Effect of drying methods on nutritional value of some vegetables

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Keywords:

ascorbic acid, β carotene, drying, nutrient, vegetables

Abstract

Leafy vegetables, in addition to protein, contain a wide variety of substances and in particular significant amounts of vitamins, minerals and lipids. As all vegetables are not available in abundance throughout the year, it can be preserved in dried form and can be used throughout the year. In this experiment three green leafy vegetables coriander, curry leaves, mint and bitter gourd are used to study effective drying method for retention of nutrients. These vegetables were dried by five different methods of drying as Oven at 60^{o}C, Oven at 90^{o}C, Red light dry, Sun dry, Shade dry. After completion of drying decrease in dry weight, relative water content was also determined. Dried vegetable samples were grinded used for analyses of β carotene, Ascorbic acid content and water soluble reducing sugar. Large variation in nutritional value of vegetables by different methods of drying was observed.

INTRODUCTION:

Green Leafy Vegetables (GLVs) occupy an important place among the food crops as these provide adequate amounts of vitamins and minerals for humans. Begum and Pareira (1977) analyzed thirty two varieties of edible green leaves easily available in South India for their beta-carotene content in different seasons of the year. Preservation of these vegetables can prevent huge wastage and makes them available in the lean season at remunerative prices (Lakshmi and Vimala, 2000).

Vegetables have a unique place in diet because of their color, flavor, nutrient content and health benefits (Peter *et al*., 2010). They serve as rich sources of β carotene, ascorbic acid, iron, zinc, folate and dietary fiber (Negi and Roy 2000). Some experiments carried out exhibited that green leafy vegetables contains considerable amount of protein, β carotene, ascorbic acid and can be enhanced by application of organic manures (Naikwade *et al*.,2011, Mogle *et al*.,2013, Naikwade 2014a, Naikwade 2014b). Average intake of green leafy vegetables in the Indian population is much less than the recommended daily allowance; therefore, the people suffer from deficiency diseases.

The rainfall in India is seasonal, as a result bulky amount of vegetables are available in the rainy season and under the favorable conditions during winter, all of which are not properly utilized. Some the low cost methods of praservation of vegetables include blanching, improved traditional techniques (Naikwade *et al*.,2012a, Naikwade *et al*.,2012b) etc. GLV's are highly perishable due to their high water activity, therefore methods involving removal of this moisture helps in their preservation. During the dry months of the year, there is wide spread acute shortage of vegetables throughout the country and the cost will be increased beyond the purchasing limit of a poor citizen. To satisfy the needs of the people surplus vegetables must be conserved for use when required.

The ideal less expensive and quite simplest method of conservation of vegetables is to drive of the surplus moisture in the fresh material and forage crops through sum of hot and dry natural air (Chatterjee and Malti, 1978). The dried powder of vegetables is used to check malnutrition in India. Dried vegetable powder is added to the meals and served in government schools in Delhi under the Mid Day Meal Scheme. In West Bengal**,** small-scale trials of adding leaf powders of drumstick, fenugreek, curry leaf etc in badi, papad, sauce and soup powder keep up the quality and taste.

However, there is limited information comparing the quality of leafy vegetables by different drying methods. Coriander, mint, curry leaves are rich in iron, β carotene, ascorbic acid , chlorophyll and are mainly used spices in India.

The demand for fresh and dehydrated curry leaves, mint and coriander has considerably increased over the last two decades. Bitter gourd is treated as remedy for diabetes. This study has been undertaken to investigate the effect of different drying methods on the nutritional quality of three leafy vegetables and bitter gourd. A comparative evaluation of the effectiveness of the drying vegetables as preservation techniques is also described.

MATERIALS AND METHODS

Experimental site and Materials

Field experiment was carried out in the Research lab located in the Botanical garden of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad during the period from 2 May to 10 May 2011. Three green leafy vegetables coriander, curry leaves, mint and bitter gourd, were collected from local Aurangabad vegetable market early in the morning. The vegetables were washed with water and debris and mud was removed.

Treatments -

Vegetables were dried by five different treatments i.e. Oven at 60^{o}C, Oven at 90^{o}C, Red light dry, Sun dry, Shade dry. Temperatures of two different ovens were set at 60^{o}C and 90^{o}C respectively. Vegetables were kept in these ovens. For Sun light drying, vegetables were kept in a wooden tray and set aside in Sun light. For Red light dry treatment red colored glass was set on vegetable tray and kept in Sunlight. Sun light rays were converted into red light while passing through red colored glass and hence drying of vegetables under red light became possible. For shade drying vegetables were arranged on wooden racks and kept in room.

