Progressive Research – An International Journal
Print ISSN : 0973-6417, Online ISSN : 2454-6003
Volume 13 (Special) : 551-556 (2018)

Society for Scientific Development in Agriculture and Technology
Meerut (U.P.) INDIA

QUALITY ASSESSMENT OF DIFFERENTLY DRIED ONION (*Allium cepa*l) AND STORAGE STUDIES OF ONION POWDER WITH DIFFERENT PACKAGING CONDITIONS

Shalini Chakraborty[1], Rohit Nyma[2], Subir Kumar Chakraborty[3] and Manoj Kumar Tripathi[3]

[1]*Fruit Research Station (RVSKVV, Gwalior), Entkhedi, Bhopal, M.P.*

[2]*RAK College of Agriculture (RVSKVV, Gwalior), Sehore, M.P.* [3]*ICAR-Central Institute of Agricultural Engineering, Bhopal, M.P.*

Email: shalini17576@gmail.com

ABSTRACT

Drying of sliced onion (var. Agrifound light red) was carried out in tray dryer (50 ± 5°C temp. for 6-8 hrs), solar dryer (10 hr), microwave drying (800 W, 4 minute) and shade drying (room temperature) at Fruit Research Station, Entkhedi, Bhopal (Department of Horticulture, RAK College of Agriculture, Sehore M.P.). Onions were uniformly sliced to a thickness of 4 mm before being blanched in boiling water for 10-15 seconds followed by dipping in 0.2 per cent potassium meta sulphite (KMS) for 5 minutes at room temperature, this was called treated sample. The treated samples and untreated samples (control) were subjected to different drying techniques followed by evaluation in terms of product recovery, rehydration ratio, cutting strength, colour, tritatable acidity and ascorbic acid content. Experiments were designed using the Factorial Completely Randomized design. It was observed that product recovery and rehydration ratio was maximum for micro wave drying. Oven dried onion slices exhibited maximum deviation in colour and also had the highest cutting strength. Titratable acidity and ascorbic acid content was best for the shade dried samples. All the results were statistically valid.

Key words : *Onion-slice; Onion-powder; Quality; Texture; Microbiology; Packaging.*

Present times have seen the ascend of onion from being just a crop to an agricultural produce potentially capable of toppling governments. This can be attributed to the prominence that this agricultural commodity holds in the everyday life of a common Indian. It is regarded as thequeen of Indian kitchen (Selvaraj, 1976). Onion (*Allium cepa*L.) is among the oldest bulb crops, known to mankind and consumed worldwide. It is one of the most important spice and commercial vegetable crop grown in India and believed to be originated in Central Asia. Onion is valued for its distinct pungent flavor and is an essential ingredient for the cuisine of many regions. As a food additive onion have been used for thousands of years (Patel and Srinivasan, 2004). Onion contain oils, which provide the flavour and taste to the cusine, are also good source of á-carotene, vitamin C, calcium and iron; onion also carry some medicinal values it plays an important role in preventing heart diseases (Augusti,1990).

Adoption of improved agricultural practices is leading to an increased production of onion. Increase in production brings upon the requirement of improved storage. But storage methods have their own impact on post-harvest life and keeping quality ofonion.

Dehydration is one of the convenient methods of preservation of onion. In addition to increasing variety in menu and reducing wastage, labour and storage space, dehydrated onions are simple to use and have longer shelf life than fresh one (Chauhan and Sharma, 1993). These can not only be stored for longer period of times but also saves time, money and energy. Moreover, in dehydrated stage, onion powder is less prone to microbial contamination. Application of onion in food system require them to be used as ground paste or liquid form mainly for flavouring and seasoning of food. Hence making dried value-added products from onion in the form of slices and powder shall add an extra dimension to the utility of this commodity.

The present research work was planned with the following objectives, - assessment of physical characteristics of onion in bulk, study the quality parameter of onion slices produced by different drying methods (shade drying, microwave drying, oven drying, solar drying) and to verify the storage stability of onion powder made thereof from the differently dried onion slices.

