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Improvement of post-harvest life of curry leaves through modified atmosphere packaging and storage

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Abstract
Green leaves are high in water, low in protein and fat. They are improvement sources of both digestible carbohydrates, mineralas and vitamins especially vitamin A and C. The postharvest losses of both fresh and freshly processed Agricultural produce have been estimated to be as 25 to 40 per cent of the total production. Post-harvest losses the use of modified Atmosphere storage has increased for bulk storage and also for consumer sized packages. More over Modified Atmosphere Packages complies with recent trends in the use of healthy convenient foods that are minimally processed and less heavily preserved as compared with traditionally processed foods. The main objective of this study was to asses the impact of refrigerated modified atmosphere storage conditions on the chemical, nutritional, microbiological and organoleptic qualities of minimally processed curry leaves. A slightly modified version of modified atmosphere packaging unit was fabricated and erected. The vegetables were minimally processed in the form of pretreated in one percent citric acid, potassium metabisulphite and salt for 30 seconds. The pretreated curry leaves were stored under modified atmospheres (oxygen, carbon dioxide and nitrogen) in 500 ml bottles at refrigeration temperature (12°C.) During storage period, there was a gradual reduction in moisture PH, fibere, total sugar and ascorbic acid contents, An increase was observed in acidity, total soluble solids and reducing sugar continents in curry leaves. (Yadav,.1999) [12] The pretreatments T2 (MAP) and T3 (MAP+citric acid) were the best followed by others. Adecreasing trend was observed during storage of curry leaves. During storage the moisture, total sugar and ascorbic acid decreased to 60.10.g and 3.90 mg per cent from its initial values. A gradual increase was found in fiber (7.8g) total soluble solids (7° brix) and reducing sugar (0.07 g) per cent after 22 days of storage respectively. The bacterial and fungal counts increased to 8.50x 10-6 cfu/g and 5.60x10-3 cfu/g respectively. The organoleptic evaluation showed that there was no change in the chutney and other products. (Gorrir and Pepelenbos,1993) [8].

Keywords: post-harvest, atmosphere, storage

Introduction
Most fresh-cut products will maintain their best quality at temperatures near 0°C (32°F) for temperate and 4-10°C for tropical vegetables. Having achieved excellent temperature control, Modified Atmosphere Packaging (MAP) can be used to further reduce the respiratory rate, loss of moisture, metabolic heat, yellowing, browning, decay and sensitivity to ethylene. The primary guardians of this value added are low temperature and Modified Atmosphere Packaging (MAP). Traditionally only sterile and / or processed foods could be delivered to distant markets during off seasons. With the globalization of food markets and increased consumer desire for fresh foods year around, lucrative markets have been opened to those able to present fresh foods without chemical additives. To this end novel packaging approaches to the preservation to avoid deterioration have emerged under the name of "extended shelf life packaging". The majority of these packages rely on a combination of modified atmosphere and rigorous refrigeration to forestall microbial and chemical deterioration (Thompson, l999) [11].

Modified Atmosphere Packaging (MAP) is the enclosure of food products in high gas barrier materials, in which gaseous environment has been changed once to slow respiration rates; reduce microbial growth and retard enzymatic spoilage with the final effect of increasing shelf life. Modified Atmosphere Packaging (MAP) is a term applied to a range of food packaging technologies that rely on mixtures of the atmosphere gasses like oxygen (02), carbon dioxide (C02), and nitrogen (N2) in different concentrations than these in air, to retard deterioration process in foods (Zagory, 1998) [13]. The technology thus relies on gases that are generally safe, common, cheap and readily available. Different combinations of these gases are appropriate for important foods and package types. Carbon dioxide is important because of its biostatic activity against many spoilage organisms and inhibitory effects and respiration rates oxygen inhibits the growth of anaerobic pathogens. Nitrogen serves as a filler gas to reduce the concentration of other gases.