Method -

Bitter gourd was cut into circular slices of thickness 2-3 mm. The initial amount 300 gm each of bitter gourd slices, coriander, mint and 220 gm of curry leaves were kept for drying in different treatments and decrease in weight was noted every 24 hours till it gives constant weight. In all cases the materials were uniformly spread. After completion of drying decrease in dry weight, relative water content was also determined. The dried samples were grinded and passed through 0.5 mm sieve to get equal size and packed in air tight polythene bags for analyses of nutrient uptake.

The loss of water from vegetables during drying at various stages was measured after every 24 hrs. by calculating relative water content (R.W.C.) as described by Harris and Thaine (1975) using following equations,

$$R.W.C. = (Wt - Wd / Ws - Wd) \times 100$$

Where,

Wt is the sample weight at time‘t’

Ws is the saturation or initial weight, and

Wd is the dry weight.

Nutrient Analyses -

The amount of β-carotene (Pro- vitamin A) was estimated by following Knuckles *et al*. (1972). Ascorbic acid was estimated by titration method given by Sadasivam and Manickam (1992). Water soluble reducing sugar (WSRS) determined with the help of Folin-Wu tubes (Oser, 1979).

Statistical analysis -

All the results were statistically analyzed by calculating Standard Deviation (S.D.) and Coefficient of variation (C.V.) by following Mungikar (1997).

RESULTS AND DISCUSSION:

Decrease in weight and relative water content

a) Mint

Mint took less time for drying as compared to other vegetables. The Minimum days for complete drying were taken by Oven at 90^{o}C treatment i.e.3 days followed in order by Oven at 60^{o}C, Sun drying, Red light drying and maximum in Shade drying i.e. 8 days. Relative Water Content (RWC) of mint is shown in Fig. 1.

b) Coriander

For coriander, the Minimum days for complete drying were taken by Oven at 90^{o}C treatment i.e.3 days followed in order by Oven at 60^{o}C, Sun drying, Red light drying and maximum in Shade drying i.e. 9 days(Table 2). Relative water content was decreased from 100 to 0 (Fig 2).

c) Curry Leaves

For curry leaves, the Minimum days for complete drying were taken by Oven at 90^{o}C treatment i.e.3 days followed in order by Oven at 60^{o}C, Sun drying, Red light drying and maximum in Shade drying i.e. 9 days. Relative water content was decreased from 100 to 0 (Fig 3).

d) Bitter gourd

ANALYSIS

Decrease in weight

During experiment all the vegetables were weighed and decrease in weight was determined after every 24 hrs. (1day), till constant weight. For bitter gourd, the Minimum days for complete drying were taken by Oven at 90^{o}C treatment i.e.4 days followed in order by Oven at 60^{o}C, Sun drying, Red light drying and maximum in Shade drying i.e. 9

days. Changes in Relative water content are shown in Fig 4. At the end of drying, the weight of all dried vegetables was higher in shade drying treatment compared to Sun drying which indicated higher solid loss during Sun drying. Joshi and Mehta (2010) also proved that shade dried samples show more moisture than sun dried samples. Negi and Roy (2000) had reported that sun drying of leafy vegetables seemed to present a disadvantage of more solid losses during drying. Gupta and Nath (1984) have also reported higher dehydration ratio in sun-dried samples.

Nutrient Content

i) β carotene content:

β carotene is often considered as pro-vitamin A, as its one molecule gets converted into two molecules of vitamin A after consumption by human beings (Mertz, 1967). After drying by different methods, the β carotene content and % overall retention in vegetables was calculated and is mentioned in Table 1.

The β carotene was highest in fresh mint followed by coriander, curry leaves and bitter gourd. The values are comparable to those reported earlier (West, *et al*., 1988; Simpson, 1983). After drying the highest carotene content in mint was found by Shade drying and lowest in Sun drying. Variation of β carotene content was observed when mint dried by various methods (C.V.37.19). Overall retention of β carotene was maximum in Shade drying while minimum in Sun drying. After drying, the highest carotene content in coriander was found by Shade drying and lowest in Sun drying. Large variation of β carotene content was observed when coriander dried by various methods (C.V. 63.22).