MATERIALS AND METHODS

Raw material : Onion (*Allium cepa*, var. Agrifound light red) was procured from the Fruit Research Station, Entkhedi, Bhopal (M.P.) for the present experimental work.The onion was manually peeled, washed and sliced into 4±1mm thickness.

Pretreatments : Blanching and sulphiting was carried out to improve the color and shelf life of the onion slices. The slices were subjected to blanching by steeping the slice in boiling water for 10-15 seconds followed by immersing in 0.2 per cent KMS solution for 5 minutes at room temperature (Singh et al, 1997).

Drying methods : Treated onion slices were dried by four different drying methods. (i) Shade drying, 100 g onionslices were dried in shade at room temperature; (ii) Oven drying, 100 g onion slices was subjected to a dryer temperature of 60±5°C and drying was carried for a time period of 6-8 h; (iii) Microwave drying, 100 gonionslices were dried at a power and time of 800 W and7 minutes, respectively; (iv) Solar drying, the temperature of the hot air solar dryer was 54°C, onion slices were kept in it for 6-8 h.The dryer is an in-house production of ICAR - Central Institute of Agricultural Engineering, Bhopal, (M.P.).The slices obtained after drying were pulverized to obtain onion powder.Dried slice was made to powder using a domestic grinder for 2 minutes. The powder was allowed to cool at room temperature before storage.

Product recovery : This parameter help in estimation of the final amount of dried matter obtained from the raw onion slices. A sample of 100 gm onion slice was dehydrated and the product recovery (per cent) of sample at constant drying rate was expressed as following :

Product receovery (percent)

$$= \frac{\text{Final weight of dried sample, g}}{\text{Initial weight to sample, g}} \quad 100$$

Rehydration ratio : Rehydration ratio of dried onion slice was estimated as per the method described by Ranganna, 1986. Several trail runs were carried out to standardize the experimental conditions for estimation time of rehydration. Dried onion (W_D = 2 g) was put in boiling water for 25 minutes and the contents were passed through whattman no. 4 filter paper. The rehydrated onion sample was weighed, and the weight was recorded as W_R. The rehydration ratio (RR) was computed using the following equation (Ranganna, 1986).

$$RR \quad \frac{W_R}{W_D}$$

Cutting strength : It was determined instrumentally by using a texture analyser (TA XT2i, Stable Microsystems, Surrey, England) with Texture Expert Exceed 2.46 version software. The cutting strength of onion slices was recorded by using the knife blade probe at test speed: 0.5 mm/s; distance: 10 mm; load cell: 250 kg. Cutting strength was recorded as the peak force (N) required to snap the material that was placed below the downward moving probe of the texture analyser.

Colour : Colour is one of the important parameters, which is an indicative of the commercial value of the product. Colour ofdried onion powder was determined using Hunter Lab Miniscan XE plus Colorimeter (Hunter, 1975). Samples were placed on the measure head of XE plus colorimeter and measurements of colour were performed for all prepared samples. A standard white colour was used for calibration and experiments were replicated thrice. Totalcolour change (ÄE) between fresh onion sample (L_o*, a_o*and b_o*) and dried onion samples (L*, a* and b*) was determined using the following expression :

$$E \quad \sqrt{(L_0^* \quad L^*)^2 \quad (a_0^* \quad a^*)^2 \quad (b_0^* \quad b^*)^2}$$

Where, *L* islightness, *a* isgreenness to redness and *b* is blueness to yellowness.

