

Influence of herbal extract and storage duration on fruit quality of china lime

Abstract

Thin edible organic coating helped to improve the fruit quality and are consumable without any side effects on health. China lime has good market value both at national and international level. The objective of the work was to study the Influence of herbal extracts and storage duration on fruit quality of china lime. An experiment was conducted at the Post Harvest Laboratory, Department of Horticulture, The University of Agriculture Peshawar during the year 2015-2016. The research was carried out by using Completely Randomized Design (CRD) with two factors repeated three times. The fruits of china lime were treated with various herbal extracts like ginger, garlic, lemon grass and chilli and stored for 40 days at temperature 20±10C with relative humidity 45-50%. The treated fruits of china lime were analyzed for various physico-chemical attributes at 0, 10, 20, 30, and 40 days intervals. The post-harvest application of herbal extracts and storage durations significantly influenced most of qualitative. A significant variation was recorded for various quality attributes when treated the china lime fruit with herbal extracts. However, less percent weight loss (20.79%), fruit juice pH (2.75), TSS (5.880Brix), and maximum fruit firmness (1.51kgcm⁻²), percent titratable acidity (6.01%), ascorbic acid contents (16.86 mg 100 ml⁻¹), was recorded in fruits treated with garlic extracts. While, concerning storage duration, all the variables studied showed a significant difference after studying there physical-chemical characteristics. It is concluded from the significant findings of present research that the china lime fruits should be treated with garlic extract and stored for 30 days to retain most of the quality attributes. It was concluded that post harvest treatments of herbal extract were more effective to maintain the quality attributes of china lime fruits in order to retain the maximum physical-chemical characteristics of china lime fruits. The fruit could be treated with garlic extract in order to store for 30 days at room temperature 20±10C with relative humidity of 45-50% to maintain the quality attributes.

Keywords: citrus, *Citrus aurantifolia*, edible coating, organic agriculture, shelf life

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Introduction

Citrus is non climacteric fruit and had greater shelf life as compared to climacteric fruits. In citrus fruits during maturity and ripening stage the composition of ethylene and respiration are not varied as like in climacteric fruits. Citrus fruits might have some post harvest physiological problems if not handled and stored appropriately. Weight loss and some physiological disorders are the major problems of citrus which not only cause quantitative losses but it also result qualitative problems such as softening, shriveling and wilting. Among these water loss is considered as the most important physiological disorder.¹

Among citrus crops, China lime '*Citrus aurantifolia*' is the third crucial species after orange and mandarin² family belongs to Rutaceae and citrus genus with sub family Aurantioideae. Citrus includes those fruits which contain enough quantity of citric acid and hence, classified as acid fruits. The citrus is medium evergreen tree having different size and shapes of fruits containing fragrance, juice and flavour. The skin of fruit is rough and bright, it prevents fruit from external injuries.³

Shelf life of food means the useful storage life and for any food, it is an essential property. In food chain shelf life has a great importance to everybody from producer up to consumer.⁴ Characteristic changes develop in food at the end of shelf life in aroma, taste, appearance or

texture which are considered undesirable or unacceptable.⁵ Basically these changes might be due to the chemical reactions such as, oxidation microbial and biochemical changes during storage. These reactions resulted from reactions catalyzed by endogenous enzymes and eventually lead to enzymatic browning, proteolysis and lipolysis.⁶

Various diseases and pest caused damages to citrus fruit during growth, harvesting, packing, transportation, marketing and storage (Ajibola et al., 2009). In food spoilage and deterioration, fungi are the main cause worldwide, which ranked second position to insect.⁷ To reduce these losses from infestation of potential or actual insects and fungal diseases, various chemical and physical preservation practices were performed to avoid food spoilage and deterioration. One of the phytosanitary practices for citrus fruits is cold storage especially when delivering fruits from detrimental insect pest harboring areas.⁸ But on the other hand cold sterilization may cause chilling injury especially in china lime.⁹

China lime is the second most sensitive citrus crop to chilling injury.¹⁰ Citrus fruits are susceptible to chilling injury since; originated from subtropical climate.¹¹ On the Flavedo surface chilling injury cause pitting and exhibit a lesion with dark color and sunken nature¹¹ which adversely affect the post-harvest quality of china lime, hence, the marketable value ultimately reduced.¹² While the chemical treatments may cause hazardous effect on citrus consumer for long term. In consumer the awareness regarding the impact of chemical

preservative is recently increased and people changed their mind to use natural preservative or additives in food product instead of chemicals.¹³

It is admirable to know that the use of medicinal herb (plants have phytochemicals) has begun to increase and become more popular in present situation. Nowadays, some of the food ingredients such as ginger, garlic and lemon grass are using for their medicinal values like antioxidant and antimicrobial properties.¹⁴ Garlic and ginger extracts has the capability to inhibit the growth of various bacteria and fungi.¹⁵ The phytochemical compound of garlic are allicin, diallyl disulphate and thiosulphuric acid which inhibit the growth of microbes.¹⁶ Gingerol, zingiberol, paradole, bisabolene and zingiberine are phenolic compounds produce by ginger.¹⁷ These compounds are responsible for both the anti-fungal and antibacterial activity of garlic and ginger.⁶ Therefore, the current study aiming to control the post-harvest losses of china lime fruits with natural additive and avoid the use of injurious chemicals. The research has objective, to determine the appropriate herbal extract in order to maintain better fruit quality of china lime during storage and optimum storage duration for china lime fruits with herbal preservatives.

