EXTENDED SHELF LIFE OF GREEN CHILLI BY USING LOW TEMPERATURE AND MODIFIED ATMOPHERE PACKAGE.

By

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DECLARATION

The work is described in this thesis was carried out by me at the Food Research Unit,Gannoruwa, under the supervision of Mr. T. D. W. Sriwardena and Mr M. A. J. Wansapala. A report on this has not been submitted to any other University for another degree.

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AFFECTIONATELY DEDICATED

TO MY EVERLOVING

PARENTS, SISTERS, BROTHER, AND HUSBAND.

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ABSTRACT

Net production of green chilli in Sri Lanka is 62,470 MT (in 1998). Green chilli is the second major export vegetable in Sri Lanka. Export quantity of the green chilli was 115,271 Kg(In1999). Because of poor post harvest handling and poor storage facilities and microbiological decaying limits the export quantity of green chilli. So, this experiment carried out for, find the suitable storage temperature, package type and to reduce post harvest pathogen in green chilli pods.

Using, two temperatures (11^{0}C and 8^{0}C), three varieties (Dehlli hot, Arunalu and MI2), and two package types (non perforated and perforated) experiment was done.

'Dhelli Hot' variety gave good quality pods end of the storage life but the disease development some what higher in 'Dhelli Hot' variety.Non-perforated LDPE package was the suitable package for green chilli. Suitable temperature was around 8^{0}C. But there was the problem in non-perforated package due to increasing RH. For the disease development RH was directly affected.

Soft rot was the most abundant disease in green chilli and stem rot also can be seen.

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CHAPTER I
INTRODUCTION

Capsicum annum L is the botanical name of the Chilli. It belongs to family *Solanaceae* Chilli is one of the most valuable crop in Sri Lanka. The crop is grown largely for its' fruits all over Sri Lanka. It is used as a principle ingredient of curries. It also use for vegetables, spices, condiments, sauces and prickles. Dry chillies are used for curry powder. Pungency in chillies is due to the active constituent "Capsacin" Capsacin; an alkaloid is extracted from chillies and is used in medicine.

Chilli is a native crop of tropical America and West Indies. It is believed to have been introduced in to India by the Portuguese in the seventeenth Century. Chillies are rich in Vitamins, Especially Vitamin A and C. Chili, Chilli, Paperika, Pepper and pimipen are the other names for green Chilli.

The Chilli is a plant of tropical sub tropical region. It grows well in warm and humid climate and a temperature of 20^0 C to 25^0 C MI - 1, MI - 2, and KA - 2 are the local varieties grown in Sri Lanka Net production of green chilli in Sri Lanka is about 62,470 MT (in 1998). Production of green chilli is higher in dry zone than wet zone. Dambulla, Hambantota, Embilipitiya, Tissamaharam, Anuradhapura, Moneragala and Hettipola are the major districts of growing chilli in Sri Lanka.

Green chilli is the second major export vegetable in Sri Lanka. Its export to many Europe countries and Middl East countries. Green chilli exports quantity and values giving below.

Table 1.1 Export chillies(Fruit of the genus capsicum)

Year	Quantity(Kg)	value(Rs) F.O.b.
1995	372,222	31,060,409
1996	59, 787	12,015,100
1997	68,205	12,162,665
1998	70,256	12,885,825
1999	115, 271	860, 930

Source: External Trade Statistics-Sri Lanka(Sri Lanka Customs)

Tropical environment (including high temperature and relative humidity) flavors the growth of post harvest Pathogens, which facilitates the development of rot during handling and transport (Lizada 1993). Thus the post harvest environment should be manipulates in such a way that the fruit retains its qualities at its optimum acceptable condition until it reaches consumer.

From this net production of capsicum, 35% may consider as post harvest losses due to poor handling, poor storage facilities and poor technology. From low temperature and modified atmosphere we can decrease the post harvest losses.

Table 1.2 the post harvest loses (35%) from producer to retailer

Producer	Collector	Whole sale	Retailer	Total loss (Capsicum)
6%	7%	10%	12%	35%

Objectives

Green chilli is highly perishable commodity. So, the shelf life is very low in room temperature. Main object of this experiment is, increase the shelf life of green chilli using low temperature and modified atmosphere package. From that, quantity of the green chilli to be exported can be increased. Post harvest losses also can decrease using low temperature and modified atmosphere package.