In case of curry leaves, after drying the uppermost carotene content was found by Oven at 60^{o}C and smallest in Sun drying. Variation of β carotene content was observed when curry leaves dried by various methods (C.V.53.36). After drying, the peak carotene content in bitter gourd was found by Oven at 90^{o}C and least in Sun drying. Large variation of β carotene content was observed when bitter gourd dried by various methods (C.V. 65.52).

While comparing each other, highest retention of β carotene was found by Shade drying in case of mint and coriander; on the other hand in case of curry leaves and bitter gourd, highest retention of β carotene was found by means of Oven at 60^{o}C, Oven at 90^{o}C respectively. However in all vegetables lowest retention of β carotene was found by Sun drying. Devadas *et al.* (1978) revealed that sun drying of green leafy vegetables and their subsequent storage for 1 year resulted in 10–60% retention of β carotene. Loss of β carotene by Sun drying can be minimized by using red colored glass under Sunlight.

Vitamin A (β carotene) is very sensitive to light. Retention of β carotene after sun drying ranged between 18.32 and 39.84%. Kowsalya *et al.* (2001) reported β carotene retention after sun drying from 17.7 to 32.4%. In the earliest study by Amandeep Kaur *et al*., (2008), β carotene retention after drying in mint ranged from 26.08 to 65.59 %. In the present study, β carotene retention after drying in mint varied between 39.84% and 65.31%. Statistical analysis indicates that there are enormous variations in β carotene content as a result of various treatments.

ii) Ascorbic acid content:

In fresh samples of vegetables, ascorbic acid content was highest in coriander followed by mint, curry leaves and bitter gourd (Table 2). There was reduction in ascorbic acid content after drying. After drying the highest amount of ascorbic acid in mint was found in Oven at 90^{o}C and lowest in Red light drying. Variation of ascorbic acid content was observed when mint dried by various methods (C.V. 50.98). After drying, the maximum ascorbic acid content in coriander was found by Oven at 60^{o}C and minimum in Sun drying. In case of curry leaves, after drying the topmost ascorbic acid content was found by Oven at 90^{o}C and smallest in Shade drying. The highest ascorbic acid content in bitter gourd was found by Oven at 90^{o}C and least in Sun drying.

While comparing each other, highest retention of ascorbic acid was found by Oven at 90^{o}C in case of mint, curry leaves and bitter gourd except coriander in which highest retention of ascorbic acid was found in Oven at 60^{o}C. The lowest retention of ascorbic acid was found by Sun drying in case of coriander and bitter gourd nevertheless, lowest retention of ascorbic acid was found by Red light drying and shade drying in case of mint and curry leaves respectively.

Lakshmi and Vimala (2000) reported that retention of ascorbic acid ranged from 15 to 31% in sun-dried leafy vegetables. Thus, in the present study, retention of ascorbic acid ranged from 25 to 38% which is more than previous reported values. All drying methods significantly cause loss of vitamin C (Kiremire *et al.*,2010) and this could be attributed to the fact that vitamin C is highly prone to oxidative destruction in the presence of heat, light, oxygen, enzymes, moisture and metal ions (Russell and MacDowell 1989).

iii) Water Soluble Reducing Sugar content:

Total reducing sugar was determined of different vegetables on dry matter basis (Table 3). In mint, highest percentage of total reducing sugar was found through Shade drying and lowest in Oven at 90°C. In coriander, maximum reducing sugar percentage was found by Red light drying and minimum in Shade drying (3.50). In case of curry leaves, highest percentage of total reducing sugar was found through Sun drying and lowest in Oven at 90°C. The uppermost percentage of total reducing sugar in bitter gourd was found by Oven at 60°C and smallest in Oven at 90°C.

From the point of view of preservation of total reducing sugar effective treatment for mint is shade drying, for coriander Red light drying, for curry leaves sun drying and for bitter gourd drying in oven at 60°C are efficient. Statistical analysis indicates that there are satisfactory variations in β carotene content as a result of various treatments.

iv) Nitrogen and Crude Protein

Nitrogen and crude protein percentage of different dried vegetables was estimated (Table 4). In mint, maximum percentage of nitrogen was found through Oven at 60°C and lowest in Shade drying. Same pattern was followed in case of crude protein.

