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Effect of Chemical Additives on the Shelf Life of Cucumber Juice

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ABSTRACT
Cucumber (*Cucumis sativus* L.) is a commercially cultivated worldwide as a seasonal vegetable crop. The aim of the experiment was to compare the effect of different chemical additives namely Sodium benzoate, Potassium metabisulfite(KMS) and their combination, on the physicochemical and phytochemical parameters and antioxidant activity of cucumber juice. The storage was done for 6 months at room temperature and the analysis was conducted at the interval of one month. For the physicochemical parameters like TS, TSS, acidity, color values (Lab), a very slight but non-significant change was observed. Vitamin C, total phenols and antioxidant activity changed significantly ($p \leq 0.05$). The variation was found in the color of different samples. Considering all the parameters, samples treated with potassium metabisulfite maintained the maximum nutrient stability.
Keywords: Antioxidant activity, Chemical additives, Cucumber, Phytochemicals

I. INTRODUCTION

Cucumber (*Cucumis sativus* L.), belongs to the Cucurbitaceae family. It is commercially cultivated worldwide as a seasonal vegetable crop. It is native to India, found wild in the Himalayas from Kumaun to Sikkim and cultivated throughout the country [1]. It is widely consumed fresh in salads or fermented (pickles) or as a cooked vegetable [2]. The fruits are sweet, refrigerant, haemostatic and tonic. Therefore traditionally it is used for the wide spectrum of cure in rural and urban areas to remove general debility, for treatment of skin problems and as a cooling agent [3]. Several pharmacological activities including the antioxidant, antiwrinkle, antimicrobial, antidiabetic, and hypolipidemic potentials have been reported with this plant. Few bioactive compounds have been derived from this plant belonging to different chemical groups. Bitter principles Cucurbitacins are the characteristic properties of this species that exhibited cytotoxicity and anti-cancer activity. The polyphenol contents have also been reported in cucumber [4]. The seeds are useful for quitting burning sensation, constipation, tonic and intermittent fevers [3]. The methanolic extract of C. sativus seeds possessed significant ulcer potential which could be due to the antioxidant activity [5].

But during the harvesting seasons, large quantities of Cucumber get spoiled due to excess production. So a Long term preservation method is required that could be useful to prevent spoilage of cucumber such that it could be consumed in off seasons as well. Keeping in view, the present study was conducted to process and preserve the cucumber juice.

II. MATERIALS AND METHODS

2.1. Raw materials

The study was conducted in the Department of Food Science and Technology, Punjab Agricultural University, Ludhiana. Cucumbers were procured from the local market.

2.2. Extraction process of cucumber juice

Fresh cucumbers were washed thoroughly and cut off from the top and bottom. Cucumber juice was extracted in a juicer extractor (Kalsi: 9001-2008). The juices were pasteurized at 83°C for 3 min and citric acid @ 0.15% was added, followed by chemical preservatives.

Dose distribution of chemical additives

Sample	Chemical additives	Dose(ppm)
T_2	Na-benzoate	3000
T_3	KMS	3000
T_4	Na-benzoate+ KMS	1500+1500

The pre-sterilized glass bottles were filled with the hot juice and corked. T_1 sample was given the pasteurization treatment followed by processing at 100°C for 20 min in boiling water bath and gradually cooled to a low temperature under running tap water. These processed juices were kept for storage at room temperature for six months.

2.3. Physico-chemical analysis

Cucumber juices were analysed at regular interval of one month for the parameters like Total solids**,** acidity using AOAC methods [6]. TSS was taken using hand refractometer(ERMA, Japan), color using Minolta Hunter colorimeter.

