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Shelf Life of Fresh Cut Beans as Influenced by Different Pre Storage Treatments

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Abstract: *Fresh beans of good quality was surface sanitized using 30 ppm sodium hypo chlorite solution, outer strings removed, washed and fresh cuts were made, treated using different chemical solutions, air dried and kept in aluminiumtrays wrapped with cling film under refrigerated storage. Analysis of physical, physiological and chemical quality parameters and microbial revealed that 1% calcium chloride as the effective pretreatment chemical for fresh cut beans.*

Keywords: *Beans,fresh cut vegetables, pre storage treatments, shelf life.*

INTRODUCTION

Lifestyle of people has been changing and the new consumer's profile is ''rich in cash and poor in time'' and eating habits are diverse in different parts of the world; however, some aspects in the production and consumption of food are universal, such as the consumption of ready-to-eat products such as pre-cooked and minimally processed foods. Fresh-cut or minimally processed products are also referred to as "lightly processed," "partially processed," "fresh-processed," and "pre-prepared". Fresh-cut products are fruit or vegetables that have been trimmed and/or peeled and/or cut into 100 percent usable product that is bagged or prepackaged to offer consumers high nutrition, convenience, and flavor while still maintaining its freshness [11]. But they are highly perishable due to damaged and exposed tissues and lack of protective skin. The fundamental principle underlying quality of fresh-cut fruits and vegetablesis that they are living tissues, and as a consequence, show physiological response to minimal processing procedures as well to post-processing handling and treatments and ultimately to the package environment in which they are enclosed.Physical and physiological parameters differed significantly among different treatments used to control undesirable physiological and physical changes that adversely affect quality of fresh cut products. Hence chemical treatments are used in fresh cut vegetables for controlling its decay, for reducing browning and thereby retaining its firmness. Today's food marketplace is alive with new products and changing trends, and in this context fresh-cut produce remains as the top listed of product by meeting the needs of today's busy life schedule of consumers. Hence an experiment was conducted to study the effect of different pre storage treatments for extending the shelf life of fresh cut beans.

MATERIALS AND METHODS

Fresh beans of uniform maturity and good quality were uniformly processed from FSRS, Sadananthapuram washed in tap water followed by distilled water and subjected to surface sanitization using 30 ppm sodium hypo chlorite solution [7] for 10 minutes.Sanitizing solution was drained after 10 minutes, outer strings removed, washed again in distilled water and made into uniform cut piecesusing vegetable cutter. Fifty grams of treated fresh cut beans were completely immersed in followingdifferent chemical solutions for 10 minutes. T1-0.1% KMS and 0.1% ascorbic acid, T_2-0.1% KMS and 0.1% citric acid, T_3-0.1% Sodium benzoate and 0.1% ascorbic acid, T_4-0.1% Sodium benzoate and 0.1% citric acid, T_5-Calcium chloride (1%), T_6-Calcium ascorbate (1%), T_7-Sodium chloride (2%), T_8-Acetic acid (0.1%) and T_9-Control (without any

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treatment).The solution was drained,cuts air dried, kept in aluminium trays wrapped with cling film and stored under refrigerated condition (5-7°C). Physical, physiological and chemical quality parameters of fresh cut beans were analyzed to find out the most effective treatment for increasing its shelf life.

The treated cut beans were steamed for 60 seconds and physical parameters like color, texture, appearance, flavor and taste of the steamed cuts were examined on the thirdday of storage by conducting a sensory evaluation trial performed by a 30 member semi-trained panel using a nine point hedonic scale [20].

Physiological parameters like physiological loss in weight (PLW), transpiration loss and percent leakage were recorded on the third day of storage using standard techniques. Physiological loss in weight was determined on initial weight basis using a laboratory level weighing balance and expressed as percentage.Weight of water molecules adhering on the cling film used for wrapping and inside the aluminium foil tray was recorded and expressed as transpiration loss in g/100g of the sample. Fresh cut beans were dipped in distilled water for three hoursand absorbance of distilled water was recorded at 273nm, shreds were heated in water bath at 100°C for 20 minutes and absorbance was again recorded at 273nm. The ratio of initial and final absorbance values was recorded as percent leakage [18]. Chemical parameters like starch, vitamin C, carotenoids [19] and total phenol [18] of treated beans were recorded on the third day of storage.