In coriander, highest nitrogen and crude protein percentage was found by Oven at 60°C followed in order by, Sun drying, Oven at 90°C, Shade drying and minimum in Red light drying. In case of curry leaves, maximum percentage of nitrogen and crude protein was found through Oven at 60°C. In bitter gourd, the highest percentage of nitrogen and crude protein was found by Shade drying and smallest in Oven at 90°C. From these observations it can be concluded that highest percentage of crude protein was found by Oven at 60°C in all vegetables. Earlier experiments (Awogbemi and Ogunleye 2009) also showed that protein percentage decrease day by day while drying.

From these results it get cleared that drying methods are useful for preservation of vegetables in tropical India. Preservation of these green leafy vegetables can prevent huge wastage and makes them available in the lean season at remunerative prices (Lakshmi and Vimala, 2000). Dehydration is a simple and economical method of preservation of these vegetables (Mandhyan *et al*. 1988). Dehydrated vegetables are simple to use and have a longer shelf life than fresh vegetables (Chauhan and Sharma, 1993). Use of sun drying can be increased by realizing the pollution-free nature and renewable energy source of Sun (Pande *et al*. 2000).

All vegetables were dried quickly by Oven at 90°C within 3-4 days, while it took 9 days for complete drying in shade. The β carotene was highest in fresh mint followed by coriander, curry leaves and bitter gourd. Ascorbic acid content in fresh sample was the highest in coriander followed by mint, curry leaves and bitter gourd. Maximum β carotene retention was observed in Shade drying. The highest retention of ascorbic acid was found by Oven at 90°C. Drying in oven at 60°C results in maximum preservation of nitrogen and crude protein in all vegetables. A particular method could cause least losses of one nutrient but show the highest loss for another. One method is suitable for particular vegetable but not effective for other vegetable. Therefore the author feels that an ideal method or combination of methods has to be developed to protect the plant nutrients at optimum level to use the seasonal and surplus vegetable. Finally it can be suggested that drying in oven at 60°C and Red light drying these two treatments cause minimum loss in nutrients and can be used for drying of vegetable competently.

Table 1. Effect of different drying methods on Beta carotene content and % retention

	Mint		Curry Leaves		Bitter gourd			
Treatment	mg/100 gm	% Retention	mg/100 gm	% Retention	mg/100 gm	% Retention	mg/100 gm	% Retention
Fresh	6.40	100	3.76	100	3.57	100	2.93	100
Oven 60°C	3.12	48.75	1.20	31.91	1.86	52.10	0.66	25.19
Oven 90°C	2.73	42.66	1.62	43.09	1.69	47.34	1.71	65.27
Red Light	3.94	61.56	1.00	26.60	1.06	29.69	1.13	43.13
Sun Dry	2.55	39.84	0.84	22.34	0.97	27.17	0.48	18.32
Shade Dry	4.18	65.31	1.74	46.28	1.49	41.74	1.62	61.83
Mean	**3.82**		**1.69**		**1.77**		**1.42**	
S.D.	**1.42**		**1.07**		**0.95**		**0.89**	
C.V.	**37.19**		**63.22**		**53.36**		**65.52**	

Table 2. Effect of different drying methods on Ascorbic acid content and % retention

	Mint	Coriander	Curry Leaves		Bitter gourd			
Treatment	mg/100 gm	% Retention	mg/100 gm	% Retention	mg/100 gm	% Retention	mg/100 gm	% Retention
Fresh	295	100	314	100	267	100	193	100
Oven 60^{0}C	179	60.53	182	58.01	82	30.77	64	33.31
Oven 90^{0}C	204	69.01	143	45.50	104	38.95	79	40.71
Red Light	82	27.85	107	34.12	75	28.09	68	35.16
Sun Dry	111	37.53	89	28.44	71	26.75	61	31.46
Shade Dry	93	31.48	93	29.57	68	25.41	75	38.86
Mean	**160.48**		**157.71**		**111.24**		**89.90**	
S.D.	**81.81**		**85.60**		**77.38**		**50.94**	
C.V.	**50.98**		**55.33**		**69.57**		**56.66**	

Table 3. Effect of different drying methods on Water Soluble Reducing Sugar %

Treatment	Mint	Coriander	Curry leaves	Bitter gourd
Oven 60^{0}C	4.49	4.54	3.20	3.43
Oven 90^{0}C	3.99	3.86	2.75	2.57
Red Light	4.16	4.82	3.05	3.28
Sun Dry	4.31	4.04	3.55	2.70
Shade Dry	5.05	3.50	3.02	3.00
Mean	4.40	4.15	3.12	3.00
S.D.	0.41	0.53	0.29	0.37
C.V.	9.24	12.79	9.42	12.23