2.4. Phytochemical analysis

For phytochemical parameters, Vitamin C was determined by the titrimetric method using dichlorophenol indophenol dye [7]. Total phenolic content was determined by Folin-ciocalteau reagent [8]. A standard curve was plotted by taking known amount of Gallic acid as reference standard and concentration was calculated from the standard curve. The % Antioxidant activity was determined by DPPH (2, 2-diphenyl-2-picrylhydrazyl) method [9]. Methanolic extract of sample was taken for antioxidant activity analysis and calculated according to the following formula. BHT was taken as a standard at a fixed concentration of 5mg/ml.

$$\% \text{ AA} = \frac{\text{Control OD (0 min)} - \text{Sample OD (30 min)} \times 100}{\text{Control OD (0 min)}}$$

2.5. Statistical analysis

The results were evaluated by Analysis of Variance (ANOVA) and Tukey's post hoc tests using Systat statistical program version 16 (SPSS Inc., USA).

III. RESULTS AND DISCUSSION

The samples were studied for the effect of different chemical additives on Physicochemical [TS, TSS, Acidity, Color (L, a, b)], Phytochemical (Ascorbic acid, Total phenols) and % antioxidant activity for the storage period of 6 months.

3.1. Effect on Total solids and TSS

TS increased non-significantly ($p \leq 0.05$) in all the juices during the storage. On the day of preparation, the amount of TS in sample T1, T2, T3, T4 were 4.77, 5.23, 5.07 and 5.40 respectively. At the end of 6 months, the TS in the samples increased to 5.41, 5.88, 5.72 and 6.15 respectively (Table 1). The TSS values of samples T_1 to T_4 on day first were 3.2, 3.6, 3.4 and 3.5 which gradually increased to 3.4, 3.8, 3.6 and 3.7 respectively after 6 months of storage. Although TSS increased for all the samples but the changes were non-significant ($p \leq 0.05$). Similar results reported an increase in soluble content of apple pulp during storage when preserved with chemical preservatives [10]. The minimum TSS was found in T_1 and the maximum in sample T_2.

3.2. Effect on Color (L a b values)

On the day of preparation, the lightest sample was T_2 followed by T_1, T_3 and T_4. Similarly, at the end of 6 months, T_2 remained the lightest and T_3 was darker than the other samples. In terms of greenness 'a', T2 retained the maximum greenness than the other 3 samples(Table 1). Again, b values were highest for T_2 and lowest for T_1 and results after 6 months of storage, remained the same for all the samples. On the whole, sample T_2 with Sodium benzoate retained the best color of all the 4 samples. Tomato juice with Na benzoate seems to be more stable than the other preservatives during 6 months of storage and developed lesser off color and turbidity [11].

3.3. Effect on acidity

According to the results, chemical additives have no significant effect ($p \leq 0.05$) on acidity of the cucumber juice. The titratable acidity of samples T_1 to T_4 found to be on day first was 0.028 0.029, 0.031 and 0.034 that gradually increased to 0.064, 0.049, 0.051 and 0.05 respectively(Table 1). An increase in titratable acidity of apple pulp was found during storage [10]. The acidity of the thermally treated sample (T_1) increased more as compared to other chemically treated samples and the change was least in T_4 sample.

3.4. Effect on Vitamin C content

According to the results, chemical additives have significant effect ($p \leq 0.05$) on Vitamin C content of cucumber juice. On the day of preparation, Vitamin C content in samples T_1, T_2, T_3 and T_4 was 4.23, 6.05, 7.26 and 6.65mg/100g respectively. The values came out to be lower in T_1 as heat treatment destroys Vitamin C. at the end of 6 months, the Vitamin C content reduced to 2.77, 2.86, 4.12 and 3.76 respectively(Table 2). Vitamin C is light and heat sensitive, the concentration of Vitamin C follows first order kinetics and thus storage time affects Vitamin C content [12]. Out of the chemically treated samples, potassium metabisulphite retained the maximum Vitamin C. The application of KMS reduces the loss of ascorbic acid during the storage of leafy vegetables [13].

3.5. Effect on Total Phenols

The total phenolic content in samples T_1 to T_4 on the first day was 240, 320, 340 and 370 respectively. The added chemicals preserved the phenolic content more than thermally treated sample (T_1). At the end of 6 months, the total phenolic content came out to be 139, 221, 279 and 304 respectively (Table 2). According to the findings, a decrease in total polyphenol content of tomato juices after 3, 6 and 9 months of storage were reported [14]. The decrease was found to be least in sample T_3, followed by T_4 and T_2.

