Biological Forum – An International Journal **14(2a): 576-582(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of Chemical Pretreatments on the Chemical Characteristics of Dehydrated Onion Slices

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(Received 30 April 2022, Accepted 23 June, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The present investigation was carried out in Department of Post Harvest Technology at College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari District of Andhra Pradesh during 2017 and 2018 with an objective to study the effect of different pretreatments on chemical characteristics of onion slices. Dehydration of onion is required to provide a way for utilization during off-season and pretreatments are used to improve the quality attributes of onion slices. In preparation of dehydrated onion slices, four pre-treatments *viz*., 0.5% potassium metabisulfite (KMS), 2% calcium chloride ($CaCl_2$), 2% Sodium chloride (NaCl) and control with two varieties *viz*., Agrifound Dark Red and Phule Safed were used. The experiment was conducted in completely randomized factorial design with the above two factors at unequal levels and replicated thrice. Pungency was more in Agrifound Dark Red variety pretreated with 0.5% KMS (6.20 µ mol pyruvic acid/g). Maximum total soluble solids were recorded in Phule Safed pretreated with 0.5% KMS (13.79 ºBrix). Reducing sugars were recorded high in Phule Safed variety pretreated with 0.5% KMS (19.19%). Phule Safed variety pretreated with 0.5% KMS (38.35%) recorded maximum total sugars. Among the pretreatments, the highest non reducing sugars were recorded in the onion slices pretreated with 2% NaCl (18.99%). Among the varieties, highest non reducing sugars were recorded in Phule Safed (18.95%). Ascorbic acid was recorded maximum in Agrifound Dark Red variety pretreated with 0.5% KMS (35.94 mg 100 g^{-1}). Among the pretreatments, the maximum titrable acidity was recorded in the onion slices pretreated with 2 % NaCl (3.57%). Among the varieties, maximum titrable acidity was recorded in Agrifound Dark Red (3.49%).

Keywords: Chemical characteristics, pretreatments, Agrifound Dark Red, Phule Safed, onion slices

INTRODUCTION

The most widely cultivated species of the genus *Allium* which belongs to the family Alliaceae is onion (*Allium cepa* L), also known as bulb onion or common onion (Brewster, 2008). It is necessary to employ modern preservation techniques to extend storage life for better distribution and to preserve them for utilization in the off-season. Onions stored for long periods are subject to storage rot, sprouting, rooting, and loss of water (Akbari and Patel 2003). The storage losses of onion in India ranges from 30 to 60% due to various factors such as physiological loss in weight (25-30%), rotting due to fungal diseases (10-15%) and sprouting of bulbs (10-15%) (Pramod *et al.,* 2014). Dehydrated onions are simple to use and have more shelf life than fresh ones. Dehydration of onion is necessary for consumption, storage and utility of onion in off-season. By dehydrating the produce, the bulkiness of the fresh produce is reduced which in turn reduces the transportation cost and is easy to handle. Dried onions are of considerable importance in world trade and made in several forms *viz*., flaked, minced, chopped and powdered. Pre-treatments play an important role in permeabilisation, enzyme inactivation, oxidation, and acceleration of drying rate in many fruits and vegetables (Tiwari *et al.,* 2021). Dehydrated onion is also used as a flavouring additive in several products in food industries such as meat products, sauces, soups, salad dressings, pickles and other snack items (Lewicki *et al.,* 1998). In dehydration of onion, the moisture content is reduced to a safe storage level without destroying its texture, colour, flavour and nutritive value under controlled conditions (Adarsh *et al.,* 2014). Various dehydration techniques have been reported by several workers to improve the quality of dehydrated onions (Pawar *et al.,* 1988; Singh and Sodhi 2000; Kalra and Bharadwaj 1981; Sagar, 2001). Pretreatments are common in most drying processes to improve product quality or process efficiency. Potassium

metabisulphite is used as a stable source of sulphur dioxide. Calcium chloride was reported to be a possible inhibitor of browning. Its inhibitory effect is due to the chelation of calcium with amino acids. Sodium chloride kills or limits the growth of food borne pathogens and spoilage organisms by decreasing water activity. The aim of this experiment is to find the effect of chemical pretreatments on chemical characteristics of dehydrated onion slices.