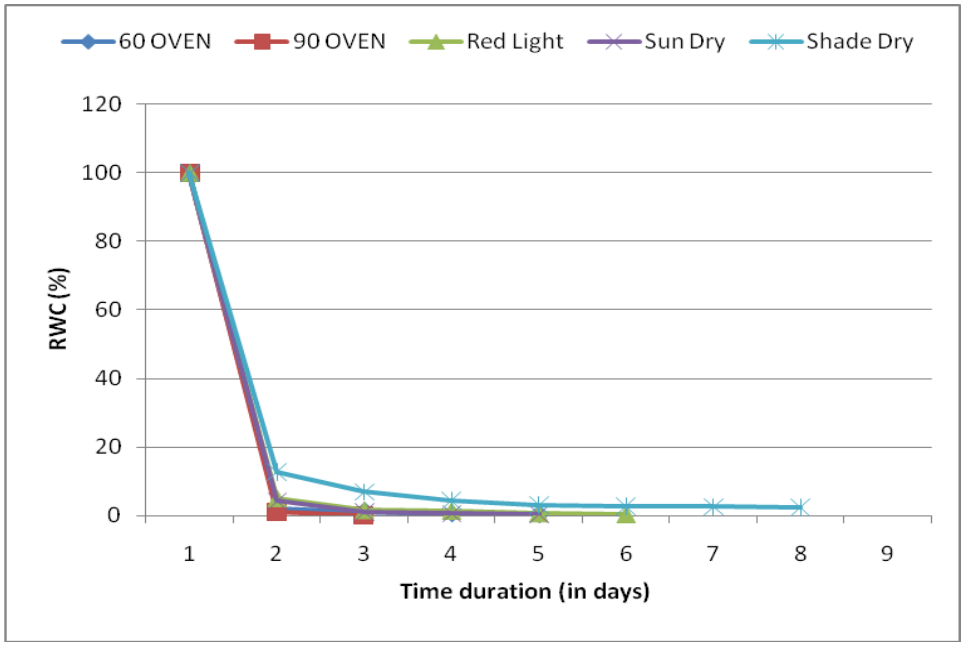

Fig 1. Relative water content of Mint

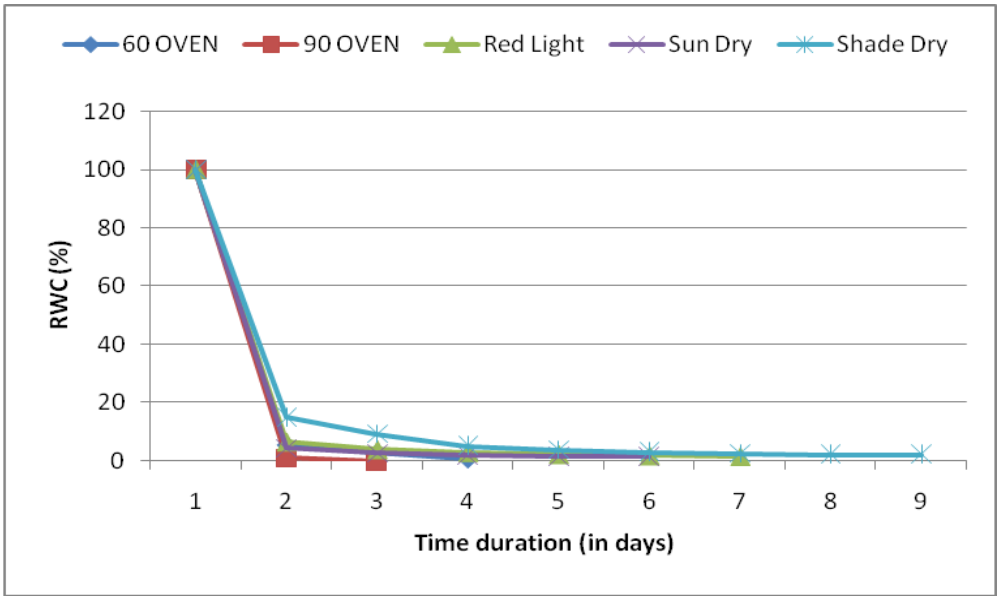

Fig 2. Relative water content of Coriander

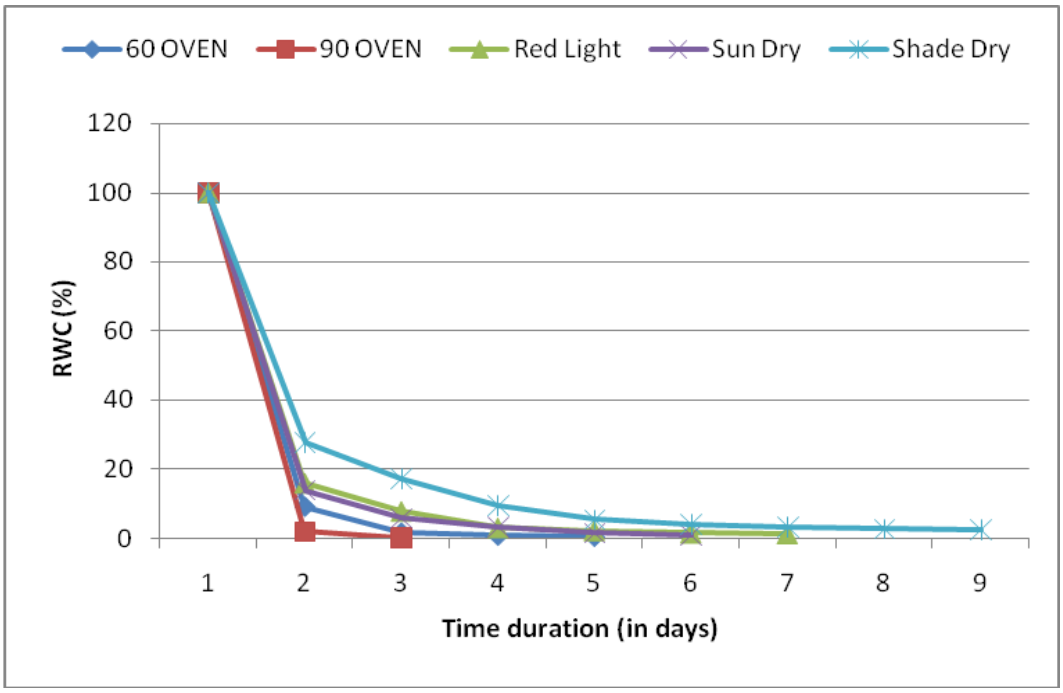