Materials and methods

Evaluation of herbal extracts and storage duration on fruit quality of china lime was carried out at Post Harvest Laboratory, De *Citrus aurantifolia* partment of Horticulture, The University of Agriculture Peshawar during the year 2015-2016 at room temperature of (20±1°C) with relative humidity of 45-50%. The experiment was carried out by using Completely Randomized Design (CRD) with two factors. For analyzing various qualitative attributes, three randomly selected fruits of each treatment were tested in post harvest laboratory.

The extraction process was carried out in the Laboratory of Weed Science Department, The University of Agriculture Peshawar. Leaves of lemon grass, garlic cloves, ginger corms and chili fruits were used to obtain extract. The leaves, cloves, corms and fruits were washed with running water in order to get rid of dirt and then dehydrated overnight in the laboratory electric oven at 70°C. After drying each was then crushed individually by using grinder in order to make powdered. This was further preserved in glass bottles for future use.¹⁸

From already prepared herbal powder 50 g of each was dissolved in 450 ml distilled water in order to make 10 percent solution (w/v).¹⁹ The solution was kept for 24 hours in a beaker.²⁰ After 24 hours the fruits were dipped in the required solution and let them for 10

minutes. The treated fruits were then air dried and stored according to the experiment. The experiment was consisted of 25 treatments and for each treatment 10 fruits were treated with three replication. Therefore, a total of 750 fruits were used in the experiment.

The experiment was carried out by using Completely Randomized Design (CRD) with two factors. For analyzing various qualitative attributes, three randomly selected fruits of each treatment were tested in post harvest laboratory. The observations were recorded on first day of storage and then subsequently after 10 day's intervals till the end of experiment (up to 40 days of storage). The two factors were Water (control), Garlic, Ginger, Chili, Lemon grass) and evaluated at storage interval of 10, 20, 30 and 40 days.

The variables studied were, Percent weight loss, fruit firmness (kgcm⁻²) by using penetrometer (Wagner fruit firmness tester model FT-327) equipped with 8 mm tip, Juice contents (%) juice contents were extracted and weighed and data were recorded in grams, pH using electronic pH meter (Inolab Level-1), Percent titratable acidity was determined as per the procedure described by Ranganna (1986), Total soluble solid (°Brix) measured with the help of refractometer (Karnco, instruments co.texas), Ascorbic acid content (mg 100ml⁻¹) was calculated as mg/100 ml juice.

Results and discussion

Percent weight loss

The percent weight loss of china lime (Table 1) reveal that the application of herbal extract and storage duration significantly influenced. Fruits coated with garlic extract proved to be better in reducing the percent weight loss (20.79%) up to minimum level which was statistically similar with the weight loss (25.75%) recorded in fruits coated with ginger extract. storage duration data showed that weight loss increased with increase in storage duration from 9.08% to 46.61% from 10days to 40days respectively. Weight loss in citrus are the major problems of citrus which not only cause quantitative losses but it also result qualitative problems such as softening, shriveling and wilting.¹ Thin edible coating like herbal of organic origin helped to improve the fruit quality and are eaten without any side effects on health²¹ They worked efficiently against exterior constituents, reducing water losses, gas exchange aroma, flavor and solute passage towards cuticle.²² The weight loss was lower in fruits treated with garlic extracts.²¹ Therefore weight loss can be control up to certain level by treating the fruits with herbal extracts like garlic and ginger.

Table 1 Influence of herbal extract and storage durations on weight loss of china lime fruits

Herbal extracts	Storage durations (days)				Mean
	10	20	30	40	
Control	14.00	29.00	40.00	52.00	33.75 a
Ginger	7.00	20.00	32.00	44.00	25.75 bc
Garlic	5.00	14.05	26.05	38.05	20.79 c
Lemon grass	9.42	25.00	37.00	49.00	30.10 ab
Chilli	10.00	26.00	38.00	50.00	31.00 ab
Mean	9.08d	22.81c	34.61b	46.61a	

LSD_α 0.05 for extract (E)=7.2020 and storage durations (SD)= 6.4417 with mean followed by different letters are significantly different at 5% level of significance.

