging (passive MAP) for a particular product consists of carefully selecting film with suitable gas permeability and selectivity to obtain optimal O₂ and CO₂ atmosphere. Mathematical models are useful tools for defining the package requirements for MAP. Several models are available in the literature (Henig and Gilbert, 1975; Cameron et al., 1989; Mannapperuma et al., 1989; Edmond et al., 1991; Fishman et al., 1995). Basically those models use the principles of O₂ and CO₂ mass balances to describe the interactions among the product respiration, the film permeability, and the environment. In many cases, it takes a long time to reach gas equilibrium (Cameron et al., 1995) showed that it can take 2 to 3 wk to
attain steady-state at low temperatures depending on the void volume and the rate of product respiration. During this transient period, the product can be exposed to unsuitable gas composition thus preventing the positive effects of the steady-state atmosphere. For example, Barron et al. (2002) showed that in mushroom packages, the transient CO$_2$ peak can induce browning. The use of passive MAP for fresh products is restricted mainly by the unavailability of appropriate films that provide gases fluxes, selectivities, and temperature compensation to function effectively (Exama et al. 1993). To overcome the limited ability to regulate a passively established atmosphere, actively establishing the atmosphere could be preferred (Kader and Watkins, 2000; Lange, 2000). Active MAP consists essentially of gas flushing or gas-scavenging (O$_2$, CO$_2$, ethylene and so on) to quickly establish equilibrium condition within the package and to avoid high content of unsuitable gases. For example, most of O$_2$-sensitive foods, such as fresh-cut lettuce or potato products are gas flushed or vacuum packaged to quickly attain atmospheres of less than 1% O$_2$ to slow browning caused by polyphenol oxidation. O$_2$ Oxygen absorbers also are used to decrease rapidly the O$_2$ partial pressure from package headspaces and also to remove the O$_2$ that permeates through the packaging film (Rooney, 1995; Gontard, 2000). To date, considering the economical and technical advantages of using absorbent technology, oxygen absorbers have been successfully used with nonrespiring product (meat, pastries) (Brody et al. 2001; Roussel, 2000). For respiring products, research is needed into the use of gas absorbers inside packages and how they can be useful to maintain a desired package atmosphere. One problem with reduced oxygen in MAP of fresh or minimally processed fruits and vegetables is that if the oxygen is under the product tolerance limit, it may lead to anaerobic conditions. Such conditions may result in not only the production of malodorous compounds but also the growth of pathogenic anaerobic microorganisms.

Hence, to extend the storage life of tomatoes, regulation of ripening by retarding the metabolic activities coupled with prevention of microbial attack is an important consideration. In this view, several methods of storage techniques are being employed like refrigeration, fungicide and sterilant treatments and modification of the atmosphere surrounding the produce. Although, the prevalent method of preservation of fresh tomato is by cooling, storage at low temperatures is precluded by their susceptibility to chilling injury, which causes pitting, poor or uneven ripening and increased fungal spoilage (Tomkins, 1963, Ryall and Lipton, 1972). Alternatively, modified atmosphere packaging has been recognized as a promising
and inexpensive way to improve the shelf life and minimizing produce quality impairment (Zagory and Kader, 1988; Geeson et al., 1985). The present investigation was therefore undertaken to study the extension of post harvest shelf life of tomato by employing various Modified packaging and storage conditions with the following objectives.

**Objectives of the study**

The overall objective of the study is to determine the optimum conditions of MAP storage for the extended shelf life of tomatoes. The specific objectives of this study are:

1. To study the effect of post harvest treatments on the quality and shelf life of tomato.
2. To study various parameters affecting respiration of tomato and to develop optimum gaseous concentration for Modified Atmosphere Packaging of Tomato.
3. To study objective and Subjective performances of modified atmosphere packages and to evaluate their performance at various storage temperature.
4. To assess the economic viability of post harvest treatments and MAP system for tomato storage.