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IMPACT OF HURDLE TECHNOLOGY ON PRESERVATION OF CARROT

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ABSTRACT

Hurdle technology is a combination of different treatments. To develop suitable hurdle treatment for preservation of carrot, first fresh carrot was blanched at 100°C for 60 sec., followed by dipping into 0.25% potassium metabisulphite for 10 minutes. Then blanched carrot were steeped into different concentrations & combinations of preservatives– P0 (Control sample-fresh without treatment), P1 (35°Brix Syrup+8% Salt+500 ppm Potassium metabisulphite), P2 (35°Brix Syrup+10% Salt+400 ppm Potassium metabisulphite), P3 (35°Brix Syrup+12% Salt +300 ppm Potassium metabisulphite), P4 (25°Brix Syrup+8% Salt+500 ppm Potassium metabisulphite+100 ppm Sodium benzoate), P5 (25°Brix Syrup+10% Salt+400 ppm Potassium metabisulphite+200 ppm Sodium benzoate) and P6 (25°Brix Syrup+12%Salt+400 ppm Potassium metabisulphite+300 ppm Sodium benzoate). Steeped carrot were aseptically packed into food grade polyethylene pouches & stored at two different temperatures T1(30-37°C) & T2(5-7°C) for different time intervals i.e. 0, 30, 60, 90, 120, 150 and 180 days respectively. Thus there are 14 combinations of treatments under study- P0/T1, P0/T2, P1/T1, P1/T2, P2/T1, P2/T2, P3/T1, P3/T2, P4/T1, P4/T2, P5/T1, P5/T2, P6/T1& P6/T2 for 180 days of storage period. Among 14 different treatments, the treatments which remained microbial safe for 180 days of storage period were P6/T1, P6/T2 and P5/T2. Among these three, treatment P6/T2 was scored lowest in physical and highest in sensory & nutritional evaluation. So best hurdle treatment for preservation of carrot till 180 days of storage period was P6/T2.

Keyword: Hurdle, ppm

INTRODUCTION

India is a leading vegetable producing country in the world with the production of 113.5 million tons. The overall productivity of vegetables is 14.4 tons per hectare. The production of vegetables increases due to advancement of hybrid varieties. But our market strategy is not equipped with the handling of large quantity of vegetables as a result quantities of vegetables get spoil. It varies between 5-39% of the total production. The shelf life of perishable vegetables is very low. In brinjal, carrot and chilly post harvest losses were found to be high ([9]Jayanthi 2008).

Preservation is to maintain foods with desired properties as long as possible. Preservation lies at the heart of Food Science & Technology & it is the main purpose of Food Processing ([3]Barnettand & Blanchfield, 1995). The Hurdle concept was first introduced by Prof. [10]Luthar Leistner of Germany & his colleagues in 1978. The hurdle governs many preservation processes. Intense heat (F) preserves canned foods, low water activity prevents microbial growth in dried products and low pH is responsible for prolonged shelf life of fermented foods. This preservation technique is also called combination techniques or barrier technology or metodascombinados in Spanish, technologia degli ostacoli in Italian, Hurdle Technology in German. Potential hurdles for food preservation are – Temperature (High or Low), pH (High or Low), Water activity (High or Low), Modified atmosphere (Co_2, N_2 etc), Packaging (Vacuum packaging, aseptic packaging, edible coating etc.), Radiation (UV, microwave, irradiation etc), Preservatives (Class I & II). Hurdle Technology is a technology by which 2 or more hurdles are employed in a suitable combination and every hurdle is used at an optimum level so that damage to the overall quality of food is kept to the minimum. Hurdle Technology foods are defined as "Products whose shelf-life and the microbial safety are extended by use of several factors none of which individually would be totally lethal towards spoilage or pathogenic microbes" ([5]Berwal, 1994).

Objectives of the research–

1.1.1- To study the impact of hurdle technology (different concentration & combinations of preservatives, storage temperatures & storage periods) on the microbial (Yeast & mold count, Total plate count and E-coli) content of preserved carrot.