Many of the beneficial results of modified atmosphere storage cannot simply be attributed to a reduction in respiration. In banana under ideal experimental conditions a 12 fold size in the storage life of green banana can be comprising Co2 -5 percent, 02-3 per cent and N2 -92 per cent in the absence of ethylene, but respiration measured in terms of 02 uptake is reduced to only one quarter at the rate in air. Agar *et al*.,1994 [1] The greatly increased storage life is attributed to a reduction in the rate at natural ethylene production by the bananas and also to a reduced sensitivity

of the fruits to ethylene. In green vegetables improved retention of green colour m low 02 atmosphere is due mainly to a lowering at the rate of chlorophyll destruction Interesting and contrasting effect has been noted in potato The retention of flavor may also be improved under this by increasing CO2 and reduced oxygen, reduced rotting of produce by retarding ripening and senescence, since the natural resistance of the produce host to pathogen decreases as it ripens or ages.

Materials and Methods

Raw materials

French beans (phaseolus vulgaris L.)

Miscellaneous items

Refined oil, salt, mustard, black gram dhal and sugar were purchased from local Departmental store.

Packaging materials

Gas tight glass bottle of 500 ml capacity with rubber cork was purchased from local market.

Chemicals

The chemicals like citric acid and potassium metabi-sulphite, used were food grade and other chemicals and reagents used in this study were either AR,LR,or GR grade.

Equipments

Designing and erection of Modified Atmosphere Packaging unit (MAP),Gas chromatograph, Klett summer son photoelectric colorimeter, Braun balance, ripple beam balance, Refrigerator, Hand Refrectometer, Ph meter, Hot air oven, centrifuge, Muffle furnace and photo electric colorimeter.

Pretreatments

The minimally processed French beans (phaseolus vulgaris L.) Were pretreated by soaking them in the following solution for 30 seconds. Potassium metabisulphite, citric acid and salt were 1.0 percent.

Packaging

The bottles were flushed with gas mixtures for two minutes. Then the pretreated minimally processed French beans (phaseolus vulgaris L.) Were filled into bottles and packed under modified atmosphere packaging with standardized gas mixtures. French beans (phaseolus vulgaris L.) Oxygen-7.0, corbondioxide-13.0 and nitrogen80.0 were stored at refrigeration temperature maintained at 10+-2.c and 80+-5 per cent relative humidity.

Storage studies

chemical analyses were done in stored vegetables at periodical intervals (once in a 15 days. as per the procedures given below. Moisture content, pH, titrable acidity, fibere, TSS, Reducing sugar, Total sugar, Ascorbic acid, organoleptic evaluation and microbial examination were followed by Ranganna, 1995 [9]. The data on chemical characteristics of the samples were statistically analyzed by factorial completely randomized design as per method described by Gomez and Gomez, 1984 [7].

Materials and Methods

Minimal processing is ageneric term and therefore a number of processes fit into this definition. Minimal processing is the process conversion of raw harvested curry leaves in to clean, safe, convenient, appearing and storable commodities which retains to a high degree their fresh like characteristics. Minimally processed vegetables may be simply trimmed or may consist of trimmed, peeled, sliced/shredded and washed and /or disinfected vegetables. (Peera and Rahman, 1997) [9]. Many of the benefitted results of modified atmosphere storage cannot simply be attributed to a reduction in respiration. In green vegetables improved retention of green colour in low O2 atmosphere is due mainly to a lowering at the rate of chlorophyll destruction. Interesting and contrasting effect has been noted in potato. The retention of flavor may also be improved under this by increasing CO2 and reduced oxygen, reduced rotting of the produce host to pathogen decreases as it ages. Considering their advantages an effort was made to generate technologies to improve the shelf life of minimally processed commercially important and high export value fruits vegetables and matured greens with the following objectives. To standardize the optimum Modified Atmosphere Packaging and storage for extended post-harvest life of curry leaves. To study the phsico-chemical characteristics of the curry leaves during storage. To process value added products from the stored curry leaves and
To study the consumer acceptability. (Peera, C. and Rahman, M.S. 1997) [9].

Raw materials

Curry leaves

Packaging materials

Gas tight glass bottle of 500 ml capacity with rubber cork was purchased from local market.