CHAPTER II
LITERATURE REVIEW

2.1 Extent of losses

Presented data relating to post harvest losses of several fruit and vegetable commodities at the wholesale, retail, and consume levels, pointing out main areas of losses, namely, the actual product or material loss and to a lesser extent the nutritional loss. Each these forms of loss were due to weight (wilted, over ripe, etc.), bruise, peel, trim, decay, or pest activity during the harvesting, handling, storage, transportation, distribution, retailing, and processing of the produce. (Sparks,1976)

2.2 Post harvest diseases.

Black ripe rot (c.o. - *Alternaria alternata*)

Black ripe rot due to *A. alternata* is a field disease but causes appreciable additional loss during transit and storage.

The lesions are well defined, first appear as small, circular, grayish - green water soaked, sometimes-sunken spots anywhere on the fruit. The spots gradually enlarge, become tan to mouldy brown and are covered by a scanty mycelium of a velvety green sporulating mass. (Hirematham, Govinda, 1973).

Anthracnose (c.o - *Coetotrichum capsici* state of *Glomerella cingulata*)

This disease is prevalent throughout the year and is common on semi-ripe to ripe fruits appearing as small, water soaked, and circular and sunken spots. They enlarge gradually with dirty brown to black center later turning in to straw and blackish - brown advancing margin and a straw coloured center with black setae erupting the fruit skin. A well-developed spot is oblong, up to 2 cm wide. Acervuli appear as black pustules in concentric rings at the center. Under humid conditions, creamy pink spore masses can be noticed along with the sparse grey- black mycelium. High humidity favors disease development.(Bilgrani et. al.,1979-1981).

Soft rot (c.o. - *Fusarium oxysporum, F. Solani, F. Diversisporum*)

Infection starts mostly from the stylar end as small, water soaked, and brownish area with scanty mycelial growth on the surface. Rotten fruit becomes soft and leaks milky juice, emitting an offensive smell. Under high humid condition, fluffy mycelial cottony growth fully covers the fruit surface Infection due to F. solani and f. diversisporum turns the whole fruit soft and yellow within two days. High humidity favors the disease.(Sharma et. al., 1981)

2.3 Chilling Injury

Numerous minutes to fairly large, shallow, round depression may occur on the mature green pepper as a chief system of chilling injury. (McColloch,1962) termed this symptom sheet pitting . Chilling induce pits at the surface of wounds may also be present, but they are irregular in shape and not evenly distributed. The browning of the seeds,(Ogata et.al.1968), discoloration and death of calyx, and grayish brown, dull surface of the pod are the further symptoms. Alternaria rot follows severe chilling injury. Symptoms develop more rapidly at nonchilling temperatures following chilling exposures than at continuously low temperatures. Chilling injury generally de expected within 2 to 4 days at 0^0C, within 7 days at 1.1^0C, within 9 days at 4.4^0C, and within 14 to 15 days at 5.6 to 7.2^0 C. Chilling induced pitting is aggravated by drying condition and can be delayed by high relative humidity (RH)(above 95%). Ripe peppers are immune to sheet pitting.(Ryall, Lipton, 1972).

2.4 Other disorders

Sunscald-affected tissue is dry and peppery and is of concern in tropical areas. Such fruits can easily be discarded at harvest. Milder forms of solar injury may induce a unilateral yellowing and an occasional mild wilting. Sometimes pepper readily become soft and flabby when held a few days below 90% RH, in spite of their natural waxy surface. termed this disorders as wilting(Ryall and Lipton,1972), found no correlation between the incidence of green pitting and fruit length, or diameter, number of locules, or pericarp thickness in 11 bell pepper cultivars of queensland. Pitting was, however, correlated with high calcium content of the fruit (Hibberd, 1981)

2.5 Storage condition

Endogenously generated or exogenously applies modified atmospheres (MA) can extend the storage life of many types of perishable produce by reducing the rate of respires, ethylene produced and metabolic process associated with the ripening or senescence (Kader et.al. 1989). The uses of polythen film reduces moisture loss and restricts ventilation resulting in build up of carbon dioxide and a reduction of available oxygen and creating and MA condition. Unless controlled, the MA may injure the fruits; especially under ambient storage conditions MA has a direct effect on the ripening quality of fruit (Onwuzulu et. al.,1995)

Sweet peppers could be stored in good condition for at least 40 days at 0^0 C and 95 to 98% RH; only about 4% of fruits shrank in 40 days. At 4.4^0C, the peppers kept well for about 4 weeks; and at 10.0^0 C, they remained in good condition for 16 days. (Platenius et al.,1934)

The optimum temperatures to store peppers are 7.8 to 8.9^0 C at these temperatures chilling injury and ripening is minimal. Holding peppers between fast and partly ripened peppers are not objectionable. The fully ripe peppers can be held for about a week between 4.4 and 7.2 ^{0}C, with out causing injury. (Ryall and Lipton,1972).