MATERIALS AND METHODS

A. Raw material collection and Sample preparation

The varieties 'Agrifound Dark Red' and 'Phule Safed' were procured from two completely different production catchments specifically Kurnool and Nasik. The bulbs of 'Agrifound dark red' are dark red in colour, globular in shape with tight skin and moderately pungent, and 'Phule Safed' bulbs are also globular in shape with tight skin but with silvery attractive white colour and good keeping quality.

Care was taken to choose good quality onion by considering significant factors like size, shape and freedom from physical damage. The onion bulbs were then thoroughly cleansed to rid of any dirt or dust particles attached to the surface.

B. Preparation of onions for pretreatments

The cleaned onions were peeled manually by removing the skin and therefore the first layer. After peeling, they were washed thoroughly with water and then trimmed so as toavoid leaching of pungency. Onions were sliced to 2 to 5 mm thickness by using a sharp stainless steel knife in the direction perpendicular to the vertical axis.

C. Pretreatment method

Chemicals used for pre-treatment were 0.5% KMS, 2% $CaCl_2$ and 2% NaCl. 0.5 % KMS is prepared by dissolving 5 grams of KMS in one litre of distilled water. 2% $CaCl_2$ and 2% NaCl solutions were prepared by dissolving 20 grams of $CaCl_2$ and 20 grams of NaCl each in one litre of distilled water. Bulbs were soaked in these pretreatments for ten minutes. The constant ratio of pre-treatment solution to sample is 4 litres per 1 kg of onion slices *i.e.,* 4:1 at room temperature.

D. Dehydration and preparation of onion powder

The drying experiments were conducted in the laboratory using tray drier. A known weight of untreated and pretreated onion slices were spread uniformly in thin layer on aluminum trays and air dried to remove water adhered on the surfaces of strained slices. Onion slices were then thoroughly dried at 50-60 ^oC temperature till they reached the desired product quality and moisture content *i.e.,* 4-7%.

RESULTS AND DISCUSSIONS

The fresh Agrifound Dark Red onion contained5.11 µ mol pyruvic acid and 3.32 µ mol pyruvic acid in Phule Safed variety. Decreasing trend of pungency was observed during the storage of onion slices (Table 2). Among the pretreatments, 0.5% KMS treated onion slices recorded maximum pungency (5.39 µ mol pyruvic acid/g) which is followed by 2% $CaCl_2$ (5.29 µ mol pyruvic acid/g) whereas, control samples recorded minimum pungency (5.01 µ mol pyruvic acid/g)where as among varieties, maximum pungency was recorded in Agrifound Dark Red (6.08 µ mol pyruvic acid/g) and Phule Safed recorded minimum pungency (4.31 µ mol pyruvic acid/g). On all days of storage (initial, 15, 30, 45 and 60 days) Agrifound Dark Red variety pretreated with 0.5% KMS recorded maximum pungency of 6.20, 6.19, 6.16, 6.12 and 6.09 µ mol pyruvic acid/g and minimum content of pungency of 4.05, 4.03, 4.00, 3.94 and 3.89 µ mol pyruvic acid/g were recorded in untreated Phule Safed onion slices on all days of storage *i.e.,* initial, 15^{th}, 30^{th}, 45^{th} and 60^{th} day of storage. The reduction in pungency might be attributed to hydrolysis of polysaccharides and non reducing sugars where acid is utilized for converting them to hexose sugars and degradation of pungency constituents in onion. Similar results were also reported by Shock *et al.* (2004), who concluded that, there was a correlation between increase in total sugar and decrease in pyruvic acid.