Fruit firmness (kgcm⁻²)

The data pertaining to fruit firmness (Table 2) that there is significant difference for herbal extracts and storage durations on fruit firmness of china lime during storage. The fruits treated with garlic extract, ginger and chili maintain fruit firmness, 1.51 kgcm⁻², 1.48 kg cm⁻² and 1.46 kgcm⁻² respectively. The data regarding storage duration showed that firmness was significantly decreased with increase in storage duration. The minimum fruit firmness (1.29 kgcm⁻²) was recorded in

fruits stored for 40 days, followed by fruit firmness (1.36 kgcm⁻²) and (1.42 kgcm⁻²) in fruits stored for 20 and 30 days respectively. The fruits during storage loss stability of cell wall due to collapse of pectin as a result the TSS increased and firmness decreased.²³ The firmness was maximum when fruits like oranges; persimmon treated with garlic extracts.²⁴ The aqueous extract of garlic delay the process of ripening, retain firmness for longer time and boost resistance against disorders of storage.²⁵

Table 2 Fruit firmness, Juice content, pH, Titratable acidity, influence by herbal extract and storage durations of china lime fruits

Herbal extracts	Fruit firmness	Juice content	pH	Titrateable acidity
Control	1.35 b	30.1 b	2.96 ab	5.80 c
Ginger	1.49 a	36.8 a	2.74 c	5.96 ab
Garlic	1.51 a	38.3 a	2.75 c	6.01 a
Lemon Grass	1.35 b	31.2 b	2.93 b	5.84 bc
Chilli	1.47 a	35.4 a	2.85 a	5.94 ab
F	4.66*	10.93*	21.91*	3.22*
Storage Duration (Days)				
0	1.62a	37.86 a	2.31 d	6.30 a
10	1.49b	36.24 a	2.50 d	6.03 b
20	1.43bc	35.41 a	2.90 c	5.86 c
30	1.36cd	32.13 b	3.16 b	5.68 d
40	1.28d	30.06 b	3.35 a	5.67 d
F	11.69*	8.64*	195.50*	31.29*
F (v x c)	0.77ns	1.31ns	11.99 ns	1.32ns
CV	0.099	3.070	0.173	0.134

Means followed by the same letter are not significantly different at 5% level of significance by LSD test. ns= non significant and *=Significant at 5% level of significance.

Percent juice content

Herbal extract had significant effect on retaining maximum juice content. The maximum juice content 38.3% and 36.8% was recorded in fruits coated with garlic and ginger extract respectively, while minimum juice content was noticed in fruits coated with lemon grass extract and control fruits. The data regarding storage duration revealed that with the increase in storage time a significant decrease in juice content was noticed in china lime fruits. Fruit juice content (37.86%), observed in fresh fruits, which decreased to (30.66%) in fruits stored for 40 days.

The citrus fruit quality depends on many factors, percent juice content was also one of the major characters of citrus fruits. The quality of juice was an essential economic feature in citrus industry. The citrus juice is based on sugar content, which is the main economic factor for processing industry, 95% citrus crops are further processes over to make different drinks.²⁶ The fruit juice content decreased with increase in storage duration and similarly the finding of Sonkar et al.²⁷

and Yadav et al.²⁸ were also in agreement with current research. Garlic extracts has the potential to retain maximum juice content in fruits during storage since, it has essential oil^{29,30} which act like a barrier to moisture loss during storage.³¹

Fruit juice pH

The mean data of table exhibited that the untreated fruits (control) and fruits treated with lemon grass extracts resulted the maximum fruit juice pH 2.96 and 2.92 respectively. While the lowest fruit juice pH 2.74 and 2.75 was recorded in fruits treated with ginger and garlic extracts. The data concerning the storage duration a significant increase was found in fruit juice pH with increase in storage duration from pH 2.31 to 3.35 pH in fruits stored 40 days. The china lime fruits with lower pH are consider excellent as, the lower juice pH indicate high acidity which is one of the major qualitative attributes of the china lime juice. However, according to the current research, the fruit pH value of china lime fruit increased with increase in storage duration and among herbal extracts garlic was found best in terms

of maintaining the juice pH throughout the 40 days storage duration. The present results are in agreement with the findings of Jadhao et al.³² and Yadav et al.³³ who conducted research on lime and mandarin respectively.

Titratable acidity

Titratable acidity (6.01%) was recorded higher in fruits treated with garlic extracts and lower titratable acidity (5.80%) was recorded in the juice of untreated fruits (control). In case of storage durations a significant decrease was recorded in titratable acidity with storage durations. Mean data express that the minimum titratable acidity (5.67%) was recorded in the fruits stored for 40 days whereas lower were noted in fresh fruits (control).