Tritratable acidity : For determination of acidity, add a little amount of water into 5-10 g sample and mix it thoroughly. Thereafter, titrating the sample against standard 0.1 N sodium hydroxide using phenolphthalein as the indicator. Appearance of light pink colour denotes the end point. The acidity was calculated by using the following formula and expressed in percent (AOAC, 1988).

$$\text{Acidity (\%)} \frac{1 \quad \text{Eq. of acid} \quad \text{Normality of NaOH} \quad \text{Titre}}{10 \quad \text{Weight of sample}} \quad 100$$

Ascorbic acid content : Ascorbic acid or vitamin C of the onion slices was estimated by employing the standard method of analysis (AOAC, 1995).

$$\text{Ascorbicacid (mg/100 g)} \frac{0.5 \quad V2 \quad 100\text{ ml} \quad 100}{V1 \quad 5\text{ ml} \quad \text{Weight of sample}} \quad 100$$

where, V1 is the dye volume; V2 is the titre volume of the dye, ml

Microbial study by standard plate count method (SPC) : About 23.5 g of potato dextrose agar(PDA) was taken in a conical flask and 1000 ml distilled water was added to it. It was heated in steam at 12°Cunder 15 psi atmospheric pressure for 15 minutes and then cooled to about 40°C.

A series of dilution were made using 9 ml blanks.

(a) The initial 1/10 dilution (1g sample in 9 ml distil water) was performed

(b) This was mixed well in a vortex mixer. It becomes 10-1 time's dilution.

(c) 1 ml was taken and added to the next tube containing 9 ml ringer Solution and mixed well. It became 10^{-2} times dilution

(d) 1 ml was taken and added to next tube containing 9 ml ringer solution and mixed well. It then becomes 10^{-3} times dilution.

In this way, the dilution was made up to 10^{-6} times. Six sterilized petri dishes were taken and each dish was marked with a dilution number. About 15-20 ml PDA media was taken in each petridish.1 ml of the diluted sample was then pipette into each of these sterile petri dishes. The contents of the plates were mixed well by swirling on a flat surface. Each dilution was plated in triplicate. After solidification of the media the plates were kept in incubator inversely and incubated at 25°Cfor 48 to 96 hrs.

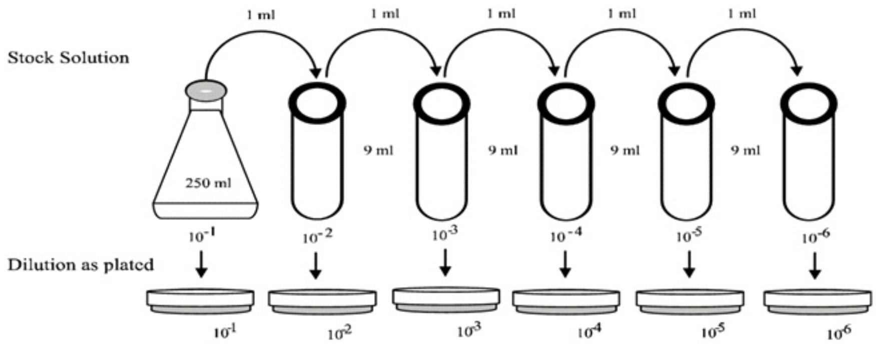

Fig.-1 : Pictorial representation of dilution process.

After incubation for stipulated time the petridishes were taken out and checked. The plates containing segregated, overlapping and confusing colonies were avoided. The plates containing bright, cleared and countable colonies were selected for easy counting of colonies.

$$\text{Number of colony forming unit } \frac{cfu}{g} \text{ or ml}$$

$$= \text{average } \frac{cfu}{plate} \quad \text{dilution factor}$$

Sensory analysis : Dried onion pieces were ground in grinder to make fine powder. The sensory quality of the developed powders in respect of colour, appearance, flavor and texture were judged by panelists using 9- point hedonic scale (Lawless and Klein, 1999).

Storage studies for onion powder : In the present study, the microbial population in onion powder samples in different packaging material by shade drying, oven drying, microwave drying and solar drying methods were assessed. The total fungal count in fresh and packed onion powder (2 g) at 0, 30, 60 days was analyzed in three different packaging materials, -polyethylene (PE) 100 gauge, multilayered (ML) 300 gauge and low-density polyethylene (LDPE) 200 gauge.

Experimental design : The design of the experiment can be understood from Table-1. It enumerates the recording of the various parameters of onion bulbs, onion slices and onion powder.