The results regarding total soluble solids showed that, there was significant difference among all the treatments and total soluble solids increased from initial to 60^{th} day of storage in both the varieties (Table 3). Maximum total soluble solids was recorded in onion slices pretreated with 0.5% KMS from the initial day of storage (13.33 ºBrix) whereas, minimum total soluble solids was recorded in untreated onion slices from the initial day of storage (12.97 ºBrix) and increases further on the progress of days. Among the varieties, maximum total soluble solids was recorded in Phule Safed from the initial day of storage (13.6 ºBrix) to final day of storage (19.33 ºBrix) and minimum total soluble solids was recorded in Agrifound Dark Red from initial (12.69 ºBrix) to final day of storage (18.73 ºBrix). On the initial, 15^{th} and 30^{th} day of storage, onion slices of Phule Safed pretreated with 0.5% KMS recorded maximum total soluble solids *i.e.,* 13.79, 14.82 and 15.66 ºBrix respectively whereas, minimum total soluble solids was recorded in untreated Agrifound Dark Red variety *i.e.,* 12.52, 13.45 and 14.36 ºBrix on initial, 15^{th} and 30^{th} day of storage. The interaction effect on 45^{th} day of storage, the maximum total soluble solids was recorded in Phule Safed pretreated with 0.5% KMS (17.43 ºBrix) and minimum was recorded in untreated Agrifound Dark Red (16.01 ºBrix) but on 60^{th} day of storage, maximum total soluble solids was recorded in Phule Safed pretreated with 2% $CaCl_2$ (19.71 ºBrix). The increase in TSS with the increase in storage period might also be attributed to the conversion of polysaccharides into soluble forms of sugars (Singh and Dhankhar 1992). These findings are in agreement with the findings of Dabhi *et al.* (2008).

Reducing sugars increased significantly with the increase in storage period from initial day of storage to 60^{th} day of storage and there was significant difference among all the treatments (Table 4). There was an increase in sugar content after dehydration which may be due to removal of moisture. Among the pretreatments, highest reducing sugars was recorded in the onion slices pretreated with 0.5% KMS from the

initial day of storage (18.72%) to 60th day of storage (26.14%) whereas, lowest reducing sugars was recorded in untreated onion slices from initial (16.90%) to the final day of storage (24.13%). Among the varieties, highest reducing sugars was recorded in Phule Safed from initial (18.05%) to 60th day of storage (25.08%) and lowest reducing sugars was recorded in Agrifound Dark Red from initial (17.24%) to the final day of storage (24.93%). Similar result was reported by Dev *et al.,* (2006). Ghavidel and Davoodi (2010) reported that $CaCl_2$ along with KMS pretreated samples showed higher sugar content followed by samples pretreated with $CaCl_2$ and NaCl and also stated that changes in sugar content may be related to two reasons *i.e.*, non-enzymatic browning which was found to be more in control samples and other is dipping duration. It is suggested that degradation of reducing sugar during storage is attributed to the formation of browning compounds resulting by the reaction of sugars and amino acids (Kyung *et al*., 2012). Wani (2015) reported that, irrespective of pretreatments and drying methods, there was a decrease of reducing sugars during storage.

Total sugars increased from initial to final day of storage. From table 5 there was significant difference among all treatments and changes in total sugar content during storage might be related to the non-enzymatic reaction (Ghavidel and Davoodi 2010). Increase in total sugar content during storage period might be due to accelerated hydrolysis of insoluble polysaccharides and other carbohydrate polymers and increased degree of inversion of sugar. Among the pretreatments, 0.5% KMS pretreated onion slices recorded highest total sugars from initial day (37.28%) to the final day of storage (44.66) whereas, lowest total sugars was recorded in untreated onion slices (34.19%). Among the varieties, Phule Safed recorded highest total sugars from initial (37.00%) to the final day of storage (44.58%) and lowest total sugars was recorded in Agrifound Dark Red from the initial day (34.43%) to 60th day of storage (40.57%). During storage period, there was a considerable increase in reducing sugars level and corresponding decline in non-reducing sugars. This could be due to the inversion of non-reducing sugars to reducing sugars caused by acid present in dehydrated product (Table 6).

