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Studies on Ambient Storage of Lime Juice Concentrate Packed in Sachet

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ABSTRACT

Lime is one of the important citrus fruits and due to its acidic nature, cannot be consumed fresh. In industry, lime juice concentrate has a big role. Lime juice was concentrated with 300, 400 and 500 g/l (GPL) citric acid concentration by heating in thin film evaporator at 60°C and 610 mm of Hg vacuum for about 90-180 minutes according to concentration levels. Subsequently, Potassium Meta-Bisulphate (0, 50 and 100 ppm) was added as preservative. Sugar syrup (50, 60 and 70 ^{0}Brix) was also added along with 1 per cent salt to enhance the taste. The prepared lime juice concentrate was packed in sachet and stored at room temperature for 3m for its shelf life. During storage, physicochemical parameters of stored lime juice concentrate such as total soluble solids, titrable acidity, total sugar, reducing sugar, non-reducing sugar, ascorbic acid, browning and pH as well as microbial analysis in terms of total plate count and sensory analysis were determined for every 15d interval. Maximum storability and consumer acceptance of prepared lime juice concentrate were found better using level of concentration (500 GPL), preservative (100ppm) and sugar syrup (70 ^{0}Brix) and can be stored up to 3m at ambient temperature in sachet.

Key Words: Lime juice concentrate, Physicochemical parameters, Sensory analysis, Sachet.

INTRODUCTION

Lime (*Citrus aurantifolia* L.) is one of the important citrus fruits appreciably not only for its beautiful appearance and pleasing flavor but also for its excellent food qualities. India ranks first in the world in lime production (Anonymous, 2011). Lime or lemon fruit is available in the market almost round the year. The lime fruit is utilized in many ways. It contains nearly 50 per cent juice and rest portion goes waste, whereas, the waste portion includes albedo (34%), flavedo (20%), seed (2%) and rang (24%). The juice can be utilized for beverage making. Lime is highly sensible to refrigeration, freezing, ethylene and odour. Lime fruits, due to its acidic nature are not consumed fresh but its juice is diluted to lemonades/sherbets for consumption. Lime is used for seasoning of various culinary preparations, salad and for making pickles. It is also used in alcoholic /non-alcoholic beverages. Lime juice finds use as a mouthwash and as a natural cosmetic for external applications (hair rinse, skin lotion). The various value added products that can be possibly manufactured from lime are juice, juice concentrate, powder, squash, cordial/barley water, Ready to Serve (RTS) beverage, Ca citrate, Na citrate, citric acid, peel oil and wet peels (dry peels and pection-150 grade). Lime pieces are preserved in brine (common salt solution) and packed in food grade plastic containers (drums/barrels) for subsequent conversion into pickles and chutneys. The peel finds use in production of marmalade, candied, brined or dried peel, bioflavonoid and peel seasoning. Lemon, considered as commonly used citrus fruit (Cautela, 2010, Peng, 2017). If its juice is concentrated and packed in a consumer pack then it makes it more valuable, available throughout the year, easily transportation and better storage. In market as well as in processing industry, lime juice concentrate has a big role for different purposes (Erdal *et al,* 2018).

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The concentration of fruit juices is industrially performed in order to reduce storage, packaging, handling and shipping costs. Concentration results in a reduction in the cost of package, shipping and storage. Sachet, as involves a small quantity, economic and readily available, more in demand particularly as retail pouch. The sachet is having attractive packaging, ease of storing and can be kept easily while travelling and working. It is also useful in food processing sectors for retail consumption. Also, Sachets have an appealing outer appearance but also protect the product through tight pouch seals and high quality materials (Raut *et al*, 2008). In the present study, lime juice was concentrated followed by bio-chemical and sensory analysis, and then stored in sachet for shelf-life study.

MATERIALS AND METHODS

The experiment followed the sequence of processes *viz.,* harvesting of lime fruits, selection and preparation of samples, extraction and straining of juice, concentration of lime fruit juice, addition of preservative, sugar syrup and salt, packing of concentrated lime fruit juice in sachet and storage of sachet under ambient condition.

