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STUDY OF CHEMICAL PRETREATMENTS EFFECTING THE PHYSICAL ATTRIBUTES OF ONION POWDER

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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 to study the effect of different pretreatments on physical characteristics 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. The experiment was conducted in completely randomized factorial design with the above two factors at unequal levels and replicated thrice. Among the pretreatments and varieties, powder prepared from Agrifound Dark Red variety pretreated with 0.5% KMS (13.15%) recorded maximum recovery percentage. Regarding moisture content, powder prepared from the slices pretreated with 2 % $CaCl_2$ recorded lowest (4.12%) among pretreatments. Among the varieties, lowest was observed in Agrifound Dark Red (4.76%). Concerning Dehydration ratio was noticed minimum in powder prepared from Agrifound Dark Red variety pretreated with 0.5% KMS (7.60). Among the pretreatments, maximum rehydration ratio recorded in powder prepared from the slices pretreated with 0.5% KMS (5.06). Among the varieties, Phule Safed recorded minimum rehydration ratio (4.94). Among the pretreatments, lowest water activity was recorded in powder prepared from the slices pretreated with 0.5% KMS (0.53). Among the varieties, Agrifound Dark Red recorded lowest water activity (0.56). Onion powder could be stored up to 60 days of storage at ambient conditions with less loss in quality. Microbial spoilage (bacteria and fungi) was observed in eight treatments but was under permissible limit until 30th day of storage. It was found that onion powder prepared from Agrifound Dark Red variety pretreated with 0.5% KMS was found with better retention of physical attributes.

***Keywords*:** onion powder, pretreatments, Agrifound Dark Red, Phule Safed, physical attributes

Introduction

The most commonly grown species of the genus *Allium* which belongs to the family Alliaceae is onion (*Allium cepa* L), also known as bulb onion or common onion. Modern preservation techniques must be employed to extend shelf life for better distribution and preserve for off-season use. Dehydrated onions are easy to use and last longer than fresh ones. Dehydration of onion is necessary for consumption, storage and utility of onion in off-season. By dehydrating the produce, the volume of the fresh produce is reduced which in turn reduces the transportation cost and is easy to handle. Dried onions are considered as significant in world trade and made in several forms viz., flaked, minced, chopped and powdered. 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 snacks (Sivamma, *et al.,* 2021).Pretreatments play an important role in permeabilisation, enzyme inactivation, oxidation, and acceleration of drying rate in many fruits and vegetables (Tiwari *et al.,* 2021).Pretreatments are common in most drying processes to improve product quality or process efficiency. Potassium meta bisulphite is used as a stable source of sulphur dioxide. Calcium chloride was reported to be a possible browning inhibitor. 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 reducing the water activity. The aim of this experiment is to find the effect of chemical pretreatments on physical characteristics of dehydrated onion powder.

Materials and Methods

Raw material collection and Sample preparation

The varieties 'Agrifound Dark Red' and 'Phule Safed' were procured from two completely different production catchments namely Kurnool and Nasik. The bulbs of 'Agrifound dark red' are dark red in colour, globular in shape with firm outer covering and moderately pungent, and 'Phule Safed' bulbs are also globular in shape with firmouter covering but with silvery 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 remove any dirt or dust particles adhering to the surface.

Preparation of onions for pretreatments

Cleaned onions were peeled manually; the skin and thus the first layer were removed. After peeling, they were thoroughly washed with water and then sliced to prevent 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.

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 1kg of onion slices *i.e.,* 4:1 at room temperature.

Dehydration and preparation of onion powder

The drying experiments were conducted in the laboratory using a tray drier. A known weight of untreated and pretreated onion slices were spread evenly in thin layer on aluminum trays and air dried to remove water adhering to the surfaces of strained slices. Then the onion slices dried completely at a temperature of 50-60 ^{o}C temperature till they reached the desired product quality and moisture content *i.e.,* 4-7%. After complete drying, the dehydrated onion slices (red and white) obtained were ground in food processor to make powder of dried onion (Plate 1).

Packing and storage

The samples were weighed and packed air tight quickly in 200 gauge LDPE (low density polyethylene) covers and subjected to ambient storage studies for a period of 2 months. Moisture percentage, recovery percentage, dehydration ratio, rehydration ratio, water activity and microbial count of dehydrated onion powder were estimated.