The results showed that there was a significant difference among all the treatments. Ascorbic acid content decreased significantly with the increase in storage period from the initial day of storage to 60 days after processing (Table 7). Among the pretreatments, better retention of ascorbic acid was recorded in the onion slices pretreated with 0.5% KMS from the initial day (35.40 mg 100 g^{-1}) to 60th day of storage (30.03 mg 100 g^{-1}) whereas, minimum retention of ascorbic acid was recorded in untreated onion slices from the initial day of processing (33.45 mg 100 g^{-1}) to the final day of storage (28.71 mg 100 g^{-1}). Among the varieties, Agrifound Dark Red variety recorded better retention of ascorbic acid from the initial day of processing (34.75 mg 100 g^{-1}) to 60th day of storage (29.60 mg 100 g^{-1}) and minimum retention of ascorbic acid was observed in Phule Safed from initial (34.11 mg 100 g^{-1}) to the final day of storage (29.02 mg 100 g^{-1}). There was more retention of ascorbic acid content in dehydrated onions which were pretreated with KMS. The entire phenomenon is not readily explicable. Similar findings with slight variations were reported earlier by Teaotia *et al*., (1987). A decreasing trend in ascorbic acid content of onion bulbs with increase in storage period was noticed by Singh and Dhankhar (1992). The changes in the titrable acidity during storage might be due to the reaction of basic amines to form compounds of lower basicity and degradation of sugars into acids as a result of maillard reaction. Pretreatment of onion slices with NaCl samples showed slightly more acidity as compared to the untreated samples. Similar findings were reported in tomato by Ghavidel and Davoodi (2010). There is decreasing trend in titrable acidity with increase in storage period. Among the pretreatments, the maximum titrable acidity was observed in the onion slices pretreated with 2% NaCl from the initial day (3.57%) to 60th day of storage (1.97%) which is followed by 0.5% KMS from initial (3.20%) to final day of storage (1.65%), whereas, minimum titrable acidity was registered in onion slices pretreated with 2% $CaCl_2$ from initial day of storage (2.45%) to final day of storage (1.01).

Among the varieties, maximum titrable acidity was recorded in Agrifound Dark Red onion slices from the initial day (3.49%) to 60th day of storage (1.65%) and minimum titrable acidity was registered in Phule Safed on the initial day (2.58%) to the final day of storage (1.33%). The interaction effect between pretreatments and varieties was found to be non significant (Table 8).

Table 1: Chemical characteristics of fresh onion used for preparation of dehydrated onion slices.

Variety	Pungency (µ mol pyruvic acid)	TSS (^{o} Brix)	Reducing sugars (%)	Total sugars (%)	Non-reducing sugars (%)	Ascorbic acid (mg 100g $^{-1}$)	Titrable acidity (%)
Agrifound Dark Red	5.11	11.48	1.78	7.93	6.15	5.72	1.28
Phule Safed	3.32	12.6	3.9	11.38	7.48	5.69	0.64

Table 2: Effect of chemical pretreatments on pungency (µ mol pyruvic acid/g) of onion slices during storage at ambient conditions.