3.6. Effect on Antioxidant activity

According to the results, on the day of preparation, percent Antioxidant activity for samples T_1 to T_4 was found to be 58.96, 64.42, 70.95 and 73.99 respectively (Table 2). Significant ($p \leq 0.05$) decrease in antioxidant activity was found during storage months. At the end of 6 months, the %

antioxidant activity decreased to 28.83, 44.10, 59.35 and 61.80 percent respectively. However, the decrease was found to be least in sample T_3. It has been reported that the decrease in antioxidant activity may be linked to a decrease in total phenolic content and vitamin C during storage [15]. According to them, antioxidant activity of orange juices decreased by 45 percent after 6 months of storage at 28°C.

IV. CONCLUSION

The experiment was to compare the effect of different chemical additives on the storage stability of cucumber juice. In this study, it is evident that potassium metabisulphite proved to be a better preservative than Na-benzoate for the stability of physicochemical and phytochemical parameters and maintaining the antioxidant activity of the cucumber juice.

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Table 1: Effect of storage on Physico-chemical properties of Cucumber juice

	SAMPLES	0	1	2	3	4	5	6
TS (%)	T1	4.77^{aA}	4.86^{aA}	4.92^{aA}	5.09^{aA}	5.14^{aA}	5.26^{aA}	5.41^{aA}
	T2	5.23^{aA}	5.27^{aA}	5.32^{aA}	5.47^{aA}	5.62^{aA}	5.78^{aA}	5.88^{aA}
	T3	5.07^{aA}	5.17^{aA}	5.27^{aA}	5.34^{aA}	5.43^{aA}	5.61^{aA}	5.72^{aA}
	T4	5.4^{aA}	5.61^{aA}	5.73^{aA}	5.87^{aA}	5.96^{aA}	6.07^{aA}	6.15^{aA}
TSS (°Brix)	T1	3.2^{aB}	3.2^{aB}	3.2^{aB}	3.3^{aB}	3.3^{aB}	3.3^{aB}	3.4^{aB}
	T2	3.6^{A}	3.6^{aA}	3.6^{aA}	3.7^{aA}	3.7^{aA}	3.8^{aA}	3.8^{aA}

	T3	3.4^{aAB}	3.4^{aAB}	3.5^{aA}	3.5^{aAB}	3.5^{aAB}	3.6^{aA}	3.6^{aAB}
	T4	3.5^{aA}	3.5^{aA}	3.5^{aA}	3.6^{aA}	3.6^{aA}	3.6^{aA}	3.7^{aA}
ACIDITY (%)	T1	0.028^{bA}	0.032^{bA}	0.035^{bA}	0.043^{abA}	0.049^{abA}	0.055^{abA}	0.064^{aA}
	T2	0.029^{aA}	0.032^{aA}	0.035^{aA}	0.039^{aA}	0.041^{aA}	0.045^{aA}	0.049^{aA}
	T3	0.031^{aA}	0.034^{aA}	0.038^{aA}	0.041^{aA}	0.044^{aA}	0.048^{aA}	0.051^{aA}
	T4	0.034^{aA}	0.036^{aA}	0.037^{aA}	0.042^{aA}	0.044^{aA}	0.045^{aA}	0.05^{aA}
L	T1	31.34^{aA}	31.27^{aA}	31.19^{aA}	31.09^{aAB}	30.86^{aAB}	30.54^{aAB}	29.92^{aAB}
	T2	32.8^{aA}	32.7^{aA}	32.57^{aA}	32.49^{aA}	32.11^{aA}	31.96^{aA}	31.84^{aA}
	T3	30.65^{aA}	30.54^{aA}	30.43^{aA}	29.09^{aB}	28.93^{aB}	28.78^{aB}	28.65^{aB}
	T4	30.59^{aA}	30.49^{aA}	30.37^{aA}	30.23^{aAB}	30.11^{aAB}	29.96^{aAB}	29.69^{aAB}
a	T1	-1.14^{aA}	-1.12^{aA}	-1.08^{aA}	-1.02^{aA}	-0.97^{aA}	-0.91^{aA}	-0.88^{aA}
	T2	-1.19^{aA}	-1.18^{aA}	-1.14^{aA}	-1.1^{aA}	-1.04^{aA}	-0.99^{aA}	-0.95^{aA}
	T3	-1.16^{cA}	-1.54^{bB}	-1.1^{abA}	-1.06^{abA}	-1.01^{abA}	-0.96^{abA}	-0.9^{aA}
	T4	-1.17^{aA}	-1.16^{aA}	-1.11^{aA}	-1.08^{aA}	-1.03^{aA}	-0.95^{aA}	-0.92^{aA}
b	T1	1.48^{aA}	1.39^{aA}	1.28^{aA}	1.21^{aA}	1.16^{aA}	1.11^{aA}	1.04^{aA}
	T2	1.86^{aA}	1.81^{aA}	1.74^{aA}	1.61^{aA}	1.54^{aA}	1.48^{aA}	1.39^{aA}
	T3	1.81^{aA}	1.75^{aA}	1.66^{aA}	1.52^{aA}	1.42^{aA}	1.35^{aA}	1.29^{aA}
	T4	1.84^{aA}	1.79^{aA}	1.71^{aA}	1.58^{aA}	1.44^{aA}	1.38^{aA}	1.31^{aA}