Results and Discussion

The moisture content of fresh onion was recorded as 86.05 in Agrifound Dark Red and 92.11 in Phule Safed. There was an increase in moisture content of dehydrated onion powder from initial to 60th day of storage. Among the pretreatments, powder prepared from the slices pretreated with 2% $CaCl_2$ recorded lowest moisture content from initial (4.12%) to 60th day of storage (7.41%) whereas, powder prepared from the untreated onion slices recorded highest moisture content from initial (5.91%) to 60th day of storage (8.42%).Among the varieties, lowest moisture content was recorded in onion powder of Agrifound Dark Red variety from initial (4.76%) to 60th day of storage (7.78) and highest moisture content was recorded in onion powder of Phule Safed variety from the initial day (4.85%) to 60th day of storage (7.90%). A similar trend was observed on the remaining days of storage. The interaction between pretreatments and varieties was found to be non significant on all days of storage. The increase in moisture content during storage from the initial day to 60th day of storage as observed in the present study could be attributed to hygroscopic nature of onion powder and high humidity in the atmosphere (table 1).In the present study, the lowest moisture content was noticed in calcium chloride treated samples which might be due to partial osmotic effect of calcium chloride upon reacting with water molecules. This effect could have resulted in increased water mobility and reduced drying time. Pretreatment with sulphites might act as plasmolysing cells facilitating the faster drying unlike other treatments. Similar results were observed by Jyothi and John (2014) in tomato powder.

Regarding recovery percentage, onion powder prepared from onion slices pretreated with 0.5% KMS found the highest recovery (12.95%) and lowest recovery was recorded in powder prepared from untreated onion slices (8.85%) among the pretreatments. Among the varieties, highest recovery was observed in Agrifound Dark Red (11.78%) and lowest recovery was registered in Phule Safed (11.26%). Among the interactions, the highest recovery was recorded in powder prepared from Agrifound Dark Red variety pretreated with 0.5% KMS (13.15%). The lowest recovery was recorded in powder prepared from Phule Safed which was untreated (8.60%)(table 2).The increase in recovery may be attributed to reduction in osmotic losses. Similar results were also reported by Vaghini and Chundawat (1986) in sapota. Maximum recovery percentage was also reported with pretreatment of KMS (0.1%) in dehydrated aonla (Prajapati *et al.,* 2011).

The data related to dehydration ratio of onion powder as affected by pretreatments are presented in table 3**.** Among the pretreatments, the lowest dehydration ratio was recorded in the onion powder prepared from slices pretreated with 0.5% KMS (7.72) and highest dehydration ratio was recorded in powder prepared from untreated onion slices (11.30). Among the varieties, lowest dehydration ratio was recorded in powder of Agrifound Dark Red variety (8.67) and highest dehydration ratio was found in powder prepared from Phule Safed variety (9.09). Among the interactions between the pretreatments and varieties, the lowest dehydration ratio was recorded in powder of Agrifound Dark Red variety pretreated with 0.5% KMS (7.60). The highest dehydration ratio was recorded in powder of Phule Safed which is untreated (11.62). This present study reveals the inverse relationship between the percent recovery and its dehydration ratio. Similar results were also found by Vaghini and Chundawat (1986). Potassium metabisulphite, MgO and $NaHCO_3$ also had an influence on dehydration ratio in dehydrated bitter gourd (Manimegalai *et al.,* 1998).

In general, rehydration ratio decreases with the increase in storage. Among the pretreatments, onion powder prepared from slices pretreated with 0.5% KMS from initial day (5.06) to 60th day of storage (4.54) recorded highest rehydration ratio whereas, least rehydration ratio was observed in powder prepared from untreated onion slices from initial day of storage (4.77) to final day of storage (4.42).Among the varieties, highest rehydration ratio was recorded in powder of Phule Safed from initial day of storage (4.94) to 60th day of storage (4.47) and highest rehydration ratio was recorded in powder of Agrifound Dark Red from initial day (4.91) to 60th day of storage (4.44). The interaction effect between pretreatments and varieties was found to be non significant (table 4).With respect to onion powder pretreated with KMS resulted in best rehydration properties and showed higher value due to the effectiveness of KMS on textural properties compared to $CaCl_2$ and NaCl. Blanching and soaking of bitter gourd in solution containing KMS, MgO and $NaHCO_3$ before drying had an influence on rehydration ratio (Manimegalai *et al*., 1998). Dev *et al*., 2006

reported that, an increase in rehydration ratio of dehydrated onion rings was observed with pre-treatment of KMS (0.25%) + citric acid (0.05g/kg) as compared to KMS (0.25%) alone. However, increased rehydration ratio with KMS (0.2%) alone was also observed in dehydrated ivy gourd (Kulkarni *et al*., 2012).