Experimental details

The uniform and fully matured yellow coloured fresh lime fruits of cv. *Kagzi Lime* were manually harvested from the nearby orchards. Details of various factors such as concentration, preservative and sugar syrup and their level are depicted in the table 1. The experimental flow chart is shown in figure 1.

This acidity represented in Gram per Liter (GPL) concentration of citric acid present in the fresh lime juice. Therefore, for the preparation of 300, 400 and 500 GPL lime juice, the amount of the lime juice to be evaporated and the final volume from one liter of fresh lime juice, respectively was calculated (Petruzzi *et al*, 2017; Maldonado *et al*, 2008).

Addition of preservative, sugar syrup and salt

Potassium Meta-Bisulphate (KMS)

Three levels of KMS as 0, 50 and 100 ppm concentrations were decided. Accordingly, 0, 0.75 and 1.5 mg of KMS was weighed and dissolved in the 15 ml of lime juice concentrate, respectively as per treatment combinations.

Table 1. Details of Treatments.

No.	Details of various factors		Factors and their levels	
1	A)	First factor's name and levels		Concentration (C) with three levels
			i)	C_1 = Concentration at 300GPL
			ii)	C_2= Concentration at 400GPL
			iii)	C_3 = Concentration at 500GPL
	B)	**Second factor's name and levels**		Preservative (P) with three levels
			i)	P_1 = 0 ppm KMS
			ii)	P_2 = 50 ppm KMS
			iii)	P_3 = 100 ppm KMS
	C)	**Third factor's name and levels**		Sugar syrup (S) with three levels
			i)	S_1 = 50 ^{O}Brix
			ii)	S_2 = 60 ^{O}Brix
			iii)	S_3 = 70 ^{O}Brix
2		Total treatment combinations		Twenty Seven (27)
3		Number of replication		Two

Fresh lime fruit
↓
Washing
↓
Sorting
↓
Cutting into halves
↓
Extraction of juice
↓
Pressed juice
↓
Straining
↓
Vacuum concentration
(60° C at 610 mm of hg of vacuum in Thin Film Evaporator)
↓
Addition of ingredient (Sugar syrup, preservative-PMS and salt)
↓
Lime juice concentrate (50°B, 60°B & 70°B)
↓
Fill and Seal in Sachet (15ml/pouch)

Fig. 1 Flow sheet for preparation of lime juice concentrates sachets

Sugar solution (^{0}Brix)

As decided sugar syrup was prepared using burner available in the laboratory and added into the concentrated just adequate to obtain 50, 60 and 70 ^{0}Brix. The ^{0}Brix was measured by using hand refractrometer.

Salt solution (%)

To enhance the taste 1 percent salt was added in all the samples irrespective of treatments.

Packing of concentrated lime fruit juice in sachet

The treated lime juice concentrate was packed in Aluminum coated sachet having width of 6 cm and height 8 cm. The volume of concentrate in each sachet was kept as 15 ml. The aluminum coated sachets of three sides sealed.

Storage of sachet under ambient condition

The prepared sachet with 15 ml lime juice concentrate was than packed in a corrugated box and stored under room temperature for 3 m. During storage the observations on biochemical parameters, sensory score and microbial status were recorded at 15 d interval. Moreover, during the experiment period, the meteorological observations in terms of maximum and minimum temperature and relative humidity on daily basis were also recorded

Observations recorded during storage

Biochemical parameters of lime juice concentrate

Total soluble solids (%) - Total soluble solids of stored concentrated lime fruit juice packed sachet was recorded by using Hand Refractometer.

Acidity (%) - The method as reported by Ranganna (1979) was adopted.

Total sugar (%) - The percentage of total sugar was expressed as invert sugar and was calculated by using following formula.

$$\text{Total Sugar (\%)} = \frac{\text{Glucose equivalent} \times (0.05) \times \text{Total volume made up} \times \text{Volume made up after inversion}}{\text{Titre} \times \text{Volume of sample} \times \text{Aliquot taken for inversion}} \times 100$$

Reducing sugar (%), non-reducing sugar (%) and Ascorbic acid (mg/100 ml of juice) were determined as per method given by Ranganna (1979).