Possibility of transporting capsicum from the tropics to Europe in refrigerated containers during winter. They found that the hydrocooling on produce before packing in plastic lined boxes increase rotting and could not be use in commercially Hydrocooling, however, had no effect on rotting of produce without plastic liner.(Seymour et al , 1980).

Peppers must be held in high RH about 95% or else they will rapidly become flabby Drying conditions also accentuate symptoms of chilling injury by accelerating dehydration of injured tissue and thus pitting. Wetting of peppers during 1 or 2 days of or retail display is harmless at 4.4 to 7.2^{0}C, but increases decay as temperatures approach exceed10.0^0 C. (Ryall and Lipton,1972),

Fruit wrapped in plastic film showed a significant increase in storage life and had a lower weight loss than in other treatment.

Recommended temperatures of 7.2 and 5.6 to 7.2 ^{0}C and a RH of 85 to 90 and 90 to 95% for green and ripe peppers, respectively. While the green peppers could be stored for about 3 to 5 weeks, the post harvest life of the red peppers was only about 2 weeks. Pantastico et al., 1975)

Exposure of sweet peppers (*Capsicum annuum L.*) to 30% CO_2 for 6 days at 13^{0}C immediately after harvest, retarded wall softening and ripening in air at 13^0 C, but caused the subsequent development of severe calyx injury and decay at 20^0 C. Slight to moderate calyx injury was induced by a 6 day exposure to 20 % CO_2 Severity of injury was greater when the CO_2 was used with 3% O_2 as compared to 21% O_2. Injury was not induced by a 6 day treatment with 10% CO_2. When stored at 13^{0}C, the quality of peppers with this treatment was this treatment was superior after 10 days, but inferior after 20 days, to that of peppers kept continuously in an atmosphere of 5% $CO_2$and 3% O_2. The benefits obtained from the 3 days elevated CO_2 treatment (10 to 30%) were nullified after 10 days of storage at 13^0 C. The production of ethylene was greatly inhibited in high CO_2 atmospheres, but rose immediately after transfer to air. The high concentration of CO_2 retarded the development of red color, degradation of chlorophyll, and accumulation of ascorbic acid. (Wang, 1977)

Different film has different CO_2 and O_2 permeability characteristics. There for a film may be selected such that desired gas concentrations are created from specific product. (Kader et al. 1989) reported that for most polymeric films, the ratio of CO_2 and O_2 permeabilities are 4 to 6. These limitation largely restrict the use of polymeric films to packaging products that required CO_2 concentration lower than 8%. (Mannaperuma et al 1998).

2.6 Packaging

Bell pepper are not generally prepackage, although the practice certainly would retard wilting. Pepper with a large surface to volume ratio, such as the long or small type, are particularly susceptible for water loss and thus are adapted to packaging (Ryall , Lipton,1972),. Ventilation of the packages should be adequate to avoid the moisture condensation inside the packages (Anadaswamy et al.,1959).That plastic wraps improve the storage of capsicum sufficiently to be of commercial use of transport.(Hughes et al. ,1981)

2.7 Waxing

Pepper is almost universally waxed before shipment to reduce moisture loss and scuffing. Strict sanitation on the packing line and drying oh surface moisture on the stem and calyx are essential to avoid increasing decay by the waxing treatment.(Johnson, 1968)

2.8 Other chemicals

Chilli and pimento pepper sprayed with 250 to 1200 ppm ethephon, ripened early when applied at the chocolate brown stage. Ethephon, as a preharvest spray, was useful to concentrate the crop maturity, especially crop with prolong maturity and harvest periods, there by making pecking and processing operation more economical.(Salunkha et al, 1975). Most of the fungal infections of capsicum start from the broken pedicel. Reclipping the pedicel or dipping either the cut surface or all the fruit in benomyl reduced fruit rotting considerably.(Seymour,et.al.,1980).