Increase in water activity was observed from initial to 60th day of storage (table 5). Among the pretreatments, minimum water activity was recorded in powder prepared from the slices pretreated with 0.5% KMS from initial (0.53) to 60th day of storage (0.67) whereas, maximum water activity was recorded in powder prepared from the slices pretreated with 2% NaCl from initial (0.58) to 60th day of storage (0.75).Among the varieties, powder of Agrifound Dark Red powder recorded minimum water activity on initial day (0.56) to 60th day of storage (0.70) and powder of Phule Safed registered maximum water activity on initial day (0.57) to 60th day of storage (0.71).The interaction effect observed between pretreatments and varieties was found to be non significant on all the days of storage. There was an increase in water activity with progress in storage due to the absorption of moisture from air by the samples.

The microbial count noted in stored samples of onion powder as affected by pretreatments are presented in table 5. Among the pretreatments, minimum microbial growth was recorded in powder prepared from slices pretreated with 0.5% KMS and 2% $CaCl_2$ whereas, maximum microbial growth was found in powder prepared from untreated onion slices followed by onion powder prepared from slices pretreated with powder pretreated with 2% NaCl. Among the varieties, minimum microbial growth was recorded in Agrifound Dark Red and maximum microbial growth was recorded in Phule Safed. Microbial growth was observed in onion powder after serial dilution method. The microbial growth of the onion powder was not observed until the 30th day of storage. Pretreatments and moisture removal may have improved the shelf life of the onion powder. The microbial growth was observed from the 45th day of storage. In all treatments, an increase in the microbial load was observed as the storage time progressed. In the case of onion powder, it was found that the powder made from slices pretreated with 0.5% KMS was better and recorded low microbial count. The drying process went a long way towards reducing the microbial count of the onion powder by reducing water activity, resulting in safer consumption and an improved shelf life of the product. The main objective of dehydration was to eliminate free water to the extent where microorganisms could not survive.

Conclusion

Based on the results of the investigations, it can be concluded that different chemical pretreatments have significantly influenced the physical characteristics of onion powder. It was summarized that the moisture content and water activity showed increasing trend while rehydration ratio showed decreasing trend. However, Onion powder prepared from Agrifound Dark Red variety pretreated with 0.5% KMS was found to be the most acceptable with better retention of physical attributes even up to two months of storage at ambient conditions

Table 1: Effect of chemical pretreatments on moisture content (%) of onion powder during storage at ambient conditions.

Pretreat-ments	Initial		Mean	15th day		Mean	30th day		Mean	45th day		Mean	60th day		Mean
	Agrifound Dark Red	Phule Safed		Agrifound Dark Red	Phule Safed		Agrifound Dark Red	Phule Safed		Agrifound Dark Red	Phule Safed		Agrifound Dark Red	Phule Safed	
0.5% KMS	4.72	4.78	**4.75**	5.51	5.66	**5.58**	6.37	6.39	**6.38**	7.45	7.47	**7.46**	7.80	7.94	**7.87**
2% $CaCl_2$	4.06	4.19	**4.12**	4.79	4.81	**4.80**	5.51	5.56	**5.53**	6.56	6.64	**6.60**	7.38	7.44	**7.41**
2% NaCl	4.38	4.48	**4.43**	5.08	5.13	**5.10**	5.70	5.73	**5.71**	6.74	6.78	**6.76**	7.59	7.71	**7.65**
Control	5.88	5.95	**5.91**	6.49	6.51	**6.50**	7.66	7.70	**7.68**	7.90	7.93	**7.91**	8.34	8.50	**8.42**
Mean	**4.76**	**4.85**		**5.47**	**5.53**		**6.31**	**6.34**		**7.16**	**7.20**		**7.78**	**7.90**	
	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	0.009	0.026		0.010	0.031		0.008	0.025		0.012	0.035		0.008	0.024	
P	0.012	0.037		0.014	0.044		0.012	0.035		0.016	0.050		0.011	0.034	
V×P	0.017	N.S		0.020	0.062		0.016	N.S		0.023	N.S		0.016	0.048	

Table 2: Effect of chemical pretreatments on recovery (%) of onion powder during storage at ambient conditions.