1.1.2- To study the impact of hurdle technology (different concentration & combinations of preservatives, storage temperatures & storage periods) on the physical (Water activity and pH) parameters of preserved carrot.

1.1.3- To study the impact of hurdle technology (different concentration & combinations of preservatives, storage temperatures & storage periods) on the sensory properties of preserved carrot.

1.1.4- To study the impact of hurdle technology (different concentration & combinations of preservatives, storage temperatures & storage periods) on the nutrient (Protein, Vitamin A & Vitamin C) content of preserved carrot.

2.0 MATERIAL AND METHODS:

2.1 Materials used in preservation

2.1.1 Carrot: Carrot was procured from local market of Naini.

2.1.2 Chemicals used in preservation: Food grade (potassium metabisulphate, sodium benzoate) chemicals were used.

2.1.3 Polyethylene pouches: Food grade pouches were used.

2.1.4 Reagents used in analysis: Analytical grade reagents were used.

2.2 Method of preservation:

First carrots were shorted and washed thoroughly in tap water. Washed carrots were cut into round shape to the size of 2×2×0.5 cm. pieces with the help of sharp edged stainless steel knife. Then finally washed with distilled water. After washing, carrot pieces were blanched at 100°C for 60 sec., followed by dipping into 0.25% potassium metabisulphite for 10 minutes. Then blanched carrot were steeped into different concentrations & combinations of preservatives – **P0** (Control sample-fresh without treatment), **P1** (35°Brix Syrup+8% Salt+500 ppm Potassium metabisulphite), **P2** (35°Brix Syrup+10% Salt+400 ppm Potassium metabisulphite), **P3** (35°Brix Syrup+12% Salt +300 ppm Potassium metabisulphite), **P4** (25°Brix Syrup+8% Salt+500 ppm Potassium metabisulphite+100 ppm Sodium benzoate), **P5** (25°Brix Syrup+10% Salt+400 ppm Potassium metabisulphite+200 ppm Sodium benzoate) and **P6** (25°Brix Syrup+12%Salt+400 ppm Potassium metabisulphite+300 ppm Sodium benzoate). Then steeped carrot were further aseptically packed into food grade polyethylene pouches and stored at two different level of temperatures- **T1** (ambient temperature – 30 to 37 °C) & **T2** (refrigeration temperatures – 5 to 7 °C) for 180 days. There are 14 combinations of treatments under study- **P0/T1, P0/T2, P1/T1, P1/T2, P2/T1, P2/T2, P3/T1, P3/T2, P4/T1, P4/T2, P5/T1, P5/T2, P6/T1& P6/T2** for 180 days of storage period (where P0, P1, P2, P3, P4, P5 & P6 are different combination of preservatives and T1 & T2 are different level of temperatures, all are explained above). This preserved carrot was studied for their microbial, physical, sensory, & nutritional properties and data obtained after analysis were statistically analyzed.

2.3 Analysis Performed

2.3.1- Microbial analysis: Yeast & mold (YMC), Total plate count (TPC) & E-coli were determined by Conventional method ([14]**Ranganna 2005**).

2.3.2- Physical test: Water activity (a_w %) was determined by using Water Activity Meter ([2]**Aqua Lab Series 4TE- 2007, Operators manual**). pH was determined by using pH meter (Electronic Corporation of India, Model 5652) as per procedure described in [12]**Ministry of Health & Family Welfare, Manual of methods of analysis of foods- Fruit and Vegetable Products , (2005)** .

2.3.3- Sensory analysis: Sensory properties (color, flavor, texture & overall acceptability) were determined by 9 Point Hedonic Scale method ([16]**Ranganna 2005**).

2.3.4- Nutritional properties: Protein determined by Micro-Kjeldahl / Kjeltec method **([15]Ranganna, 2005),** Vitamin A determined by method mentioned in ([18]**Ranganna 2005),** Vitamin C determined by 2, 6-dichlorophenol-indophenol visual titration method, **([17]Ranganna 2005).**

2.3.5- Statistical analysis: Obtained data were analyzed for ANOVA (3 Way Classification) & critical difference (C.D.) technique, described by [8]**Imran and Coover (1983)**. In statistical analysis, data used were average of replicates, total no. of treatments combinations were 14 – P0/T1, P0/T2, P1/T1, P1/T2, P2/T1, P2/T2, P3/T1, P3/T2, P4/T1, P4/T2, P5/T1, P5/T2, P6/T1, and P6/T2. Level of significance was checked at 5% probability level.