Browning - Browning was scientifically observed by taking transmittance of the solution in Systonic spectrophotometer.

pH - The pH of stored lime fruit concentrated juice was measured by dissolving the juice of sample in distilled water in 1:2.5 (juice:water) ratio and kept for 4hr.

Sensory evaluation of stored lime juice concentrate

The lime juice stored under different treatments was evaluated for sensory characteristics viz., color, aroma, taste and flavor by using Hedonic scale. Each attribute was given a separate score of 10 points.

Microbial analysis of stored lime juice concentrate

The stored lime juice concentrate was subjected to microbial analysis for total viable count using Nutrient agar for bacterial analysis and Potato dextrose agar for fungus analysis as per the standard procedure given by Ranganna (1979).

Preparation of dilutions

Sample of one gram was aseptically taken into a sterilized glass test tube and transferred to 9 ml sterile phosphate buffer dilution blank to obtain 1:10 dilution. Subsequently, 0.1 ml of above prepared dilution was used for making further dilutions in 9.9 ml phosphate buffer tubes. Suitable dilutions were prepared and poured in a set of sterile petri plates in duplicates.

Total viable count

One ml of suitable dilution from each sample prepared and was used for plating in duplicates and thereafter 15 ml of molten Nutrient Agar was poured aseptically to plates. The contents were mixed and plates were cooled. The plates then were inverted and incubated in an incubator, maintained at 37±0.5 °C for 24 hour and number of colony forming units (CFU/g) was recorded at regular interval. The experiment was laid out in a Factorial Completely Randomized Design.

RESULTS AND DISCUSSION

Biochemical composition of prepared lime juice concentrates

The parameters *viz.,* TSS (^{0}Brix), acidity (%), total sugar (%), reducing sugar (%), non-reducing sugar (%), ascorbic acid (mg/100 ml), browning and pH of prepared lime juice concentrate were determined by the procedures as above. The prepared sachets were shown in Figure 2.

Fig. 2 Prepared sachets of lime juice concentrate

Effect of different concentration levels, preservative levels and sugar syrup levels on bio-chemical compositions of lime juice concentrate

Total soluble solids (^{0}Brix)

The maximum TSS was observed at the concentration level C_1 followed by C_2 and C_3 during 3 m storage period at room temperature when packed in sachet. While in case of preservatives levels, the maximum TSS was observed in the treatment with P_1 followed by P_2 and P_3 levels during three month storage period under the room temperature and packed in sachet. Whereas for sugar syrup levels, the maximum TSS was observed in S_3 samples followed by S_2 and S_1 levels showing significantly higher results throughout the storage period.

Acidity (%)

The maximum acidity was observed at concentration level C_3 followed by C_2 and C_1 during three month storage period under storing at room temperature in sachet. In case levels of preservatives, the maximum acidity was observed at level P_1 followed by P_2 and P_3 levels during

entire three month storage period in sachet at room temperature. While for sugar syrup levels, the maximum acidity was observed at level S_1 followed by S_2 and S_3 levels showed significantly higher results throughout the storage period.

Total sugar (%)

The maximum total sugar was observed at concentration level C_3 followed by C_2 and C_1 during 3 m storage period in lime juice concentrate packed in sachet and stored at room temperature. In case of preservative levels P_1, P_2 and P_3 was observed non-significant during three month storage period. The maximum total sugar was observed at sugar syrup level S_3 followed by S_2 and S_1, showing significantly higher results throughout the storage period in sachet at room temperature.

Reducing sugar (%)

The maximum reducing sugar was observed at concentration level C_1 followed by C_2 and C_3 during 3 m storage period in sachet at room temperature. In case of preservative levels P_1, P_2 and P_3, the non-significant change was observed during three month storage period in sachet at room temperature. The maximum reducing sugar was observed at sugar syrup levels S_3 followed by S_2 and S_1 showing significantly higher results throughout the storage period.

Non reducing sugar (%)

The maximum non-reducing sugar was observed at concentration level C_1 followed by C_2 and C_3 during 3 m storage period at room temperature in sachets. The preservative levels P_1, P_2 and P_3 were observed non-significant during three month storage period in sachet at room temperature. The maximum non-reducing sugar was observed at sugar syrup level S_3 followed by S_2 and S_1 showing significantly higher results throughout the storage period in sachet at room temperature.