Pretreatments	Agrifound Dark Red	Phule Safed	Mean
0.5% KMS	13.15	12.75	**12.95**
2% $CaCl_2$	12.75	12.30	**12.52**
2% NaCl	12.10	11.40	**11.75**
Control	9.10	8.60	**8.85**
Mean	**11.78**	**11.26**	
	S.Em±	**CD at (0.05)**	
V	0.005	0.016	
P	0.007	0.022	
V×P	0.010	0.031	

Table 3: Effect of chemical pretreatments on dehydration ratio of onion powder during storage at ambient conditions.

Pretreatments	Agrifound Dark Red	Phule Safed	Mean
0.5% KMS	7.60	7.84	**7.72**
2% $CaCl_2$	7.84	8.13	**7.98**
2% NaCl	8.26	8.77	**8.51**
Control	10.98	11.62	**11.30**
Mean	**8.67**	**9.09**	
	S.Em±	**CD at (0.05)**	
V	0.006	0.017	
P	0.008	0.024	
V×P	0.011	0.034	

Table 4: Effect of chemical pretreatments on rehydration ratio of onion powder during storage at ambient conditions.

Pretreat-ments	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	5.03	5.09	**5.06**	4.86	4.88	**4.87**	4.67	4.68	**4.67**	4.61	4.61	**4.61**	4.53	4.54	**4.54**
2% $CaCl_2$	4.99	5.04	**5.02**	4.77	4.79	**4.78**	4.60	4.62	**4.61**	4.58	4.66	**4.62**	4.46	4.48	**4.47**
2% NaCl	4.85	4.86	**4.85**	4.73	4.74	**4.73**	4.56	4.59	**4.58**	4.50	4.53	**4.51**	4.41	4.40	**4.40**
Control	4.76	4.77	**4.77**	4.62	4.63	**4.62**	4.46	4.49	**4.48**	4.43	4.49	**4.46**	4.38	4.47	**4.42**
Mean	**4.91**	**4.94**		**4.75**	**4.76**		**4.57**	**4.59**		**4.53**	**4.57**		**4.44**	**4.47**	
	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	0.003	0.008		0.002	0.005		0.002	0.005		0.002	0.008		0.003	0.008	
P	0.004	0.012		0.002	0.007		0.002	0.007		0.004	0.011		0.004	0.012	
V×P	0.005	0.016		0.003	N.S		0.003	0.010		0.005	0.015		0.005	0.016	

Table 5: Effect of chemical pretreatments on water activity (a_w) of onion powder during storage at ambient conditions.

Pretreat-ments	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	0.53	0.54	**0.53**	0.57	0.58	**0.57**	0.60	0.61	**0.60**	0.64	0.65	**0.64**	0.66	0.68	**0.67**
2% $CaCl_2$	0.56	0.57	**0.56**	0.59	0.60	**0.59**	0.62	0.63	**0.62**	0.65	0.66	**0.65**	0.69	0.70	**0.70**
2% NaCl	0.58	0.59	**0.58**	0.61	0.62	**0.61**	0.64	0.66	**0.65**	0.69	0.70	**0.70**	0.74	0.75	**0.75**
Control	0.57	0.58	**0.57**	0.59	0.61	**0.60**	0.62	0.64	**0.63**	0.66	0.68	**0.67**	0.71	0.72	**0.71**
Mean	**0.56**	**0.57**		**0.59**	**0.60**		**0.62**	**0.63**		**0.66**	**0.67**		**0.70**	**0.71**	
	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	0.002	0.006		0.002	0.006		0.002	0.005		0.002	0.006		0.002	0.006	
P	0.003	0.009		0.003	0.009		0.002	0.007		0.003	0.009		0.003	0.008	
V×P	0.004	N.S		0.004	N.S		0.003	N.S		0.004	N.S		0.004	N.S	

Table 6: Effect of chemical pretreatments on microbial count (CFU×10^6) of onion powder during storage at ambient conditions.