Pretreatments	Initial			15th day			30th day			45th day			60th day		
	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean
0.5% KMS	6.20	4.58	**5.39**	6.19	4.57	**5.38**	6.16	4.54	**5.35**	6.12	4.50	**5.31**	6.09	4.46	**5.27**
2% $CaCl_2$	6.11	4.47	**5.29**	6.08	4.45	**5.26**	6.04	4.42	**5.23**	6.00	4.37	**5.18**	5.93	4.32	**5.12**
2% NaCl	6.04	4.15	**5.10**	6.02	4.13	**5.08**	5.99	4.10	**5.04**	5.96	4.04	**5.00**	5.91	4.00	**4.95**
Control	5.96	4.05	**5.01**	5.92	4.03	**4.97**	5.89	4.00	**4.94**	5.83	3.94	**4.89**	5.79	3.89	**4.84**
Mean	**6.08**	**4.31**		**6.05**	**4.30**		**6.02**	**4.26**		**5.98**	**4.21**		**5.93**	**4.17**	
	S.Em±	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**	
V	0.02	0.07		0.02	0.08		0.03	0.09		0.03	0.09		0.03	0.09	
P	0.03	0.10		0.04	0.12		0.04	0.12		0.04	0.13		0.04	0.13	
V×P	0.05	0.15		0.05	0.17		0.06	0.18		0.06	0.18		0.06	0.18	

Table 3: Effect of chemical pretreatments on total soluble solids (^{o}Brix) of onion slices during storage at ambient conditions.

Pretreatments	Initial			15th day			30th day			45th day			60th day		
	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean
0.5% KMS	12.88	13.79	**13.33**	13.79	14.82	**14.30**	14.72	15.66	**15.19**	16.55	17.43	**16.99**	18.92	18.85	**18.88**
2% $CaCl_2$	12.71	13.67	**13.19**	13.68	14.65	**14.17**	14.56	15.60	**15.08**	16.35	17.23	**16.79**	18.86	19.71	**19.29**
2% NaCl	12.64	13.58	**13.11**	13.59	14.53	**14.06**	14.48	15.46	**14.97**	16.14	17.11	**16.62**	18.63	19.51	**19.07**
Control	12.52	13.42	**12.97**	13.45	14.40	**13.92**	14.36	15.29	**14.83**	16.01	17.80	**16.90**	18.50	19.27	**18.89**
Mean	**12.69**	**13.61**		**13.63**	**14.60**		**14.53**	**15.50**		**16.26**	**17.39**		**18.73**	**19.33**	
	S.Em±	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**	
V	0.005	0.014		0.006	0.017		0.005	0.016		0.006	0.017		0.004	0.013	
P	0.007	0.020		0.008	0.024		0.007	0.023		0.008	0.024		0.006	0.018	
V×P	0.010	0.029		0.011	0.034		0.011	0.032		0.011	0.035		0.008	0.025	

Table 4: Effect of chemical pretreatments on reducing sugars (%) of onion slices during storage at ambient conditions.

Pretreatments	Initial			15th day			30th day			45th day			60th day		
	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean
0.5% KMS	18.25	19.19	**18.72**	19.42	20.34	**19.88**	20.59	21.40	**20.99**	22.95	23.71	**23.33**	25.84	26.43	**26.14**
2% $CaCl_2$	17.34	18.23	**17.79**	18.47	19.40	**18.94**	20.33	20.53	**20.43**	22.35	22.52	**22.43**	25.47	25.55	**25.51**
2% NaCl	17.12	17.23	**17.17**	18.35	18.41	**18.38**	19.45	19.62	**19.53**	21.19	21.31	**21.25**	24.18	24.32	**24.25**
Control	16.25	17.55	**16.90**	17.39	18.22	**17.81**	18.62	19.34	**18.98**	21.01	21.13	**21.07**	24.22	24.04	**24.13**
Mean	**17.24**	**18.05**		**18.41**	**19.09**		**19.75**	**20.22**		**21.87**	**22.17**		**24.93**	**25.08**	
	S.Em±	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**	
V	0.058	0.176		0.026	0.079		0.053	0.162		0.024	0.072		0.026	0.078	
P	0.082	0.249		0.037	0.111		0.076	0.229		0.034	0.102		0.037	0.111	
V×P	0.117	0.352		0.052	0.157		0.107	0.323		0.048	0.145		0.052	0.157	

Table 5: Effect of chemical pretreatments on total sugars (%) of onion slices during storage at ambient conditions.