Fig 3. Relative water content of Curry leaves

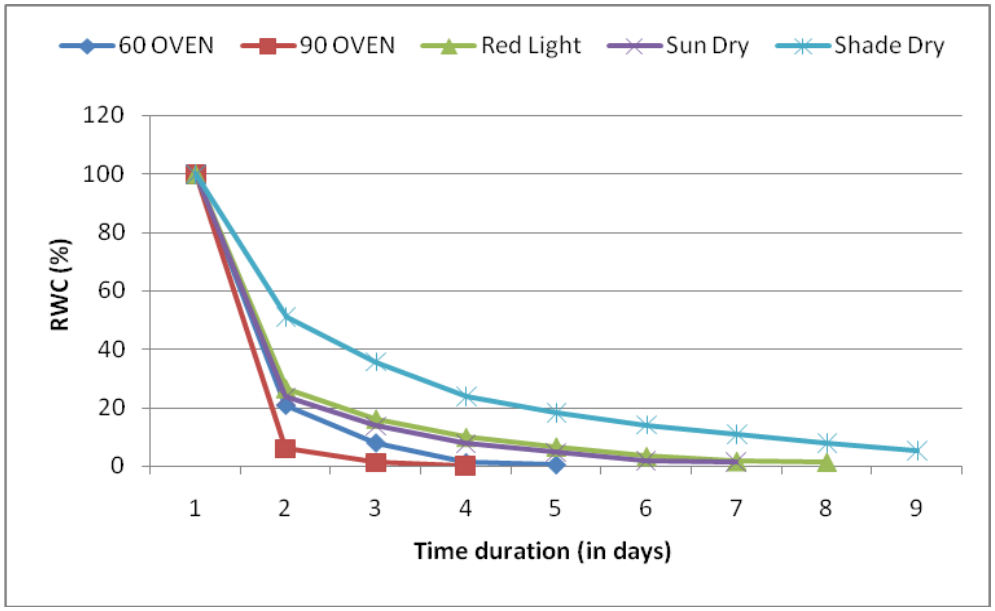

Fig 4. Relative water content of Bitter gourd

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