Pretreatments	Initial			15th day		30th day		45th day		60th day	
	Variety	Bacteria	fungi	Bacteria	Fungi	Bacteria	Fungi	Bacteria	fungi	Bacteria	Fungi
0.5% KMS	**Agrifound Dark Red**	0	0	0	0	0	0	0	$1x10^3$	$1x10^4$	$1x10^3$
	Phule Safed	0	0	0	0	0	0	$1x10^3$	$1x10^3$	$1x10^4$	$1x10^4$
2% $CaCl_2$	**Agrifound Dark Red**	0	0	0	0	0	0	0	$1x10^3$	$1x10^3$	$1x10^3$
	Phule Safed	0	0	0	0	0	0	$1x10^4$	$1x10^4$	$1x10^4$	$1x10^4$
2% NaCl	**Agrifound Dark Red**	0	0	0	0	0	0	$1x10^3$	$1x10^3$	$1x10^3$	$2x10^3$
	Phule Safed	0	0	0	0	0	$1x10^4$	$1x10^3$	$2x10^3$	$1x10^3$	$2x10^3$
Control	**Agrifound Dark Red**	0	0	0	0	0	0	$1x10^3$	$2x10^3$	$1x10^3$	$3x10^3$
	Phule Safed	0	0	0	0	0	0	$1x10^2$	$2x10^3$	$1x10^2$	$2x10^3$

Plate 1: Sequence of operations in preparation of onion powder

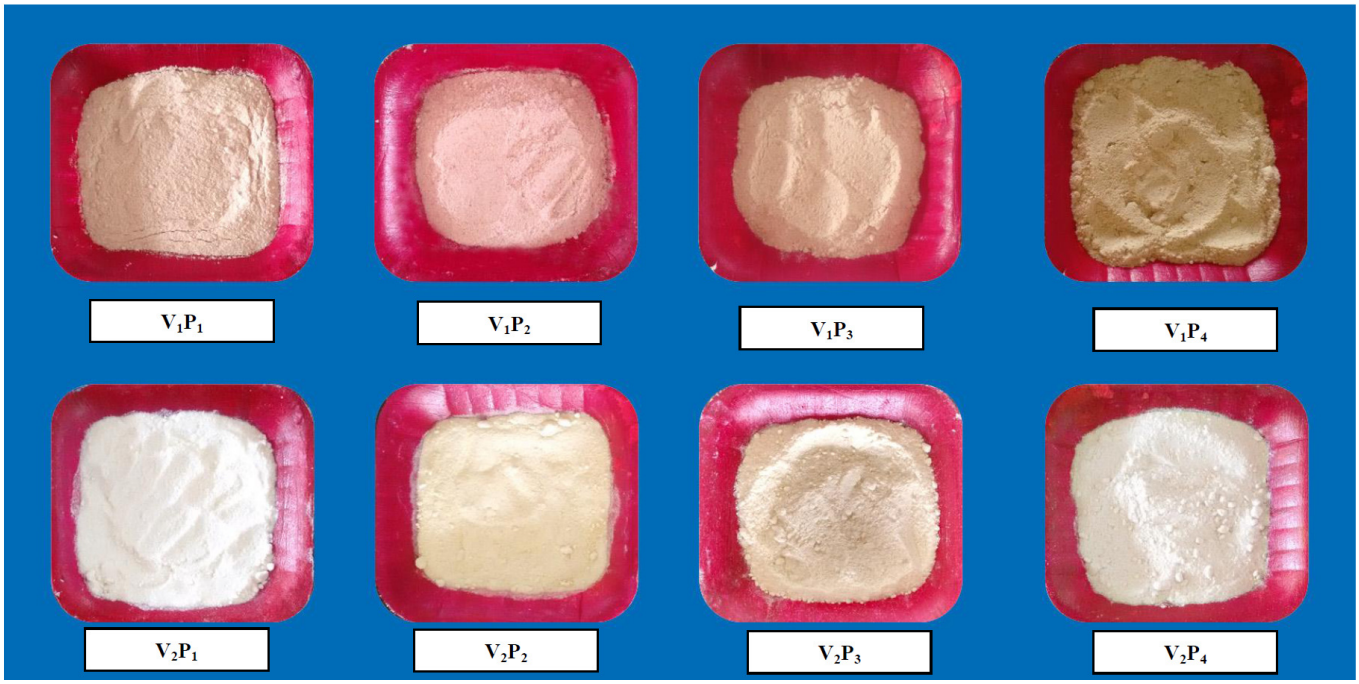

Plate 2: Effect of chemical pretreatments on the initial day of storage in preparation of onion powder during storage at ambient conditions