Pretreatments	Initial			15th day			30th day			45th day			60th day		
	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean
0.5% KMS	36.21	38.35	**37.28**	37.65	39.31	**38.48**	38.13	41.45	**39.79**	40.01	44.72	**42.36**	43.10	46.22	**44.66**
2% $CaCl_2$	34.19	36.25	**35.22**	35.57	37.62	**36.60**	35.38	39.41	**37.39**	37.34	41.51	**39.42**	39.57	43.60	**41.58**
2% NaCl	35.15	37.20	**36.17**	36.53	38.55	**37.54**	37.27	40.33	**38.80**	39.00	42.11	**40.55**	40.75	45.53	**43.14**
Control	32.16	36.21	**34.19**	33.61	37.92	**35.76**	34.39	38.87	**36.63**	36.62	40.01	**38.32**	38.87	42.99	**40.93**
Mean	**34.43**	**37.00**		**35.84**	**38.35**		**36.29**	**40.01**		**38.24**	**42.09**		**40.57**	**44.58**	
	S.Em±	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**	
V	0.029	0.088		0.024	0.072		0.035	0.107		0.027	0.082		0.113	0.342	
P	0.041	0.124		0.034	0.101		0.050	0.151		0.038	0.115		0.160	0.484	
V×P	0.058	0.175		0.047	0.143		0.071	0.213		0.054	0.163		0.160	0.685	

Table 6: Effect of chemical pretreatments on non-reducing sugars (%) of onion slices during storage at ambient conditions.

Pretreatments	Initial			15th day			30th day			45th day			60th day		
	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean
0.5% KMS	17.96	19.16	**18.56**	18.23	18.97	**18.60**	17.53	20.04	**18.79**	17.06	21.00	**19.03**	17.25	19.78	**18.52**
2% $CaCl_2$	16.85	18.01	**17.43**	17.10	18.22	**17.66**	15.04	18.88	**16.96**	14.99	18.99	**16.99**	14.10	18.04	**16.07**
2% NaCl	18.03	19.96	**18.99**	18.18	20.13	**19.15**	17.82	20.70	**19.26**	17.80	20.80	**19.30**	16.57	21.21	**18.89**
Control	15.91	18.66	**17.28**	16.22	19.69	**17.95**	15.77	19.52	**17.64**	15.61	18.88	**17.25**	14.65	18.94	**16.80**
Mean	**17.19**	**18.95**		**17.43**	**19.25**		**16.54**	**19.78**		**16.36**	**19.92**		**15.64**	**19.49**	
	S.Em±	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**	
V	0.066	0.201		0.041	0.124		0.063	0.192		0.030	0.090		0.121	0.366	
P	0.094	0.284		0.058	0.175		0.090	0.271		0.042	0.128		0.171	0.518	
V×P	0.133	0.402		0.082	0.248		0.127	0.384		0.060	0.181		0.242	0.733	

Table 7: Effect of chemical pretreatments on ascorbic acid (mg/100g) of onion slices during storage at ambient conditions.

Pretreatments	Initial			15th day			30th day			45th day			60th day		
	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean
0.5% KMS	35.94	34.86	**35.40**	35.02	34.35	**34.69**	34.96	33.32	**34.14**	32.17	31.95	**32.06**	30.15	29.91	**30.03**
2% $CaCl_2$	33.90	33.71	**33.81**	33.39	33.23	**33.31**	32.40	32.19	**32.29**	31.08	30.66	**30.87**	29.18	28.57	**28.87**
2% NaCl	35.64	34.49	**35.06**	34.96	33.96	**34.46**	33.12	32.85	**32.98**	32.06	31.26	**31.66**	30.03	29.21	**29.62**
Control	33.51	33.40	**33.45**	33.02	32.92	**32.97**	32.00	31.87	**31.93**	31.05	30.43	**30.74**	29.04	28.38	**28.71**
Mean	**34.75**	**34.11**		**34.10**	**33.62**		**33.12**	**32.56**		**31.59**	**31.07**		**29.60**	**29.02**	
	S.Em±	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**	
V	0.02	0.06		0.03	0.10		0.02	0.06		0.03	0.09		0.03	0.09	
P	0.02	0.08		0.04	0.14		0.03	0.09		0.04	0.13		0.04	0.13	
V×P	0.04	0.12		0.06	0.20		0.04	0.13		0.06	0.18		0.06	0.19	

Table 8: Effect of chemical pretreatments on titrable acidity (%) of onion slices during storage at ambient conditions.