RESULTS AND DISCUSSION

Physico-chemical parameters of fresh onionsamples : The physical parameters of fresh onion samples viz., weight of sample (g), number of bulbs/kg, , weight of bulb before peeling (g), weight of bulb after peeling (g), moisture content (%, wet basis), ascorbic acid (mg/100 g), acidity (%), total viable fungal were estimated by standard methods as described earlier, parameters of fresh onion are shown in Table-2. The physic-chemical parameter of fresh samples viz., the bulb weight of sample (100 g), number of bulbs (11±1 per kg), weight of bulb before peeling (94±3 g), weight of bulb after peeling (82±3g), initial moisture content (86±0.05 per cent,wet basis), acidity (0.24±0.017 per cent) and ascorbic acid (2.23±0.86mg/100 g), cutting strength (6.65±0.83N), no total viable fungal were recorded before drying. The results of titratable acidity were in agreement with the observations of Kandoliya *et al.* (2015) wherein they reported that titratable acidity of fresh onion ranged from 0.34 to 0.75 per cent. The moisture content values were similar to the findings of Sunandaet al. (2015) where it was observed that moisture content of fresh peeled onion bulb ranges from (84 to 86 per cent, wet basis).

Physical parameters of dried onion slice : In the present study product recovery (per cent) differed significantly with respect to the drying technique and treatments. The mean value of product recovery varied from 6.93 to 8.96 per cent in treated sample and 13.8 to14.8 per cent in untreated sample for the four drying techniques. Converse of product recovery is weight loss(g/100g), itdiffered significantly with respect to the drying technique and among treatments (treated and untreated). The weight loss(g/100g) of dried onion slice was maximum in microwave drying and minimum in oven drying under treated sample but in untreated sample maximum value was observed in shade drying and minimum in microwave drying. The mean value of weight loss was 91.06 to 93.06 in treated and 85.20 to 86.20 in untreated sample across all drying techniques.

Rehydration ratio differed significantly with respect to the drying technique and treatments. KMS treatment resulted in higher value of rehydration ratio. Similar results has been reported by Lewicki *et al.* (2002) and Davoodi *et al.* (2007) for tomato and by Devraj *et al.* (2006) for dehydrated onion slices. In the present value of rehydration ratio range in treated sample was 4.03 to 5.24 and untreated sample it was 2.98 to 3.77. Rehydration ratio was higher in microwave drying followed by other drying method in the experiment. This might be due to creation of larger surface area as a result of breakdown of cellular structure during the microwave treatment.

Table-1 : Plan of experiments for determination of various parameters.

Fresh	Physical parameter	Bulb weight of sample (g) Number of bulbs per kg Weight of bulb before peeling (g) Weight of bulb after peeling (g) Moisture content (%, wet basis)
	Quality parameter	Acidity (%) Ascorbic acid (mg/100 g)
	Microbiological parameter	Microbial count (cfu/g)
Dried Slice	Physical parameter	Final weight (g) Loss in weight (g) Product recovery, per cent Rehydration Ratio Cutting strength, N
Dried powder	Physical parameter	Moisture content, per cent Colour measurement
	Quality parameter	Acidity (%) Ascorbic acid (mg/100 g)
	Sensory evaluation	Overall acceptability
	Microbiological parameter	Microbial count (cfu/g)

Table-2 : Selected physico-chemical parameters of fresh onion.

S. No.	Parameters	Average value*
1.	Number of bulbs/kg	11 ± 1
2.	Weight of sample	100 g
3.	Weight of bulb before peeling	92 (± 3)g
4.	Weight of bulb after peeling	84 (± 3)g
5.	Moisture content% (wet basis)	86 (± 0.05) per cent
6.	Ascorbic acid	2.23 mg/100 g
7.	Acidity	0.24 (± 0.017) per cent
8.	Penetration load	6.65 N
9.	Total viable fungal	Nil

*values are average of 10 replications.

The cutting strength for the treated samples was more than it was for untreated samples. Blanching improves texture by strengthening pectin present in the vegetable matrix, this can be the reason for the increased cutting strength of treated samples. Microwave dried onion slices has minimum cutting strength, this can be attributed to the disruption of cellular structure caused as a result of the incidence of microwaves and the oscillatory dipolar movement of water molecules present abundantly in onion.