CHAPTER III

MATIREALS AND METHODS

3.1 Matireals

Green chilli

Low-density polythene bags

Cold room

Refrigerator

Lamina airflow

Electronic balance

Petridishes

PDA culture media

Auto clave

Glasswares for microbiology test

Colony counter

3.2 Methodes

Varity named as 'Dhelli Hot' were brought from the Kandy market early in the morning and MI-2 and "Arunalu" were harvested from the farm situated near to Dubulla and transported to laboratory of the Food Research Unit, Gannoruwa in the same day. Over maturity pods, diseased pods, physically injured pods, and abnormal shaped pods were discarded. Then the fruits of three varieties were packed in low-density polythene bag (LDPB) as in below

1. 200g of fruits were in 150 gauges sealed LDPB as five replicates in 8^{0}C
2. 200g of fruits were in 150 gauge perforated LDPB as five replicates 8^{0}C
3. 200g of fruits were in 150 gauges sealed LDPB as five replicates in 11^{0}C
4. 200g of fruits were in 150 gauge perforated LDPB as a five replicates 11 ^{0}C

Then observation was taken in four days intervals. Five indexes were used to record

The observations were in three different varieties.

1. Present age of weight loss (moisture loss).
2. VQR (Visual Quality Rating index).
3. Ripening index.
4. Shriveling index.
5. Disease index.

3.2.1 Percentage of weight loss (moisture loss)

Weight loss were measured in three replicate in four days intervals until end of the Storage life of green chilli and got the average of weight loss as percentage of weight loss.

3.2.2 VQR (Visual Quality Rating index)

1=Non-edible, for most discoloration and shriveling (limit of edible).

2=Slightly edible, up to 10% of surface affected.

3=Moderate edible up to 10 % of surface affected limit of edible.

4=Severe, more than 25 % of surface affected.

5=Fair, defects moderate (defects).

6=little more fair, slight defects.

7=Good slightly defects.

8= Better slightly defects.

9= Excellent.

3.2.3 Ripening index

0= 100% green not ripened.

1= 25% of fruits ripened

2=50% of fruits ripened

3= 75% of fruits ripened

4=100% of fruits ripened

3.2.4 Shriveling index

0= None

1= 25% of fruits shriveled.

2= 50% of fruits shriveled.

3= 75% of fruits shriveled.

4= 100 % of fruits shriveled.

3.2.5 Disease index

0= Non.

1 = 25% of fruits diseased

2 = 50% of fruits diseased.

3 = 75% of fruits diseased.

4= 100% of fruits diseased.

3.2.6 Statistically analysis

In the experiment used Randomized complete block design (RCBD). Data analyzed from using analysis of variance.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Result

4.1.1 Percentage of weight loss

Three varieties of green chilli samples stored in 2 different temperatures of 11^{0}C and 8^{0}C in sealed and perforated polythyene bags. Generally weight losses of green chilli stored in perforated polythyene bags were rapid than sealed polythyene bags. For kept samples in in 11^{0}C temperature, refrigerator was used.. So the temperature was fluctuate within 11^{0}C to 20^{0}C so the weight loss of the samples were very high because of the temperature fluctuation. Shelf life of the sealed polythyne bags in 8^{0}C was longer than the perforated bags. From the three varieties, weight loss of the ' Dhelli Hot' variety was lower than the other varieties. Higher weight loss showed in 'Arunalu'

After analysis of data, it shows, probability of variance (pr=0.0001) (see Appendix 5) was lower than 0.05(significant level). That mean temperatures (11^{0}C and 8^{0}C), varieties (Dehlli Hot, Arunalu and MI2), and package types(non perforated and perforated), affected to weight loss of Green chilli pods

From the ANOVA table it can say package types (P=0.0001) (see Appendix 5) and temperatures (P=0.0429)(see Appendix 5) were significant. Weight losses were different y with temperatures and package type

Duncan grouping shows, (See Appendix 5) varieties were not affected to the weight losses (means were not significantly different). But the package type and temperatures effected to weight losses because means were significantly different According to means of two different package types non-perforated package type was the most suitable package for lower the weight loss of green chilli From Duncan grouping means says, 8^{0}C was the best temperature for decrease the weight loss of green chilli

4.1.2 Visual Quality Rating Index (VQR)

VQR was high in samples, which stored in sealed polythyene bags in 8°C. VQR was very low, which stored in 11°C in refrigerator because of the fluctuation of temperature. VQR of 'Dhelli Hot' variety gave excellent quality pods within the storage period about one month. But VQR of MI2 and 'Arunalu' were lower.

According to the analysis of variance, probability (0.0002)(see Appendix 6) was less than significant level (0.05). That mean temperatures (11°C and 8°C), varieties (Dhelli Hot, Arunalu and MI-2), and package types (non perforated and perforated), reduced or increased the Visual Quality of Green chilli pods.

From ANOVA tables, (see Appendix 6) varieties and temperatures were significant and varieties to temperatures interactions also significant. So temperatures and varieties effected to Visual Quality of Green chilli. Variety to temperature interaction says; there was the significantly different samples, or sample.