3.0 RESULTS AND DISCUSSIONS:

3.1 - Microbial analysis of preserved carrot- Scores of microbial analysis [Yeast & mold (YMC), Total plate count (TPC) & E.coli] of preserved carrot are given in **Table-1**.

3.1.1-YMC Analysis- Treatments in which average YMC were found lowest with a storage period of 180 days are P6/T1 (21.14 count/gm), **P5/T2**(19count/gm) & **P6/T2** (7.57 count/gm). There were significant difference between YMC of treated samples due to combination of preservatives & storage temperatures while there was not significant difference due to days of storage at 5% probability levels.

Increase in YMC was observed in all treatments at both the temperatures. In most of the treatments YMC were found above from the standard (**as per [6] Food Safety & Standard Authority of India, 2010-Yeast/Mold not more than 100 count/gm)** with increase in storage period, which may be attributed during addition of preservatives or during packaging which could have been a carrier of microbes. While in some treatments counts remained under control as per above mentioned standard till 180 days of storage, it might be due to better handling procedure or different concentration & combinations of class I & II preservatives & low temperature of storage. The results are in agreement of previous finding of [7]**Gould (1995),** observed that the food preservation through hurdle technology cause interference with the homeostasis of yeast & mold. [1]**Alzamora et al. (1996),** also noticed that yeast and mould counts remained below 100 cfu/gm during 4 months of storage of pineapple slices preserved through hurdle technology at 5°C. [11]**Lopez- Malo et al. (1995),** preserved papaya through hurdles technology, found yeast & mold counts < 10 CFU/g during 5 months storage at 25°C.

3.1.2- TPC Analysis- Average TPC count of the treatment **P6/T2** (14.43 cfu/ml) was found lowest in comparison of other treatments in a storage period of 180 days. There were significant difference between TPC scores of treated samples due to combination of preservatives & storage temperatures while there was not significant difference due to days of storage at 5% probability levels.

In case of TPC analysis, the increase in count was observed in all treatments at both the temperatures but the count was found within standard (**as per [6] Food Safety & Standard Regulation, 2010- TPC not more than 1000cfu/ml**) till 180 days of storage period. YMC of all the preserved sample (except treatments- **P6/T1, P6/T2 & P5/T2**) were found above from the above mentioned standard of YMC in 180 days of storage period so all the preserved samples were discarded one by one on the basis of their YMC count & not considered for further analysis of sensory**.** The results of TPC are in agreement of previous findings of [1]**Alzamora et al. (1996)** noticed that TPC remain below 100 cfu/ml during 4 months of storage of pineapple slices preserved through hurdle technology at 5°C. [4]**Barwal et al. (2005**), preserved carrot by using hurdle technology, by different concentrations &

combinations of salt (5, 10, 15%), potassium metabisulphite (KMS-0.2%), and citric acid (1.0%) after blanching. The carrot steeped in 10 & 15 % salt containing 0.2% KMS were chemically, sensory microbial safe among all treatments during the entire period of storage.

3.1.3- E.coli- E.coli count of fresh & preserved samples was found Nil. In the present investigation E.coli were found to be absent in fresh as well as preserved carrot samples. This result is also supported by [6]**Food Safety & Standard Regulation 2010- E-coli- must be Nil**. This indicates that the carrots which were used in preservation were free from fecal contamination and also proper hygienic precautions had been taken during preservation as well as during packaging of treated samples.

3.2- Physical analysis of preserved carrot: Scores of water activity (a_w %) & pH of treated samples are given in **Table-2**. Lowest water activity (**0.64%)** & pH (**3.5**) were found in **P6/T2** in a storage period of 180 days. There were significant difference between water activity & pH scores of treated samples due to combination of preservatives, storage temperatures and days of storage at 5% probability levels.