Physical parameters of onion powder : Moisture content differed significantly with respect to the drying techniques and among sample (treated and untreated) it ranged from 3.03 to 3.83 per cent in treated sample and 3.9 to 5.13 per cent in untreated sample. The final moisture content is maximum in shade drying method and minimum in microwave drying. While the former consume a lot of time the later involves expenditure of energy. Across all the drying methods, the treated samples exhibited lesser final moisture content. This can be attributed to the use of 0.2% potassium meta-bisulphate (KMS) during treatment. The hygroscopic nature of KMS might have resulted in water being absorbed from inner tissues of the slice through osmosis (Lewicki et al., 2002) resulting in lesser final moisture content in treated samples. Also, sulphiting displaces air from the tissue in plant materials, softens cell walls so that drying occurs more easily,

The total colour change (E) was least in case micro wave drying. Drying techniques other than micro wave resulted in darker products. Maintaining colour during microwave drying for fresh onion slices has been reported by Chua and Chou 2005 and Arikan et al., 2012. Drying methods and temperatures exert a significant effect on the colour changes of onion powder shows the data in terms of Hunter L*, a*, b* values of fresh and dried onion slices, L* values decreases on drying as the product become darker in colour, L* values of sun and microwave drying were highest compared to other drying methods, oven dried had lowest L* values; i.e. oven dried onion samples were darker in colour compared to sun and microwave dried samples. Microwave and oven dried

Table-3 : Effect of treatment and drying methods on various parameters of dried onion slice.

Parameter	Treatment	Shade drying	Oven drying	Microwave drying	Solar drying
Product recovery (per cent)	T_1	8.39***(± 0.36)	8.96***(± 0.2)	6.93***(±0.25)	8.16***(±0.35)
	T_2	13.8 (± 0.36)	14.56 (± 0.30)	14.8 (± 0.2)	14.23 (± 0.35)
Rehydration ratio	T_1	4.03*** (± 0.15)	4.5*** (± 0.22)	5.24*** (± 0.24)	4.25*** (± 0.023)
	T_2	2.98 (± 0.18)	3.28 (± 0.20)	3.58 (0.14)	3.77 (± 0.12)
Cutting strength (N)	T_1	3.94* (± 1.11)	4.47* (± 2.87)	2.30* (± 0.66)	2.90* (± 0.92)
	T_2	5.63 ± (0.73)	8.51 ± (6.29)	2.59 (± 1.08)	7.33 (± 3.96)

T_1 : Treated, T_2 : Untreated; reported values are an average of 3 replications
Values given in the Parenthesis depicts the standard deviation
* Significant at $p < 10$ per cent
** Significant at $p < 5$ per cent
*** Significant at $p < 1$ per cent

Table-4 : Effect of treatment and drying methods on various parameters of onion powder.

Parameter	Treatment	Shade drying	Oven drying	Microwave drying	Solar drying
Final moisture (per cent)	T_1	3.83* (± 0.30)	3.03* (± 025)	2.43* (± 0.30)	3.6* (± .04)
	T_2	5.13 (± 0.40)	4.13 (± 0.35)	3.90 (± 0.3)	4.2 (± 0.3)
Colour change (E)	T_1	36.84**(± 0.01)	41.65** (± 0.01)	27.20* (± 0.06)	40.30 (± 0.01)
	T_2	38.70 (± 0.01)	42.06 (± 0.01)	35.57 (± 0.01)	40.62 (± 0.06)
Titratable acidity (per cent)	T_1	0.72** (± 0.03)	0.50 (± 0.03)	0.68** (± 0.03)	0.38** (± 0.04)
	T_2	0.79 (± 0.06)	0.51 (± 0.07)	0.75 (± 0.04)	0.45 (± 0.06)
Ascorbic acid (mg/100g)	T_1	9.11** (± 0.23)	5.06** (± 0.21)	6.28** (± 0.20)	5.84** (± 0.25)
	T_2	10.64 (± 0.16)	6.67 (± 0.10)	5.52 (± 0.27)	7.04 (± 0.27)
Overall acceptability	T_1	6.92 (± 1.54)	6.91 (± 1.05)	6.55 (± 1.13)	7.16 (± 1.45)
	T_2	7.03 (± 0.71)	6.01 (± 0.78)	6.33 (± 0.86)	6.94 (± 1.37)