Duncan grouping says, (see Appendix 6) means of the three varieties were significantly different and (D=Dhelli hot) was the best variety. Package types were not effected to visual Quality (Means were not significantly different). But the Packaged types were affected to the Visual quality of green chilli pod. D(Dehlli Hot) variety was the best . Because the mean was the 'Dheilli Hot'. variety was higher than other varieties. 8°C was given better quality pods end of the storage life.

4.1.5 Diseased Index

Diseased development was very high in sealed polythyene bags than perforated bags. In the 8°C temperature lower the disease development but increased in 11°C temperature. Disease was started in pedicel end, and it was spread to the pod. Soft rot was the main disease of stored green chilies. Disease development was very high in 'Dhelli Hot' variety. Disease development was somewhat low in 'Arunalu' variety. Disease

According to analysis of variance, probability ($p=0.0001$) (see Appendix 9) was lower than then the (significant Level). It says, for the disease development, the temperatures (11°C and 8°C), varieties (Dhehlli Hot, Arunalu and MI2), and package types (non perforated and perforated) were effected.

From the ANOVA table, (see Appendix 9) package types, temperatures, varieties to temperature interaction, package types to temperatures interaction varieties to package types to temperatures interaction were significant. Because probabilities were lower than significant level (0.05). Due to variety and temperature, Package type and temperature, there was a significant different in the samples, and temperature, Variety, and package type also were significantly affected to disease development.

Duncan grouping shows, (see Appendix 9) Means of the three varieties, were not significantly different. But the means of the package types were significantly different. That means, due to package types, shelf life was different. Between two temperatures also had significantly different. Due to temperatures, shelf life may be shorter or longer. According to the means, disease development was lower in perforated bag and 8°C temperature.

Table 4.5.1 Total plate count of green chilli pods in (8^0C temperature).

Variety	Package type	Total plate count (%)
Arunalu	perforated	16,400
Arunalu	non-perforated	11,900
Dhelli hot	perforated	400
Dhelli hot	non-perforated	5,600
MI-2	perforated	14,100
MI-2	non-perforated	2,600

Disease isolation was done end of storage life . First cultured green chilli pieces (mix culture)in PDA media (see Appendix 1). then isolated the individual mold and inoculated as pure culture (see Appendix 2,3,4).

4.2 DISCUSSION

Fruit and vegetables continue respiration and metabolic processes after harvest. These processes are associated with deterioration of product during storage. Several conservation techniques have been used to extend storage life of such agricultural products. (Liotas, 1988). As a supplement of proper temperature management one of the most widely used technique to extend shelf life is modified atmosphere packaging (MAP) (Ben-Yehoshua, 1985; Marcellin, 1974; Weichmann, 1987). MAP relies on respiration of the product and the gas exchange between a package and its surrounding environment, to produce an atmosphere, which enhances product stability. It is relatively low cost and easy to use.

When design a MA system, the aim is to achieve in package an equilibrium at which the particular commodity will be surrounded by its specific optimal atmosphere and relative humidity. Such an equilibrium determined by the following factors; 1). Stage of maturity of commodity and its respiration rate; 2) Storage temperature; 3) Type of film in respect its thickness and permeability to CO_2, O_2 and water vapor, And 4) The ratio between film surface area and fruit volume (or weight) (O'Beire, 1991).

All living organisms convert matter energy a fundamental process of life called respiration. In plant respiration primarily involves the enzymatic oxidation of sugar to CO_2 and water, accompanied by a release of energy. Loss of other reserves of plant, also take place through respiration The post harvest physiologist is concerned with the loss of these products, the need for O_2 and Deposition of CO_2 and energy and above all the area with rate at which this respiration process occurs (Salunkha et al. 1984)

Pepper classified as with high average respiratory intensity having 10-20 mg/Kg /hr CO_2 at 10 °C or 40-80 mg/Kg /hr at 20°C (Buro`.1982)

In practical storage situations, benefits can be obtained by reducing the rate of respiration, prolong the climateric peak, and by maintaining ethylene at low level in the produce. A number of biotechnologies available presently such as storage at low pressures (hypobaric storage), controlled (modified) atmosphere, and use of various chemicals can achieve this (Salunkha et al., 1984)

The ideal packaging material for gas packaging of these products must be able to keep O_2 concentrations with in the package head space, while preventing the build up of high O_2 concentration Packaging film commonly used to achieve such a balance includes LDPE and PVC (Zagory and Kader, 1988).