* Data is expressed as means
*Values followed by different upper case or lower case letters are significantly different ($p \leq 0.05$) within columns and rows respectively

TABLE 2: Effect of storage on Phytochemical properties and antioxidant activity of Cucumber juice

	SAMPLES	**0**	**1**	**2**	**3**	**4**	**5**	**6**
ASCORBIC ACID (mg/100g)	T1	5.23^{aB}	4.14^{aB}	4.02^{aA}	3.97^{aAB}	3.37^{aB}	3.02^{aB}	2.77^{aA}
	T2	6.05^{aA}	5.86^{aA}	4.62^{abAB}	3.57^{bcB}	3.46^{bcB}	3.16^{bcB}	3.26^{cA}
	T3	7.26^{Aa}	6.62^{abA}	6.01^{abcA}	5.35^{bcdA}	4.97^{cdA}	4.21^{dAB}	4.72^{dA}
	T4	6.65^{aA}	5.97^{abA}	5.23^{abcAB}	4.76^{bcAB}	4.53^{bcAB}	4.68^{bcA}	3.96^{cA}
TOTAL PHENOLS (mg/100g)	T1	240^{aB}	210^{aB}	200^{aB}	180^{aB}	167^{aB}	151^{aB}	139^{aB}
	T2	320^{aAB}	315^{aA}	297^{aA}	280^{aA}	264^{aA}	242^{aAB}	221^{aAB}
	T3	340^{aA}	335^{aA}	327^{aA}	320^{aA}	305^{aA}	291^{aA}	279^{aA}
	T4	370^{aA}	350^{aA}	343^{aA}	336^{aA}	325^{aA}	312^{aA}	304^{aA}
%A A	T1	58.96^{aC}	41.07^{bC}	36.05^{cC}	32.97^{cdC}	30.84^{dC}	29.76^{dC}	28.83^{dC}
	T2	64.42^{aB}	61.16^{abB}	58.10^{bB}	50.40^{cB}	49.45^{cdB}	45.20^{deB}	44.10^{eB}
	T3	70.95^{aA}	70.11^{aA}	67.59^{abA}	64.03^{bcA}	62.65^{bcA}	60.55^{cA}	59.35^{cA}
	T4	73.99^{aA}	70.59^{abA}	69.10^{abA}	67.30^{bcA}	65.35^{cdA}	64.40^{cdA}	61.80^{dA}

* Data is expressed as means
*Values followed by different upper case or lower case letters are significantly different ($p \leq 0.05$) within columns and rows respectively