Ascorbic acid (mg/100ml)

The maximum ascorbic acid was found at concentration level C_1 followed by C_2 and C_3 during 3 m storage period in sachet at room temperature. In case of preservative levels, maximum ascorbic acid was observed at preservative level P_3 followed by P_2 and P_1 during 3 m storage period. While the maximum ascorbic acid was observed at sugar syrup level S_1 followed by S_2 and S_3 showing significantly higher results throughout the storage period.

Browning

The lime juice concentrate prepared with concentration level C_3 showed higher browning and it was statistically differed with treatment C_2 and C_1. In case of lime juice concentrate prepared with preservative level P_3 giving higher browning and it was also statistically differed with treatment P_2 and P_1. The lime juice concentrate treated with sugar syrup level S_3 showing higher browning and was statistically differed with treatment S_2 and S_1.

pH

The maximum pH of lime juice concentrate was observed at concentration level C_1 followed by C_2 and C_3 during three month storage period when packed in sachet and kept at room temperature. In case of preservative levels, the maximum pH was observed non significant for all the preservative level P_1, P_2 and P_3 during three month storage period. While the maximum pH of sachet packed lime juice concentrate was observed at sugar syrup level S_3 followed by S_2 and S_1 during storage at room temperature.

Sensory evaluation of lime juice concentrate

Colour

Amongst all the treatment combinations prepared from the different concentration levels, preservative levels and sugar syrup levels, combination of concentration (C_3) with preservative (P_3) sugar syrup level at 70 ^{0}B (S_3) of lime juice concentrate with natural yellow colour obtained highest sensory score during three months of storage period stored in sachet at room temperature and it was remain good up to three months of storage followed by same combination with concentration level 400 GPL (C_2) and lowest

score for concentration level 300 GPL (C_1). The combinations with preservative level P_1 and sugar syrup level S_1 obtained relatively lower score for colour. While lime juice concentrate prepared from preservative level (P_1) with sugar syrup level (S_1) scored lowest. The treatment combination $C_3P_3S_3$ obtained higher score for colour as 9.0 followed by $C_2P_3S_3$ and $C_1P_3S_3$. The lowest rating was given for combinations of concentration level C_1. From the above it was concluded that concentration level 500 GPL (C_3), preservative level 100 ppm (P_3) and sugar syrup level 70 ^{0}Brix (C_1) was best from the sensory results point of view for the colour. Ratings for color were decreases as storage period increases.

Aroma

It was revealed that acceptability for aroma varied significantly due to different concentration levels, preservative levels and sugar syrup levels. The combination of concentration (C_3) with preservative (P_1) sugar syrup level at 70 ^{0}Brix (S_3) of lime juice concentrate obtained highest sensory score for aroma during three months of storage period stored in sachet at room temperature and it was remain good up to three months of storage followed by same combination with concentration level 400 GPL (C_2) and lowest score for concentration level 300 GPL (C_1). The combinations with preservative level P_3 and sugar syrup level S_1 scored relatively lower score for aroma. While lime juice concentrate prepared from preservative level (P_3) with sugar syrup level of lime juice Concentrate (S_1) assigned lowest score during storage period. The treatment combination $C_3P_1S_3$ scored higher score for aroma as 8.9 followed by $C_3P_2S_3$ and $C_3P_3S_3$. The lowest ratings were given for combinations of concentration level C_1. From the above fact it was observed that concentration level 500 GPL (C_3), preservative level 0 ppm (P_1) and sugar syrup level 70 ^{0}Brix (C_3) obtained best sensory results for the Aroma. Ratings for aroma were decreases for all the treatment combinations as storage period increases.