V_1P_1 - Powder prepared from red onion pretreated with 0.5% KMS
V_1P_2 - Powder prepared from red onion pretreated with 2% $CaCl_2$
V_1P_3 - Powder prepared from red onion pretreated with 2% NaCl
V_1P_4 - Powder prepared from untreated red onion
V_2P_1 - Powder prepared from white onion pretreated with 0.5% KMS
V_2P_2 - Powder prepared from white onion pretreated with 2% $CaCl_2$
V_2P_3 - Powder prepared from white onion pretreated with 2% NaCl
V_2P_4 - Powder prepared from untreated white onion

Plate 3: Effect of chemical pretreatments on the 15th day of storage in preparation of onion powder during storage at ambient conditions

V_1P_1 - Powder prepared from red onion pretreated with 0.5% KMS
V_1P_2 - Powder prepared from red onion pretreated with 2% $CaCl_2$
V_1P_3 - Powder prepared from red onion pretreated with 2% NaCl
V_1P_4 - Powder prepared from untreated red onion
V_2P_1 - Powder prepared from white onion pretreated with 0.5% KMS
V_2P_2 - Powder prepared from white onion pretreated with 2% $CaCl_2$
V_2P_3 - Powder prepared from white onion pretreated with 2% NaCl
V_2P_4 - Powder prepared from untreated white onion

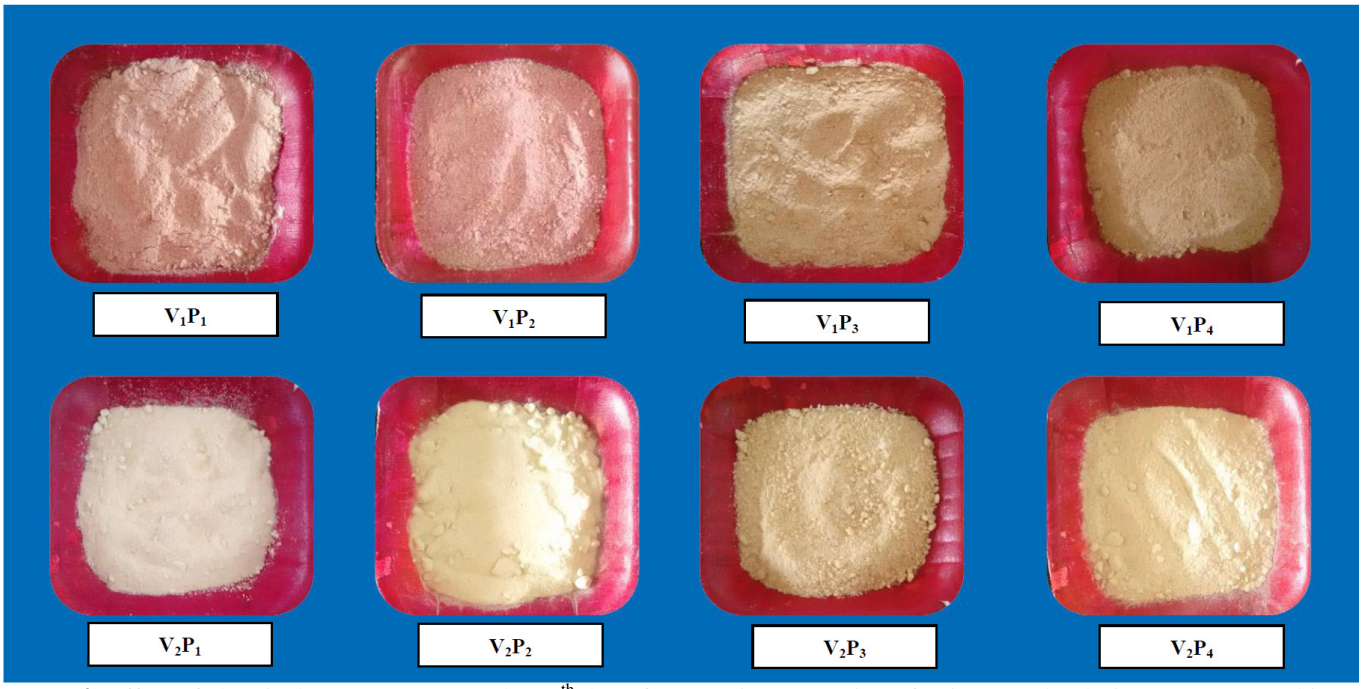

Plate 4: Effect of chemical pretreatments on the 30th day of storage in preparation of onion powder during storage at ambient conditions