LDPE Varity accounts for largest proportion of plastic for packaging. It is relatively inert chemically, moderately permeable to water vapor, but highly permeable to O_2 In general, the permeabilities to gas are high, with poor odour barrier characteristics. (Stollman et al. , 1996-1997)

Ethylene is a ripening hormone, produce possibly by all higher plant It is great importance in the post harvest physiology perishable fruit and vegetable. While the acceleration of aging induced by ethylene with respect to fruit ripening is often considered beneficial. It is unquestionably harmful when it result in early senescence of vegetable tissue.(Lipton, 1965)

The detrimental effect of ethylene can be minimized by holding the produce between $0^{0}C$ and $1.1^{0}C$, adequate ventilation, or by forcing the air through the filters of the activated charcoal (brominated) or alkdin $KmnO_4$ (purafil).(Salunkha et aL, 1984).

In addition, although some hot peppers exhibit a climtric-type pattern of ethylene production(Gross et al. 1986) and respond to exogenous ethylene with a climetric-like rise in respiration(Lu et al., 1990).

The slow colour development may instead be related to decreased Water stress.(Lowonds et al. 1994).

In experiment showed, chillies stored in a perforated polythene bag (PPEB) have raced the ripening than sealed polythene bag (SPEB) It may happen due to high CO_2 and high ethylene. But disease development has slowed. Because the RH of the inside package was minimum.

All vegetables continue to lose water through evaporation or transpiration after they are harvested. If water loss or transpiration is not retarded, The produce can rapidly wilted, tough, and mushy and eventually inedible. The vegetable can become inedible, when they have loss between 5-10 % of their weight due to respiration, the exact percentage depending upon their structure(Salunkha et al., 1988.) started that the structure and condition of the vegetable strongly influence the rate of weight loss.Which in tum depend on; 1) Relative humidity and temperature of the storage atmosphere; 2) Air movement; 3) Atmophereric pressure. (Ryall and Lipon, 1965)

It is generally expressed the in fresh vegetable (or fruit) signs of shrivel become objectionable when weight loss reach about 5% of the harvest weight, although reports of shrivel available. The average percent weight loss per day with moderate shrivels for pepper 2.2. Several factors such as surface to volume ratio, nature and structure of surface coating, RH, temperature, movement of air, atmospheric pressure, and mechanical damage, influence the loss of water in the harvested vegetable, resulting in shriveling of the produce. (Salunkha et al., 1984)

Because of the transpiration and respiration amount of water molecules were increased inside of the package. So, RH of the SPEB was increased. This reason may be increased the development of mould growth than PPEB.

When the cuticle layer thickness is high transpiration and respiration become lower. So, weight loss also become lower.

The rate of respiration of vegetables vanes with temperature. The temperature quotient (q_{10}) has been used to study the relative rates of respiration and pereshability of the vegetables. The temperature quotient (q_{10}) named after the Dutch chemist Van't Hoff, states, that the rate of chemical reaction approximately double for each 10^0C rise in temperature.(Salunkha et al., 1984)

Fruit water loss is the result of fruit respiration and diffusion Through the friut cuticle While not measured directly , fruit respiration probably played a minor role in water loss because peppers are non-climacteric (Lu et al., 1990, Saltveit,1977)

Water loss by diffusion is controlled by the water potential gradient from inside to the out side the fruit and by the resistance of diffusion. The water potential gradient would be a function of storage temperature and RH, while diffusional resistances would be associated with the fruit cuticle. Differences in water losses among cultivars at each storage temperature or when packaged would suggest differences in cuticle permeability .These differences were primarily between pepper types and may have been related to fruit maturity or genetic differences such as cuticle thickness; presence of pores or /and cracks ;and epicuticular wax quantity, distribution, or chemistry. Alternatively, the difference due to difference in fruit surface area: volum ratio (Ben-Yehoshua,1997) .

Table 5. 1.Recommended storage condition for green pepper

	Temp(^{0}C)		RH (%)		Storage life (weeks)		H2O water Loss(%)	
	A	B	A	B	A	B	A	B
Green pepper	7.2-10	7.2	95+	85-90	2	3-5	92	7.2

the q_{10} of deterioration for pepper from harvest fresh unsaleble time (table5.1). (Krochta et. al. ,1975)

Due to increased the temperature metabolic rate also increased. So in high temperature (about15-20^{0}C) shelf life of the green chilli become lower. (About12 days). Diseases development was also high with increasing temperature. Because of high temperature flavor the growth of mold.