Chemicals

The chemicals like citric acid and potassium metabi-sulphite, used were food grade and other chemicals and reagents used in this study were either AR,LR, or GR grade.

Equipments

Designing and erection of Modified Atmosphere Packaging unit (MAP),Gas chromatograph, Klett summer son photoelectric colorimeter, Braun balance, ripple beam balance, Refrigerator, Hand Refrectometer, Ph meter, Hot air oven, centrifuge, Muffle furnace and photo electric colorimeter.

Pretreatments

The minimally processed curry leaves were pretreated by soaking them in the following solution for 30 seconds

Table 1

Chemical	Concentration
Potassium meta bi sulphite,	1.0 per cent
citric acid	1.0 per cent
Salt	1.0 per cent

Packaging
The bottles were flushed with gas mixtures for two minutes. Then the pretreated minimally processed curry leaves were filled into bottles and packed under modified atmosphere packaging with standardized gas mixtures.

Table 2

Product	Per cent composition of gas		
	Oxygen	Carbohydrate	Nitrogen
Curry leaf	20.0	10.0	80.0

Storage studies
Chemical analysis were done in stored vegetables at periodical intervals (once in 15 days. as per the procedures given below. Moisture content, tithable acidity, reducing sugar, Total sugar, Microbial examination and Ascorbic acid were followed by (Ranganna, 1995) [10]. The data on chemical characteristics of the samples were statistically analyzed by factorial completely randomized design as per method described by (Gomez and Gomez, 1984) [8]

Result and Discussion
Changes in the moisture content of (g%) curry leaves during storage.
Moisture
The initial moisture content of curry leaves was 63.80 g per cent. It reduced to 62.21,60.20 and 10 g per cent in 7,15 and 22 days of storage respectively.

Changes in the fibre content of (g%) curry leaves during storage
It was observed that initial fibre content was 6.4 g per cent where as it increased during storage.The percentage increase was found to be 6.9 g in 7 days.7.20g in 15 days and 7.8 g in 22 days

Table 3: Changes in the moisture,fibre and total soluble solid (TSS) content of (g%) curry leaves during storage.

Storage period (Days)	Moisture (g%)	Fibre (g%)	Total soluble solids (g%) (TSS)
Initial	63.80	6.4	4.0
7	62.61	6.9	4.0
15	60.20	7.2	4.0
22	60.10	7.8	4.0

Changes in the total soluble solids (TSS) content of (g%) curry leaves during storage
From table 3. it was observed that TSS increased slightly during storage. The initial TSS content was 4° brix. During storage it increased to 4,4 and 5 Brix in 7,15 and 22 days of storage.

Reducing sugar content of (g%) curry leaves during storage
An increase in reducing sugar content was observed during storage from the table 3. The initial reducing sugar content was 0.05 g per cent. During storage it was increased 0.06,0.06 and 0.07 g per cent in 7 days,15 days and 22 days respectively. (D.S. and Lee.D.S.1997)

Total sugar content of (g%) curry leaves during storage
The initial total sugar content of curry leaves 0.81 g per cent from table 51. During storage the total sugar was found to be 0.89 g.090 g and 0.95 g per cent in 7,15 and 22 days of storage respectively

Ascorbic acid content of (g%) curry leaves during storage
Curry leaf contained 4.00 mg per cent ascorbic acid initially whereas it decreased during storage Table The reduction was found to be 3.99,3.95 and 3.90 mg per cent in 7 days,15 days and 22 days of storage respectively. (Forney, E.F. and Lipton, S.R. 1990)

Table 4: Changes in the reducing sugar, total sugar, ascorbic acid content of (g%) curry leaves during storage

Storage period (Days)	Reducing sugar (g%)	Total sugar (g%)	Ascorbic acid (g%)
Initial	0.05	0.81	4.0
7	0.06	0.89	3.99
15	0.06	0.90	3.95
22	0.07	0.95	3.90

Organoleptic evaluation of curry leaf
From table 4. it was observed that curry leaf chutney prepared in the initial and final stage 22 days of storage scored more or less similar values The appearance of curry leaf scored 4.00 per cent initially and finally. The colour, flavor, texture, taste and overall acceptability scored3.91,3.54,3.43,3.82,3.77 and 3.77 per cent respectively in the initial stage of storage. At the end of the storage period it was rated higher than initial expect in colour which was 3.76 per cent. Thus flavor, texture, taste and overall acceptability scored 3.82,3.47,3.92 and 3.93 per cent respectively.