V_1P_1 - Powder prepared from red onion pretreated with 0.5% KMS
V_1P_2 - Powder prepared from red onion pretreated with 2% $CaCl_2$
V_1P_3 - Powder prepared from red onion pretreated with 2% NaCl
V_1P_4 - Powder prepared from untreated red onion
V_2P_1 - Powder prepared from white onion pretreated with 0.5% KMS
V_2P_2 - Powder prepared from white onion pretreated with 2% $CaCl_2$
V_2P_3 - Powder prepared from white onion pretreated with 2% NaCl
V_2P_4 - Powder prepared from untreated white onion

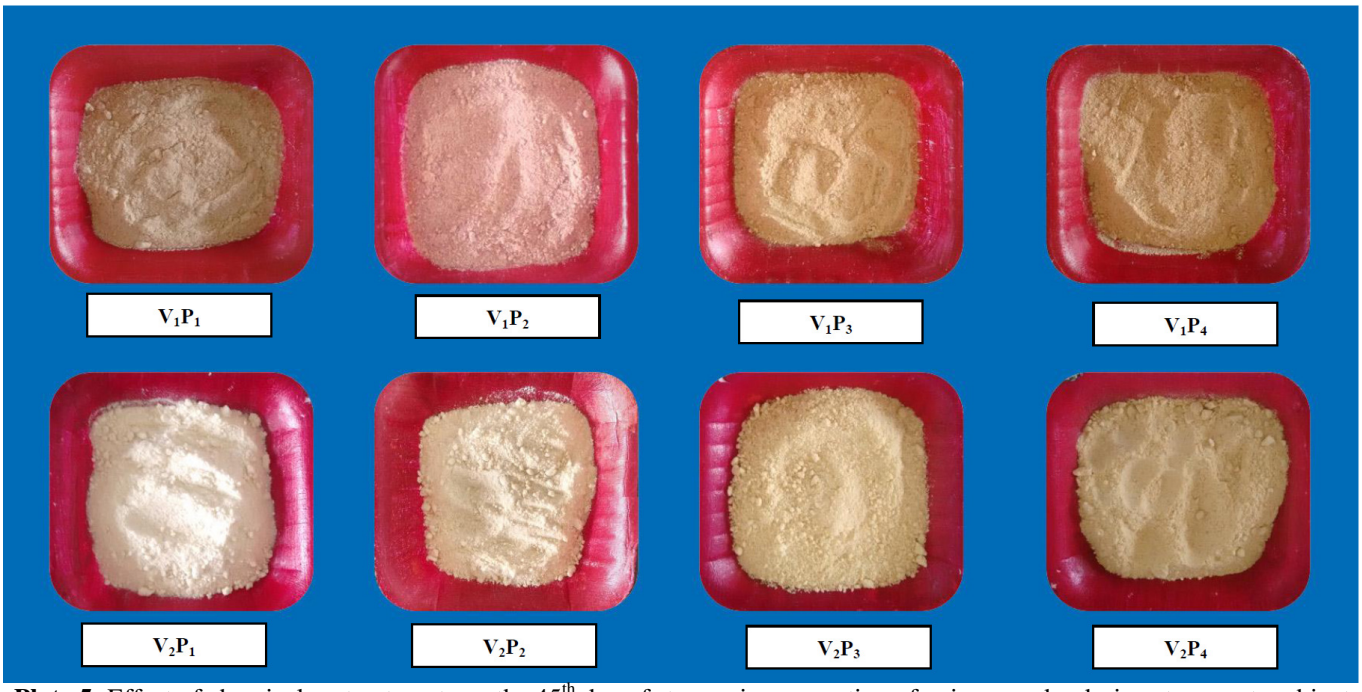

Plate 5: Effect of chemical pretreatments on the 45th day of storage in preparation of onion powder during storage at ambient conditions