CHAPTER V

CONCLUTIONS

Modified atmosphere packaging (MPA) and low temperature storage increased the storage life of green chilli. Most suitable temperature was 8°C. Non-perforated package also increased the shelf life of green chilli. From the three 'Dhelli hot' variety gave better quality pods end of the storage duration about one month. After two weeks ago few of non-perforated package became to vacuum condition. This non-perforated vacuum package gave good quality pods and long shelf life.

Weight loss was reduced in low temperature and non-perforated packed. Ripening was increased in perforated package. But ripening was lower in 8° C and ' Dhelli Hot' variety. Treatments used in experiment were not affected to shriveling of green chilli pods. Visual quality was high in non-perforated package and in 8°C temperature. Disease development was high in non-perforated package 11° C.

Soft rot was the most abundant disease in stored green chilli. Stem end rot also could be seen in samples.

Isolation of diseases form green chilli was not success. Because, when the inoculation was done from mix culture to pure culture, mix culture may have been in death phase. the growth of the mould cannot be expected in pure culture.

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APPENDIX

1 Preparation of potato dextrose media (PDA).

Materials

Peeled potato	200g
Dextrose	20g
Agar	25g
Distilled water	1l

Method

Boiled potato cubs were mashed and filtered through the muslin cloth. Then sugar ,dextrose and water were added and auto cleaved for 15 min. at 15 lb/inch2 pressure and poured into petridish aseptically.

2 Isolation of fungi from the green chilli pods.

1). Pods were surfaced sterilized from 95% alcohol.
2). Then 1-2mm pieces were cut from the four levels of the pods and placed in the petridish.
3).After growth of mix culture, mold were inoculated to slide with PDA media.
4)Then examined under microscope.

3 Preparation of ringor solution

8gs of NaCl were measured and dissolved in flask and sterilized.

4 Preparation of the total plate count plate.

100 ml of rigor solution were measured in the flask. Green chilli pods were put in to the flask and mixed well. Then 1 ml of solution were transferred to the pendish After three days reading were taken.

5 Percentage of weight losses
Analysis of Variance Procedure

Dependent Variable: WEIGHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	14951.76521	1359.25138	11.41	0.0001
Error	58	6908.33537	119.10923		
Corrected Total	69	21860.10058			

R-Square	C.V.	Root MSE	WEIGHT Mean
0.683975	5.646622	10.91372	193.278714

Dependent Variable: WEIGHT

Source	DF	Anova SS	Mean Square	F Value	Pr > F
VARIETY	2	305.78774	152.89387	1.28	0.2848
PACKTYPE	1	13307.90184	13307.90184	111.73	0.0001
VARIETY*PACKTYPE	2	78.56629	39.28315	0.33	0.7204
TEMPER	1	510.38652	510.38652	4.29	0.0429
VARIETY*TEMPER	2	190.96553	95.48276	0.80	0.4535
PACKTYPE*TEMPER	1	300.08018	300.08018	2.52	0.1179
VARIETY*PACKTY*TEMPER	2	258.07711	129.03856	1.08	0.3452

Duncan Grouping	Mean	N	VARIETY
A	195.920	24	mi2
A			
A	192.909	24	a
A			
A	190.801	22	d

Duncan Grouping	Mean	N	PACKTYPE
A	207.067	35	c
B	179.491	35	p

Duncan Grouping	Mean	N	TEMPER
A	195.229	46	8
B	189.540	24	11

6 Visual Quality Rating

Analysis of Variance Procedure

Dependent Variable: VQR

		Sum of	Mean		
Source	DF	Squares	Square	F Value	Pr > F
Mode	11	109.5780342	9.9616395	4.08	0.0002
Error	61	148.7795000	2.4390082		
Corrected Total	72	258.3575342			

R-Square	C.V.	Root MSE	VQR Mean
0.424133	21.19473	1.561732	7.36849315

Dependent Variable: VQR

Source	DF	Anova SS	Mean Square	F Value	Pr > F
VARIETY	2	49.60836758	24.80418379	10.17	0.0002
PACKTYPE	1	2.36258680	2.36258680	0.97	0.3289
VARIETY*PACKTYPE	2	5.82933628	2.91466814	1.20	0.3097
TEMPER	1	13.16753425	13.16753425	5.40	0.0235
VARIETY*TEMPER	2	27.46413242	13.73206621	5.63	0.0057
PACKTYPE*TEMPER	1	1.01824653	1.01824653	0.42	0.5206
VARIETY*PACKTY*TEMPER	2	10.12783039	5.06391519	2.08	0.1342