Based on physical, physiological and chemical parameters the superior four pre treatments were selected for further microbial analysis. Whole beans were surface sanitized using 30 ppm sodium hypo chlorite, cuts prepared, treated with selected top four pretreatments and microbial count on one gram treated beans sample was calculated once in two days for five days using serial dilution spread plate technique [14]. Based on the efficiency in controlling microbial population best effective pre storage treatment for increasing the shelf life of fresh cut beans was selected.

The scores given by 30 judges in the panel during sensory evaluation were converted into mean rank values and statistically analyzed using the non-parametric anova (Kruskall Wallis test) and mean ranks and critical values were calculated for the quality parameters evaluated. Physiological and chemical observations were analyzed statistically in a Completely Randomized Design and significance was tested using analysis of variance technique [10].

Results and Discussion

Physical and physiological parameters

Effect of different pre-storage treatments on physiological and physical quality parameters of fresh cut beans showed significant difference (Table 1 and 2).

Fresh cut productsare highly susceptible to weight loss because the internal tissues are exposed [4]. They have high rate of respiration, which generally leads to ageing of products by using reserve energy during oxidative–reduction process. The earliest physiological response to wounding is the enhanced production of ethylene and an enhanced respiration. Large increase in ethylene production, as a consequence of cutting, was reported in tomato (*Lycopersiconesculentum*) and in winter squash (*Cucurbita maxima*) [3]. Higher the rate of respiration, shorter will be the shelf life of product. Any fresh cut vegetable with least transpiration rate, percent leakage and physiological weight loss maintains its turgidity, freshness and quality.

Table 1
Effect of pre storage treatments on physiological parameters of fresh cut beans

Prestorage Treatments	*Physiological loss in weight (%)*	*Transpiration loss (g/100g)*	*Percent leakage*
0.1% KMS +0.1% ascorbic acid	1.29	0.20	93.41
0.1% KMS +0.1% citric acid	1.35	0.26	91.00
0.1% Sodium benzoate +0.1% ascorbic acid	1.43	0.25	91.04
0.1% Sodium benzoate +0.1% citric acid	1.24	0.22	90.27
Calcium chloride (1%)	1.05	0.17	88.49
Calcium ascorbate (1%)	1.21	0.17	88.68
Sodium chloride (2%)	1.28	0.28	91.56
Acetic acid (0.1%)	1.61	0.24	94.21
Control (without any treatment)	1.77	0.31	93.87
CD (P = 0.05)	0.23	0.02	0.61

Table 2
Effect of pre storage treatments on physical quality parameters of fresh cut beans

Pre storagetreatments	*Mean rank values*					
	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
0.1% KMS + 0.1% ascorbic acid	26.43	26.93	37.58	30.50	44.43	30.29
0.1% KMS + 0.1% citric acid	23.50	26.93	37.58	25.79	38.79	30.29
0.1% Sodium benzoate + 0.1% ascorbic acid	29.36	37.00	37.58	27.71	35.43	27.71
0.1% Sodium benzoate + 0.1% citric acid	51.21	32.21	29.93	34.79	32.07	35.43
Calcium chloride 1%	51.64	55.71	46.79	55.93	41.07	56.79
Calcium ascorbate 1%	53.21	54.64	43.07	55.93	32.07	55.71
Sodium chloride 2%	36.79	37.00	23.93	38.50	46.71	34.93
Acetic acid 0.1%	5.07	4.86	4.57	6.43	7.29	5.79
Control (without any treatment)	10.79	12.71	27.64	12.43	10.14	11.07
CV	19.20					