In physical test, the reduced water activity (a_w %) & pH of preserved sample were found as compare to initial or fresh commodity. Reduced water activity & pH were found effective for long time storage. The results are in agreement of previous finding of [20]**Vibhakara et al.(2007),** maintenance of pH< 4.5 helped in controlling multiplication and survival of spores & also helpful in achieving shelf stability. Low pH and water activity solutions are used as antimicrobial agent or as antioxidant to prevent browning, to reduce discoloration of pigments, and to protect against loss of flavor, changes in texture ([22]**Wiley, 1994**).

3.3- Sensory analysis of preserved carrot: Scores of sensory analysis are given in **Table-3**. In preserved samples, treatment **P6/T2** scored highest in color & appearance (7.42), flavor & taste (7.85), body & texture (7.71) & overall acceptability (8.14) with a storage period of 180 days. There were significant difference between color & appearance, flavor & taste, body & texture & overall acceptability scores of treated samples due to combination of preservatives & days of storage while there was not significant difference due to storage temperatures at 5% probability levels.

In sensory evaluation, the difference & decrease in color & appearance, flavor & taste, body & texture & overall acceptability scores were observed which may be attributed due to increase in microbial count with increase in storage period. But treatments **P6/T1, P6/T2 & P5/T2** which remained microbial safe till 180 days of storage period were scored highest among all treatments & from 3 of them, P6**/T2** was scored highest in sensory evaluation in 180 days of storage period. The results are in agreement of previous finding of [13]**Pruthi (1990),** the vegetables like potatoes, carrot, carrot, cabbage, bitter guard, peas, mushroom and animals foods (meat, fish and poultry) preserved in an acidified sulphited brine solution through steeping can be used for pickling or home cooking after leaching out the salt and acid. [4]**Barwal et al. (2005)** standardized the low cost and low energy processing technology for preservation of carrot involving different concentration and combination of salt (5-10%), potassium metabisulphite (0.2%) and citric acid (1%) after blanching. The preserved carrot was accepted in sensory evaluation after 90 and 180 days of storage by reconstituted in running water for half an hour & evaluated for the preparation of pickle and pakora

3.4- Nutritional analysis of preserved carrot: From **Table-4** - highest retention of protein, vitamin A and vitamin C were found in treatment P6/T2 in a storage period of 180 days. There were significant difference between protein, vitamin A and vitamin C scores of treated samples due to combination of preservatives, storage temperatures & days of storage at 5% probability levels.

In nutritional evaluation, loss of nutrients were found in each treatments but on other hand better retention of protein, vitamin A and vitamin C were also observed in treatments of 180 days of storage period. The results are in agreement of previous finding of [19]Srivastava & Kumar (2002), sulphur dioxide is widely used throughout the world in the preservation as it acts as an antioxidant and bleaching agent. These properties help in the retention of vitamin C, vitamin A and other oxidizable compounds. Sulphur dioxide with potassium metabisulphite (if added in the solution) helps to retain vitamin C content of the preserved material ([21]Verma & Joshi, 2000). Low pH and water activity solutions were also effective towards nutrient retention ([22]Wiley, 1994).

5.0- CONCLUSION:

From 14 different steeping treatments (P0/T1, P0/T2, P1/T1, P1/T2, P2/T1, P2/T2, P3/T1, P3/T2, P4/T1, P4/T2, P5/T1, P5/T2, P6/T1& P6/T2), only 3 treatments – P6/T1, P6/T2 & P5/T2 were microbial safe till 180 days of storage period. Among these 3, only P6/T2 was found best in physical, sensory & nutritional evaluation in 180 days of storage period. So best hurdle treatment for preservation of carrot for 180 days was P6/T2.