Duncan Grouping	Mean	N	VARITY
A	8.229	24	d
A			
A	7.620	25	mi2
B	6.246	24	a

Duncan Grouping	Mean	N	PACKTYPE
A	7.546	37	c
A			
A	7.186	36	p

Duncan Grouping	Mean	N	TEMPER
A	7.675	48	8
B	6.780	25	11

7 Ripening index

Analysis of Variance Procedure

Dependent Variable: RIPE

		Sum of	Mean		
Source	DF	Squares	Square	F Value	Pr > F
Model	11	36.07382778	3.27943889	7.04	0.0001
Error	60	27.93963750	0.46566063		
Corrected Total	71	64.01346528			

R-Square	C.V.	Root MSE	RIPE Mean
0.563535	122.2501	0.682393	0.55819444

Dependent Variable: RIPE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
VARIETY	2	7.64880278	3.82440139	8.21	0.0007
PACKTYPE	1	14.86033472	14.86033472	31.91	0.0001
VARIETY*PACKTYPE	2	6.18796944	3.09398472	6.64	0.0025
TEMPER	1	4.30908403	4.30908403	9.25	0.0035
VARIETY*TEMPER	2	0.01210972	0.00605486	0.01	0.9871
PACKTYPE*TEMPER	1	2.88716736	2.88716736	6.20	0.0156
VARIETY*PACKTY*TEMPER	2	0.16835972	0.08417986	0.18	0.8351

Duncan Grouping	Mean	N	VARIETY
A	0.978	24	a
B	0.513	24	mi2
B			
B	0.183	24	d

Duncan Grouping	Mean	N	PACKTYPE
A	1.012	36	p
B	0.104	36	c

Duncan Grouping	Mean	N	TEMPER
A	0.904	24	11
B	0.385	48	8

8 Shriveling index

Analysis of Variance Procedure

Dependent Variable: SHRIVEL

		Sum of	Mean		
Source	DF	Squares	Square	F Value	Pr > F
Model	11	0.89906956	0.08173360	1.52	0.1461
Error	61	3.27064688	0.05361716		
Corrected Total	72	4.16971644			

R-Square	C.V.	Root MSE	SHRIVEL Mean
0.215619	383.7327	0.231554	0.06034247

Dependent Variable: SHRIVEL

Source	DF	Anova SS	Mean Square	F Value	Pr > F
VARIETY	2	0.25727581	0.12863791	2.40	0.0993
PACKTYPE	1	0.08327472	0.08327472	1.55	0.2174
VARIETY*PACKTYPE	2	0.04230966	0.02115483	0.39	0.6757
TEMPER	1	0.24125446	0.24125446	4.50	0.0380
VARIETY*TEMPER	2	0.17921134	0.08960567	1.67	0.1965
PACKTYPE*TEMPER	1	0.04154472	0.04154472	0.77	0.3822
VARIETY*PACKTY*TEMPER	2	0.05419886	0.02709943	0.51	0.6058

Duncan Grouping		Mean	N	VARIETY
	A	0.1419	24	a
	A			
B	A	0.0400	25	mi2
B				
B		0.0000	24	d

Duncan Grouping	Mean	N	PACKTYPE
A	0.0946	36	p
A			
A	0.0270	37	c

Duncan Grouping	Mean	N	TEMPER
A	0.1400	25	11
B	0.0189	48	8

9 Disease index

Analysis of Variance Procedure

Dependent Variable: DISEASE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	1. 79364726	0.16305884	4.94	0 0001
Error	61	2.01375000	0.03301230		
Corrected Total	72	3.80739726			

R-Square	C.V.	Root MSE	DISEASE Mean
0.471095	282.2038	0.181693	0 08438356

Dependent Variable: DISEASE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
VARIETY	2	0.15281393	0.07640696	2.31	0.1074
PACKTYPE	1	0.20157143	0.20157143	6.11	0.0163
VARIETY*PACKTYPE	2	0.07076831	0.03538415	1.07	0.3487
TEMPER	1	0.40820559	0.40820559	12.37	0.0008
VARIETY*TEMPER	2	0.46561385	0.23280693	7.05	0.0018
PACKTYPE*TEMPER	1	0.22213946	0.22213946	6.73	0.0119
VARIETY*PACKTY*TEMPER	2	0.27253468	0.13626734	4.13	0.0208

Duncan Grouping	Mean	N	VARIETY
A	0.1292	24	d
A			
A	0.0400	25	mi2
A			
A	0.0250	24	a

Duncan Grouping	Mean	N	PACKTYPE
A	0.1162	37	c
B	0.0111	36	p

Duncan Grouping	Mean	N	TEMPER
A	0.1680	25	11
B	0.0104	48	8