In the present study, physiological loss in weight was least (1.05) for shredded beans treated with 1% calcium chloride which was on par with the sample treated with 1% calcium ascorbate(1.21), 0.1% sodium benzoate + 0.1% ascorbic acid (1.24) and 2% sodium chloride (1.28) and highest (1.77) weight loss was recorded by the untreated samples. Least (0.17) transpiration loss was for the sample treated with 1% calcium chloride and 1% calcium ascorbate followed by the sample treated with 0.1% KMS + 0.1% ascorbic acid (0.20) and the highest (0.31) transpiration loss was for the untreated shredded beans. Percent leakage is negatively correlated with the integrity of cell membrane. Shredded beans treated with 1% calcium chloride scored the least (88.49) percent leakage which was on par with the sample treated with 1% calcium ascorbate (88.68). The maximum (94.21) percent leakage was for 0.1% acetic acid treated shredded beans which were on par with untreated shredded beans (93.87).

Treatments which maintain the freshness naturally should be accepted by the consumers. Loss in moisture results in reduction of fresh weight accompanied by loss of freshness, appearance and texture in cabbage [13]. In the present study all the beans shreds pre treated with calcium compounds which had superior physiological parameters showed high acceptability for physical parameters like appearance, colour, flavor,taste and texture. Calcium lactate solution resulted in textural improvement similar to calcium chloride and had better flavour in cantaloupe melon [8] and similar result was also reported by [15] who compared the effect of calcium chloride and calcium lactate dips in fresh-cut cantaloupe firmness evaluation.

Combination treatment of sodium benzoate + citric acid was also found effective for fresh cut beans there by giving better appearance for fresh cut samples. But those treatments resulted in high percent leakage and transpiration loss, hence exhibiting low rank values for texture, color and overall acceptability. Two percent sodium chloride was another chemical which was effective in retarding the physiological weight loss of shredded beans, and hence shredded beans treated with this chemical scored better mean rank value for physical parameters like appearance, texture and color during sensory evaluation.

Acetic acid treated fresh cut beans were not at all accepted by the sensory panels which is evident from low mean rank values. Steamed sample of 0.1% acetic acid treated shredded beans showed adverse color change during steaming which had resulted in least sensory scores for all the physical parameters evaluated.

CHEMICAL PARAMETERS

Chemical quality parameters viz., vitamin C, and total phenol were influenced by the application of pre storage treatments while there was no significant difference on the starch content of fresh cut beans (Table 3).

Starch content of shredded beans was same for all samples whether treated or untreated. Higher starch content could be attributed to lesser break down of starch due to influence of chemicals by preventing the activities of enzymes like amylase and hydrolyze [21]. Inhibition of starch hydrolysis resulted in higher firmness for the tissues and thus scoring high mean rank values for texture during organoleptic test (Table 1).

Highest vitamin C (10.12) content was observed in shredded beans treated with 1% calcium chloride which was on par with the samples treated with 1%

Table 3
Effect of pre-storage treatments on chemical quality parameters of fresh cut beans

Pre storageTreatments	*Starch (%)*	*Vit. C (mg/100g)*	*Total phenol (mg/100g)*
0.1% KMS + 0.1% ascorbic acid	3.85	9.87	27.29
0.1% KMS + 0.1% citric acid	3.82	9.85	28.90
0.1% Sodium benzoate + 0.1% ascorbic acid	3.73	9.72	32.35
0.1% Sodium benzoate + 0.1% citric acid	3.75	9.92	24.63
Calcium chloride (1%)	3.66	10.12	21.53
Calcium ascorbate (1%)	3.72	9.96	23.57
Sodium chloride (2%)	3.66	9.76	29.35
Acetic acid (0.1%)	3.56	9.46	32.18
Control (without any treatment)	3.74	9.47	33.93
CD (P = 0.05)	NS	0.21	1.11

calcium ascorbate (9.96) and 0.1% sodium benzoate + 0.1% ascorbic acid (9.92). Here combination treatment of preservatives and acidulants were also effective in increasing the vitamin C content. Cauliflower can be preserved by using different concentrations and combinations of potassium metabisulphite (KMS) and citric acid in maintaining better physio-chemical, sensory qualities and checking microbial growth as discussed by [5]. The maximum content of ascorbic acid in the shreds might be due to the presence of ascorbic acid content in the anti browning chemical, calcium ascorbate and thereby less enzymatic oxidation of L-ascorbic acid to de hydro ascorbic acid [12]. Another result by [17] reported that ascorbic acid infusion in potato yielded a product of comparable colour and quality as that of sulphited product but with a lower shelf life. Similarly [21] reported a higher ascorbic acid retention in potato slices and cubes treated with 0.5% ascorbic acid + 0.2% KMS + 2% NaCl.