V_1P_1 - Powder prepared from red onion pretreated with 0.5% KMS
V_1P_2 - Powder prepared from red onion pretreated with 2% $CaCl_2$
V_1P_3 - Powder prepared from red onion pretreated with 2% NaCl
V_1P_4 - Powder prepared from untreated red onion
V_2P_1 - Powder prepared from white onion pretreated with 0.5% KMS
V_2P_2 - Powder prepared from white onion pretreated with 2% $CaCl_2$
V_2P_3 - Powder prepared from white onion pretreated with 2% NaCl
V_2P_4 - Powder prepared from untreated white onion

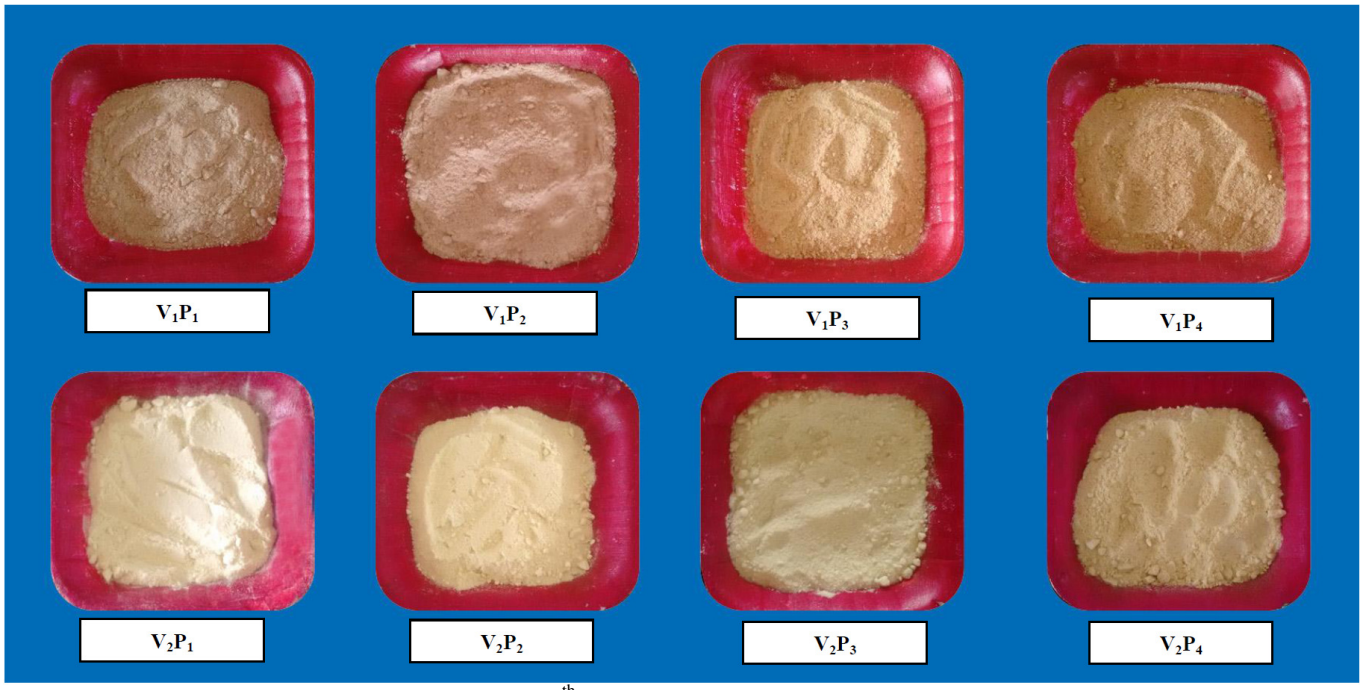

Plate 6: Effect of chemical pretreatments on the 60th day of storage in preparation of onion powder during storage at ambient conditions

V_1P_1 - Powder prepared from red onion pretreated with 0.5% KMS
V_1P_2 - Powder prepared from red onion pretreated with 2% $CaCl_2$
V_1P_3 - Powder prepared from red onion pretreated with 2% NaCl
V_1P_4 - Powder prepared from untreated red onion
V_2P_1 - Powder prepared from white onion pretreated with 0.5% KMS
V_2P_2 - Powder prepared from white onion pretreated with 2% $CaCl_2$
V_2P_3 - Powder prepared from white onion pretreated with 2% NaCl
V_2P_4 - Powder prepared from untreated white onion

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