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TABLES:

Treatments with its Shelf life(in days)	YMC/gm	TPC(cfu/ml)	E.coli
P0/T1 -180	22*	17.43*	Nil
P0/T2 -180	22*	17.43*	- do -
P1/T1 - 90	50.6	58.4	- do -
P1/T2 -120	46.33	55.33	- do -
P2/T1 - 60	35	42.25	- do -
P2/T2 - 90	27.8	35.4	- do -
P3/T1 - 30	51	56.66	- do -
P3/T2 - 60	46.75	53	- do -
P4/T1 -120	25.33*	31.17*	- do -
P4/T2 -150	29.14	36.29*	- do -
P5/T1 -150	37.9	47.57	- do -
P5/T2 -180	19*	31.14*	- do -
P6/T1 -180	21.14*	27.43*	- do -
P6/T2 -180	7.57*	14.43*	- do -

YMC/gm-Yeast & mold count/gm; TPC(cfu/ml)-Total plate count (colony formation unit/ml); E.coli- Escherichia coli; All values are MEAN; *Significant values

Table-1: Scores of microbial analysis (YMC, TPC & E.coli) of preserved carrot in different treatments with its shelf life

Treatments with its Shelf life (in days)	Water activity (%)	pH
P0/T1 -180	0.94*	5.8*
P0/T2 -180	0.94*	5.8*
P1/T1 - 90	0.75	4.1
P1/T2 -120	0.74	3.97*
P2/T1 - 60	0.71	4.3
P2/T2 - 90	0.68*	4.12
P3/T1 - 30	0.76	4.5
P3/T2 - 60	0.73	4.2
P4/T1 -120	0.69*	4.0*
P4/T2 -150	0.67*	3.8*
P5/T1 -150	0.74	4.0*
P5/T2 -180	0.68*	3.8*
P6/T1 -180	0.7*	3.6*
P6/T2 -180	0.64*	3.5*

All values are MEAN; *Significant values

Table-2: Scores of Water activity (%) & pH of preserved carrot in different treatments with its shelf life

Treatments with its	Color & Texture	Flavour &	Body &	Overall acceptability	Shelf life(in days)	appearance	Taste
P0/T1 -180	9*	9*	9*	9*			
P0/T2 -180	9*	9*	9*	9*			
P1/T1 - 90	7*	7*	7*	7*			
P1/T2 -120	7.2*	7*	6.66	7.4*			
P2/T1 - 60	6.66	6	6	6.66			
P2/T2 - 90	7.0*	6.25	6	6.75			
P3/T1 - 30	6.75	6.25	6.25	7.3*			
P3/T2 - 60	6.8	6.8	6.6	7.8*			
P4/T1 -120	7.28*	7.14*	7.14*	6.8			
P4/T2 -150	8.14*	8*	8*	7.5*			
P5/T1 -150	7.16*	7*	7*	7.16*			
P5/T2 -180	7.0*	7.3*	7.16*	8*			
P6/T1 -180	6.6	6.6	6	7.43*			
P6/T2 - 180	7.42*	7.85*	7.71*	8.14*			

All values are MEAN; *Significant values

Table- 3: Scores of sensory analysis of preserved carrot in different treatments with its shelf life

Treatments with its	Protein	Vitamin-A	Vitamin-C

shelf life (in Days)	(mg/100gm)	(mg/100gm)	(mg/100gm)
P0/T1 -180	0.95*	3.2*	3.56*
P0/T2 -180	0.95*	3.2*	3.56*
P1/T1 - 90	0.81	2.4	1.03
P1/T2 -120	0.83	2.8	1.16
P2/T1 - 60	0.89	2.6	1.15
P2/T2 - 90	0.89	2.7	1.3
P3/T1 - 30	0.91	2.8	1.5
P3/T2 - 60	0.92	2.9	1.6
P4/T1 -120	0.64*	1.6	0.64*
P4/T2 -150	0.67*	1.8*	0.9
P5/T1 -150	0.48*	2.0*	0.64*
P5/T2 -180	0.52*	2.1*	0.6*
P6/T1 -180	0.46*	1.9*	0.46*
P6/T2 -180	0.6*	2.3*	0.72*

All values are MEAN ; * Significant values

Table-4: Protein, Vitamin-A & Vitamin-C scores of preserved carrot in different treatments with its shelf life