Least (9.46) vitamin C was recorded by the cut beans sample treated with 0.1% acetic acid which was on par with the untreated sample (9.47), which might be due to the oxidative reduction of vitamin C in presence of molecular oxygen by ascorbic acid oxidase enzyme [21] and similar result was also observed in capsicum by [6].

Any fresh cut vegetable should have low phenol content to avoid enzymatic browning and visual quality loss. Total phenol was least (21.53) in sample treated with 1% calcium chloride which was found significantly different from all the other treatments. The lower phenol content indicate least enzymatic browning and hence scored superior rank value in physical parameters like appearance and color. Highest phenol content was recorded by untreated shredded beans (33.93) hence they scored poor mean rank values in physical parameters.

When the effect of different pre-storage treatments was tested, none of the treatments showed uniform superior performance for all the quality parameters tested. Hence comparatively more important physiological and chemical parameters which decide the quality of any fresh cut vegetables, have given more weightage and discriminal function test was conducted, based on which selection index was calculated (Table 4). Fresh cut beans treated with a good pre- storage treatment chemical should have low PLW, percent leakage and phenol content, and at the same time; it should retain increased vitamin C. Hence these characters were considered for calculation of selection index.

Table 4
Microbial count on beans shreds treated with superior treatments

Pre storage treatments	*Bacterial count × 10^4 cfu/g*
0.1% KMS + 0.1% ascorbic acid	2.44
0.1% sodium benzoate + 0.1% citric acid	2.46
Calcium chloride 1%	2.42
Calcium ascorbate 1%	2.41
CD (0.05)	0.046

Based on selection index, calcium chloride, calcium ascorbate and KMS + ascorbic acid and sodium benzoate + citric acid were selected as top four pre-storage treatments for shredded beans.Then fresh cut beans were surface sanitized using 30 ppm sodium hypochlorite solution and pretreated with the top four selected pre-storage treatments and subjected to microbial analysis.

Microbial analysis on the top four pre storage treated shredded beans showed that KMS + ascorbic acid, calcium chloride and calcium ascorbate were equally effective in reducing the microbial population which was supported by [9] thatdipping treatments after peeling and/or cutting both reduce microbial loads and rinse of tissue fluids, and thus reduce the

growth of microorganisms**.** But comparing with other three treatmentssodium benzoate + citric acid showed significant difference (Table 4) and the result was supported by [4] and [22] that increase in microbial population on minimally processed products is associated to damaged tissues and broken cells andsimilarly [23] revealed that increased handling of the product provides greater opportunity for contamination by pathogenic organisms.

Compared with the three microbially effective chemicals calcium ascorbate is very costly and compared to KMS + citric acid, calcium chloride treated samples had good colour when steamed for sensory test and hence calcium chloride was selected as the best pre storage treatment for shredded beans which was supported by [2] who reported that one percent calcium chloride was effective in extending the shelf life of fresh cut pomegranate and pine apple by maintaining the freshness and quality.

In general, any pretreatment having capacity to maintain physical, physiological and chemical quality parameters and to reduce the microbial population of shredded beans, stored under refrigerated condition can be selected as the efficient pre-storage treatment. The present study revealed the superiority of calcium for pre storage treatments and this Calcium chloride has been one of the most frequently used salts of calcium and other calcium salts such as calcium lactate, calcium propionate or calcium ascorbate have been investigated as alternative sources of calcium [8, 1, 16]. Hence on the basis of physical, physiological and chemical parameters, one percent calcium chloride was selected as the best effective pre storage treatment for increasing the shelf life of fresh cut beans under refrigerated storage.

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