Table 5: Organoleptic Evaluation of Curry leaf chutney

Quality attributes	Initial	7th Day	15th Day	22nd Day
Appearance	4.00	3.91	3.84	3.80
Colour	3.91	3.54	3.56	3.56
Flavor	3.97	3.43	3.82	3.82
Texture	3.98	3.82	3.77	3.47
Taste	3.98	3.77	3.56	3.92
Over all acceptability	3.97	3.77	3.84	3.93

Bacterial and fungal enumeration of stored curry leaf
From table it was observed that bacterial counts increased during storage. Bennik *et al* (1996) [4]. The initial count was 7.50x10-6 cfu. During storage it increased to 8.00,8.50,8.50 and 8.50x10 -6 cfu/g in 7 days (d2),15 days (d3)and 22 days (d4) respectively.
Fungix10-3cfu/g
The initial Fungai count was 2.40 x 10 -3 cfu/during storage it increased to 3.60,3.70 and 3.80 x 10-3 cfu/g in 7,15 and 22 days of storage (d2, d3 and d4) respectively according to table. 5.

Table 6: Enumeration of Fungi and Bacterial (x10-3 cfu/g) in stored curry leaves

Storage period	Fungi (x10-3 cfu/g)	Bacterial (x10-3 cfu/g)
Initial	2.40	7.50
7	3.60	8.00
15	3.70	8.50
22	3.80	8.50

Summery and Conclusions

A short summery of the results obtained from the experiments carried out to increase the post-harvest life of curry leaf through modified atmosphere packaging and storage is given below. Data on the changes in chemical constituents, microbial population and organoleptic evaluation of stored products have discussed.

Moisture

A gradual reduction in the moisture was noted throughout t the storage study. The initial moisture content was 63.80 g per cent. At the end of storage period, it was decreased to 60.10 g per cent respectively

Fiber

An increasing trend was noted in fiber content throughout the storage period. Finally, the fiber content increased to 7.8 of per cent in initial value of 6.4 of per cent respectively.

Total soluble solids (TSS)

A gradual increase in the TSS content was noted throughout the storage study. The initial TSS content was 4-degree brix. At the end of the storage period, it was increased to 5-degree brix respectively. Brash *et al* (1995) [5]

Reducing sugar

An increasing trend was noted in reducing sugar content throughout the storage period. Finally reducing sugar content increased to 0.07 g per cent from its initial value of 0.05 g per cent respectively.

Total sugar

A gradual reduction in total sugar content was recorded during the study period in curry leaves as the storage period decreased. At the end of the storage period the total sugar content was found to be 0.95 and 0.81 g per cent respectively. (Anantheshwaran, R,C, 1998 [3]

Ascorbic acid

A decreasing trend was noted in ascorbic acid content throughout the storage period. Final value of 4.0 mg per cent was found in curry leaves.

Organoleptic evaluation

The quality attributes of curry leaves chutney and other products showed that appearance, flavor, texture, taste and overall acceptability scored higher values at the end of the storage period when compared with initial values expect for colour.

Bacterial and fungal population

The curry leaves had 7.50x10-6 cfu/g g and 2.40x 10-3 cfu/g of bacterial and fungi at the initial stage.It increased to 8.50x 10-6 cfu/g g of bacterial count and 5.60 x10-3 cfu/g g of fungal count after 22 days of storage.

From the the study it was concluded that modified atmosphere package is one of the best methods to store curry leaf especially minimally processed curry leaf without much change in chemical nutritional and organoleptic changes.

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