Pretreatments	Initial			15th day			30th day			45th day			60th day		
	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean	Agrifound Dark Red	Phule Safed	Mean
0.5% KMS	3.74	2.66	**3.20**	3.30	2.45	**2.88**	2.66	2.13	**2.40**	2.13	1.81	**1.97**	1.81	1.49	**1.65**
2% $CaCl_2$	2.77	2.13	**2.45**	2.13	1.81	**1.97**	2.13	1.81	**1.97**	1.49	1.17	**1.33**	1.17	0.85	**1.01**
2% NaCl	4.05	3.09	**3.57**	3.73	2.77	**3.25**	3.30	2.45	**2.88**	2.66	2.13	**2.40**	2.13	1.81	**1.97**
Control	3.42	2.45	**2.93**	2.77	2.13	**2.45**	1.81	1.49	**1.65**	1.81	1.49	**1.65**	1.49	1.17	**1.33**
Mean	**3.49**	**2.58**		**2.98**	**2.29**		**2.48**	**1.97**		**2.02**	**1.65**		**1.65**	**1.33**	
	S.Em±	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**		**S.Em±**	**CD at (0.05)**	
V	0.065	0.195		0.063	0.189		0.063	0.189		0.053	0.161		0.053	0.161	
P	0.091	0.276		0.088	0.267		0.088	0.267		0.075	0.228		0.075	0.228	
V×P	0.129	N.S		0.125	N.S		0.125	N.S		0.107	N.S		0.107	0.323	


Selection of onions


Peeling


Washing

Trimming and slicing

Preparation of pre-treatment solutions

Soaking in pre-treatment solutions

Spreading on trays

Drying in tray drier

Preparation of pre-treatment solutions

CONCLUSION

The results obtained from this investigation clearly concluded that different chemical pretreatments marked significant influence on the chemical characteristics of onion slices. The study concluded that pungency, ascorbic acid and titrable acidity showed decreasing trend and total soluble solids, reducing sugars, total sugars and non reducing sugars showed increasing trend during storage. As stated in results, onion slices prepared from Phule Safed pretreated with 0.5% KMS showed better retention of total soluble solids, reducing sugars and total sugars whereas, pungency, ascorbic acid retained better with onion slices prepared from Agrifound Dark Red pretreated with 0.5% KMS.

FUTURE SCOPE

Evaluation of different pretreatments and varieties on quality characteristics of onion products and combination of the pre-treatments can also be tried for enhancement of various quality parameters of dehydrated onion products. Storage of the onion slices and powder in different drying methods and packages can also be evaluated. Research has to be done in varied number of vegetables.

Acknowledgement. With profound reverence, I hereby take this opportunity to thank my major advisor, and Chairman of Advisory Committee, Dr. V. Sudha Vani, Associate professor, Horticulture, College of Horticulture, Venkataramannagudem, and all my advisory committee members for their brilliant counsel, continuous inspiration, everlasting confidence, able guidance, affection, and constructive criticism, valuable and much needed suggestions throughout my association with them and particularly for the present work. I am also grateful for providing me all necessary tangible and intangible research facilities.

Conflict of Interest. None.

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How to cite this article: Srujana Eda, V. Sudha Vani, R.V. Sujatha and D.R. Salomi Suneetha (2022). Effect of Chemical Pretreatments on the Chemical Characteristics of Dehydrated Onion Slices. *Biological Forum – An International Journal*, *14*(3): 576-582.