T_1 : Treated, T_2 : Untreated; reported values are an average of 3 replications
Values given in the Parenthesis depicts the standard deviation
* Significant at $p < 10$ per cent ** Significant at $p < 5$ per cent *** Significant at $p < 1$ per cent

samples had higher a* values means higher redness in colour of these samples, also reported by Arslan and Ozcan 2010. In totality it can be observed that treated. In all the drying techniques it can be observed that treated samples has a lesser difference of colour (ÄE), this is because sulphiting reduces darkening during drying and storage. Sulphiting also destroys enzymes that cause darkening of cut surfaces and enhances the bright attractive of dried product.

The titratable acidity varied between 0.38 to 0.79 per cent in treated sample and 0.45 to 0.79 per cent in untreated sample. Maximum acidity was in shade dried samples and minimum was in sun dried samples.

The ascorbic acid content of fresh onion vitamin-C content was 2.23 mg/100g. Onion powder dried using different drying methods reported that ascorbic acid content of dehydrated onion ranged from 5.06 to 9.11 in treated condition and 5.52 to 10.64 mg/100g in untreated condition dried in four dehydration techniques. Retention of vitamin C was maximum incase of shade drying, 10.64 mg/100g for treated sample. Shade drying did not involve high temperature and vitamin C is temperature sensitive. Drying at low temperature in shade drying resulted in high vitamin C content in the dried product.

Onion powders prepared using different drying methods were found to be acceptable by the panelists. The overall acceptability score obtained for onion powder was almost same for shade dried as well as solar dried conditions, i.e. 7.03 and 6.94, respectively. Similar mean scores in the category of "liked moderately" was reported by Sangwanet al. (2010) for onion powder.

Microbiology of packed onion powder : The fungal countwas least in the microwave dried and oven dried onion powder samples across all time periods (in days) and treatment, the reason may be due to samples were dehydrated at 60°C during oven drying and 800W power during microwave drying (Michael et al., 2006). The mean fungal population values of solar dried onion samples were maximum in PE which was 9×10^4CFU/g in 60days under untreated condition compared to other dried samples, while minimum fungal count was recorded inmicrowave dried samples in multilayer packaging material under treated condition at 30 and 60 day time interval.

Table-5 : Microbial count in dried onion powder under different drying and packaging conditions.

Drying	Days	Microbial load (cfu/g)					
		Packaging material					
		T_1			T_2		
		LDPE	PE	ML	LDPE	PE	ML
Shade	0	0	0	0	1.5×104	1.5×104	1.5×104
	30	3.5×104**	5.5×104	2.5×104***	4.5×104	5.5×104	3.0×104
	60	4.5×104**	6.5×104*	3.5×104**	5.5×104	8.5×104	4.5×104
Oven	0	0	0	0	1.5×104	1.5×104	1.5×104
	30	2.5×104**	4×104**	2×104	4×104	4.5×104	2.5×104
	60	3.5×104**	5×104**	3×104**	5×104	6×104	4×104
Microwave	0	0	0	0	1.5×104	1.5×104	1.5×104
	30	2.5×104**	3×104**	2×104**	3.0×104	3.5×104	2.5×104
	60	3.0×104**	4.5×104**	2.5×104**	4.5×104	5.5×104	3.0×104
Solar	0	0	0	0	1.5×104	1.5×104	1.5×104
	30	4×104**	5×104*	3×104**	4.5×104	7.5×104	3.5×104
	60	5.5×104*	6.5×104*	3.5×104**	6.5×104	9×104	4.5×104