In citrus fruits titratable acidity is one of the prime important qualitative features for the reason that sourness is a most vital aspect in china lime acceptability. Acid furnish the quality of tartness to the produce. In china lime juice citric acid is the main acid which develop the flavor.³⁴

Generally acidity level decline during ripening because the metabolism of citric acid occur which is the main organic acid of citrus.³⁵ Therefore, the titratable acidity level in ripen fruits are usually lower than the acids in half ripen and mature green fruits during storage. The findings of other scientist were reviewed which support the current study. The reduction in titratable acidity during storage of Valencia orange was observed by Dorria et al.³⁶ Furthermore, the decline in acidity during storage with increase in maturity could be due to enhancement of sugar substance in fruits which suppose to boost respiratory action during storage in citrus fruits.³⁷ This decrease in titratable acidity during storage makes fruits lesser acidic thus it can be more suitable for consumption due to taste. While in contrast the acidity of fruits decreased by treating with garlic extracts which is not in lined with current results.^{25,38}

Total soluble solids (^oBrix)

The total soluble solids content of china lime fruits is significantly affected by post-harvest treatment of herbal extracts and storage

duration. Mean data (Table 3) showed that maximum TSS (6.44^oBrix) was recorded in untreated fruits (control fruits), while the lower TSS was noted in fruits treated with garlic extract and ginger extracts. With increasing storage duration a significant increase was observed in total soluble solids of china lime fruits. TSS (5.11 ^oBrix) in untreated fruits stored for 10days was higher (6.55^oBrix) in fruits stored for 40 days.

TSS designates concentration of sugar and amount of soluble components in the flesh, with increase in storage duration the sugar and other components of flesh degraded or distorted. During storage TSS retained by controlling water loss.¹⁸ The increase in total soluble solids of citrus fruits occurs because the organic acid slowly decline with expansion in the storage duration.³⁷ The fact about the increase in total soluble solids was accompanied by raise in sucrose amount and decrease in acid level during storage or may be the reason due to which TSS increase is the glucogenesis, the alteration of organic acid to sugar.³⁹ All these statements strongly support our current findings and many other researchers are also in lined with our results such as Rapisarda et al.⁴⁰ and Ye et al.⁴¹ conducted research works on mandarin storage and found that TSS is increasing with passage of time in mandarin.

Ascorbic acid content (mg.100ml⁻¹)

The mean data for ascorbic acid (Table 3) showed that maximum (16.86 mg 100 ml⁻¹) was recorded in the fruits treated with garlic extracts, followed by ginger extract (15.86 mg 100 ml⁻¹). Whereas minimum ascorbic acids (12.32 mg 100ml⁻¹) were observed in untreated fruits. Regarding storage duration the ascorbic acid contents significantly decreased with increase in storage duration. Ascorbic acids were found maximum (18.7 mg 100 ml⁻¹) in fresh fruits, with lower ascorbic acid (12.12 mg 100ml⁻¹) in 40 days storage. In early green fruits the ascorbic acid is in high amount with the passage of time in late fruits the amount of vit C goes to decline (Davey et al, 2000). The decline in vit C is due to increase in pH.⁴² The decline in ascorbic acid during storage of citrus fruit was due to oxidation process.⁴² The maximum ascorbic acid was maintained in fruits treated with garlic and ginger extracts. Since, there is essential oil in garlic and ginger.^{29,30}

Table 3 Total soluble solids, Ascorbic acid and Disease incidence and influence by herbal extract and storage durations of china lime fruits

Herbal extracts	Titratable acidity	Total soluble solids	Ascorbic acid
Control	5.80 c	6.44 a	12.32 d
Ginger	5.96 ab	5.91 bc	15.86 b
Garlic	6.01 a	5.88 c	16.86 a
Lemon Grass	5.84 bc	6.17 b	14.44 c
Chilli	5.94 ab	5.99 bc	15.44 b
F	3.22*	5.80*	23.83*
Storage Duration (Days)			
0	6.30 a	5.11 c	18.7 a
10	6.03 b	6.15 b	16.12b
20	5.86 c	6.26 ab	14.5 c
30	5.68 d	6.32ab	13.48c
40	5.67 d	6.55 a	12.12d
F	31.29*	33.50*	50.73*
F (v x c)	1.32ns	1.28 ns	2.64 ns
CV	0.134	0.275	2.2682

Means followed by the same letter are not significantly different at 5% level of significance by LSD test. ns= non significant and * = Significant at 5% level of significance

It was concluded that post harvest treatments of herbal extract were more effective to maintain the quality attributes of china lime fruits in order to retain the maximum physical-chemical characteristics of china lime fruits. The fruit could be treated with garlic extract in order to store for 30 days at room temperature 20±1°C with relative humidity of 45-50% to maintain the quality attributes.

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None.

Conflicts of interest

Authors declare that there is no conflict of interest.

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