Taste

It was found that acceptability for taste varied significantly due to different concentration levels, preservative levels and sugar syrup levels. The combination of concentration (C_3) with preservative (P_1) sugar syrup level at 70 ^{0}Brix (S_3) of lime juice obtained highest sensory score for taste during three months of storage period stored in sachet at room temperature and it was remain good up to three months of storage followed by same combination with concentration level 400 GPL (C_2) and lowest score for concentration level 300 GPL (C_1). The combinations with preservative level P_3 and sugar syrup level S_1 was having relatively lower score for taste. While lime juice concentrate prepared from preservative level (P_3) with sugar syrup level of lime juice concentrate (S_1) assigned lowest score during storage period. The treatment combination $C_3P_1S_3$ obtained higher score for taste as 8.8 followed by $C_3P_2S_3$ and $C_3P_3S_3$. The lowest ratings were given to combinations of concentration level C_1. The results of sensory analysis for aroma indicated that concentration level 500 GPL (C_3), preservative level 0 ppm (P_1) and sugar syrup level 70 ^{0}Brix (C_3) was best from sensory results for the taste. Ratings for taste were decreases as storage period increases for all the samples.

Flavour

It was revealed that acceptability for flavor varied significantly due to different concentration levels, preservative levels and sugar syrup levels. The treatment combination of concentration (C_3) with preservative (P_1) sugar syrup level at 70 ^{0}Brix (S_3) of lime juice concentrate obtained highest sensory score for flavor during three months of storage period stored in sachet at room temperature and it was remaining good up to three months of storage followed by same combination with concentration level 400 GPL (C_2) and lowest score for concentration level 300 GPL (C_1). The combinations with preservative level P_3 and sugar syrup level S_1 obtained relatively lower score for flavor. While lime juice concentrate prepared from preservative level (P_3) with sugar syrup level of lime

juice concentrate (S_1) was assigned the lowest score during storage period. The treatment combination $C_3P_1S_3$ obtained higher score for flavour as 8.6 followed by $C_3P_2S_3$ and $C_3P_3S_3$. The lowest ratings were given to combinations of concentration level C_1. From the above it was concluded that concentration level 500 GPL (C_3), preservative level 0 ppm (P_1) and sugar syrup level 70°B (C_3) fond best from the sensory results for flavor. The ratings for flavor were following decreasing trend with storage period.

Microbial analysis

The microbial analysis of the stored lime juice concentrate was carried out at an interval of 15 days with the assumption that there was no change in total plate count during less than 15 days. It was clear that the no total plate count was found in lime juice concentrate combinations stored in sachet up to 60th days of storage period stored in room temperature. After 75th day of storage period, bacterial load was found to be nil in treatment combinations viz. $C_3P_3S_3$, $C_3P_2S_3$, $C_3P_1S_3$ and $C_3P_3S_2$ while minimum microbial load was found in combinations with concentration of 500 GPL (C_3) concentration level. The treatment combinations of concentration C_3 was counted minimum microbial infection and increased with C_1 while, the combinations with concentration level C_1 was showing maximum microbial count after 75th days of storage period. After 90th days of storage, combination $C_3P_3S_3$, $C_3P_2S_3$, $C_3P_1S_3$ and $C_3P_3S_2$ were found to be free from microbial load. From the above discussion it was concluded that lime juice Concentrate was stable against microbial load up to two months of storage period. The combinations with concentration level C3 (500 GPL) gave minimum microbial count, while concentration C_2 (300 GPL) relatively highest microbial count than C_2 and C_3. The combinations with preservative levels (P) also affected with the microbial load during storage. While it was found that maximum microbial load was presented in combinations with preservative level P_1 (0 ppm) followed by P_2 (50 ppm) and P_3 (100 ppm). However concentration with 500 GPL level (C_3) showed minimum microbial load followed by 400 GPL (C_2) and 300 GPL (C_3).

CONCLUSION

During the storage period TSS, total sugars, non-reducing sugars in stored lime juice concentrate was increased with the advancement of storage period but declined towards the end of storage. The acidity, browning increased throughout the storage while pH decreased marginally during the entire storage period. The microbial status and sensory acceptability of the samples was satisfactory for storage period considered and the level was differed according to treatment. Maximum storability and consumer acceptability were recorded by lime juice concentrate prepared by using concentration level with 500 GPL, preservative level of KMS with 100 ppm and sugar syrup level 70 ^{0}Brix. Thus prepared lime juice concentrate, packed in sachet gives better taste, aroma, flavor and could be stored up to 90 days at ambient temperature.

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