T_1 : Treated, T_2 : Untreated; LDPE : Low density polyethylene, PE : Polyethylene, ML : Multilayer
Reported values are an average of 3 replications   Values given in the Parenthesis depicts the standard deviation
* Significant at $p < 10$ per cent   ** Significant at $p < 5$ per cent

It was observed that T_2 (untreated sample) compared T_1 (treated sample) shows higher number of total fungal count across all packaging materials at all storage periods. This can be attributed to blanching as it inactivates enzymes, reduces of microorganisms and displaces entrapped air in the plant tissues. It has been claimed by Jay (1978) that initial microbial loads as high as 99% will be reduced by blanching. Besides blanching, sulphiting has fungicidal and insecticidalproperties. Perhaps the combined effect of blanching and sulphiting had an overall effect to reduce the microbial load of onion powder for all the three packaging material.

CONCLUSION

It can be concluded from the study, that microwave drying of onion is better compared to other three drying techniques because it consumes less time and does faster dehydration. In addition microwave dehydrated onion had better less moisture content in terms of an appeal particularly dehydrated onion powder. Further microbial load was low in microwave dehydrated samples compared to other techniques dried samples. Microwave drying increased shelf life of up to three months. Products such as powder can be developed and stored beyond 60 days with lower microbial load in multilayered packaging.

REFERENCES

1. AOAC (1988). Official methods of analysis of the association of official agricultural chemists, Association of Analytical Chemists, Washington, D.C.
2. AOAC (1995). Official methods of analysis of the association of official agricultural chemists, Association of Analytical Chemists, Washington, D.C.
3. Augusti, K.T. (1990). Therapeutic and medicinal values of onion and garlic. In onion and allied crops. Ed. Brewster, *J.L. and Rabinowith, H.D., Baco Ratani, Florid CRC Press, 3:* 93-108.
4. Chauhan, R.L. and Sharma, R. (1993). New approaches in improving the shelf life of foods. Trends in Food Science and Technology. pp. 179-187
5. Chua, H.J. and Chou, S.K. (2005). A comparative study between intermittent microwave and infrared drying of bio products. *International J. Food Sci. and Technol. 40:* 23-39.
6. Davoodi, M.G.,Vijayanand, P., Kulkarni, S. G. and Ramana, K.V.R. (2007). Effect of different pre-treatments and dehydration methods on quality characteristics and storage stability of tomato powder. *Swiss Society of Food Science and Technology, 40 :* 1832–1840.
7. Devraj, V.C., Subanna, Ahlawat O.P., Pardeep Gupta and Huddar, A.G. (2005). Effect of pre-treatments on the quality characteristics of dehydrated onion rings during storage. *Journal of Food, Agriculture and Environment Vol. 4 (1) :* 30-33.
8. Jay, J.M. (1978). Modern Food Microbiology, New York. N.Y.10001.
9. Kandoliya, U.K.*, Bodar, N.P., Bajaniya, V.K., Bhadja N.V. and Golakiya, B.A. (2015). Determination of nutritional value and antioxidant from bulbs of Different onion variety. *Int. J. Curr. Microbiol. App. Sci. 4(1) :* 635-641
10. Lawless, H.T. and Klein B.P. (1991). Sensory Science Theory and Applications in minimally processed fruits and vegetables. Marcel Dekker Inc, New York.
11. Lewicki, P. P., Le, H. V. and Lazuka, W.P. (2002). Effect of pretreatment on convective drying of tomatoes. *Journal of Food Engineering, 54 :* 141–146.
12. Patel, K. and Srinivasan, K. (2004). Digestive stimulant action of spices:A myth or reality? *Indian J. Med. Res. 119 :* 167-179.
13. Ranganna, S. (1986). Hand book of analysis and quality control for fruit and vegetable production. 2ndedn. Tata McGraw Hill Publication Co. Ltd., New Delhi. P112.
14. Sangwan, A.; Kawatra, A. and Sehghal, S.(2010). Nutritional evaluation of onion powder dried using different drying methods. J. Dairying. Foods and H.S., 29: 151-153.