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RESEARCH PAPER

Effects of Treatments on Keeping Quality of Chickpea (*Cicer arietinum* L.) Sprouts

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ABSTRACT

The aim of this study was to investigate the effects of UV- irradiation, hot water dip (HWD) and ethanol vapours on the quality and storage life of chickpea sprouts. Chickpea seeds were washed, soaked and allowed to sprout (24 h). The chickpea seeds after sprouting were subjected to various treatments *viz*., ethanol vapour (30 min), hot water dip (50 °C for 2 min) and UV-Irradiation (10 kJm^{-2} for 1 h). The sprouts after treatments were examined at 24 h interval until the spoilage. Sprout length, weight and total plate count were enhanced during storage at both the storage temperature. There was no significant effect of various treatments on sprout length and weight, except in ethanol treatment, where suppression was observed. The total plate count was not significantly affected by various treatments. Sensory quality (for appearance, taste, odour and overall acceptability) decreased with increasing storage period. Hot water dip treatment results in enhancing the shelf-life of sprouts which maintained upto 72 h at room temperature and 120 h at low temperature.

Keywords: Ethanol vapours, Hot water dip, Sensory properties, Ultraviolet irradiation

Pulses are one of the most important crops in the world because of their nutritional quality. They are rich sources of complex carbohydrates, protein, vitamins and minerals (Wang *et al*. 2010). Sprouting has been identified as an effective method for improving the nutritional quality of legumes (Khattak *et al*., 2008) coupled with reduction in anti-nutritional factors (Ghavidel and Prakash, 2007). In addition to this there is increase in vitamin concentrations and bioavailability of trace elements and minerals during sprouting (El-Adawy, 2002).

There is a growing demand for chickpea (*Cicer arietinum* L.) due to its nutritional value. The seeds of chickpea contain high levels of carbohydrate (59.09%) and protein (17.80%). It contains Fat (5.80%), Fibre (6.48%) and Moisture (9%) besides other contents (Masood *et al*. 2014). The chickpea sprouts are fast gaining popularity and have become a part of traditional oriental cuisine. Due to high moisture content and high metabolic activity, sprouts are highly perishable. The rapid quality loss at relatively modest temperature emphasizes the critical need to enhance shelf-life and maintain the keeping quality of sprouts during storage. It is reported that pre-treatment of fresh cut mango with UV-C helped in maintaining its nutritional quality, preventing decay and extending storage life upto 15 days (George, 2015).

Ethanol vapour treatment and hot water dip treatment enhanced the nutritional quality and shelf-life (by inhibition of enzymatic browning) of mung bean sprouts (Goyal and Siddiqui, 2014). The shelf-life of sprouts is very limited, restricted to two days only. The use of various treatments generally regarded as

safe (GRAS) pre-treatments, low temperature storage conditions, modified atmosphere packaging, etc. have been reported to enhance the shelf-life of mung bean sprouts (Day, 1990; Goyal *et al.* 2014).

Keeping in view the importance of chickpea and its sprouts, the present investigation was undertaken to study the effect of various pre-treatments on keeping quality of chickpea sprouts during storage.

MATERIALS AND METHODS

Plant material

Chickpea seeds were procured from the local market, CCS HAU, Hisar, Haryana, India. Chickpea seeds were cleaned, washed in hypochlorite solution and soaked in 4–5 volumes of water (22–25 ˚C) for 10 h under ambient laboratory conditions. At the end of the period, the water was drained and the seed samples were allowed to germinate in sprout maker (NovellePlast, Delhi) for 24 h at 30±1 ˚C.

Treatment and storage conditions

Sprouted chickpea were divided into 4 lots of equal amount and subjected to various treatments viz., hot water dip (HWD) (50 °C for 2 min), ethanol vapours (in a glass chamber saturated with ethanol vapours) for 30 min., and UV irradiation (10 kJm^{-2} for 1 h in a laminar flow chamber). Untreated sprouts were used as a control. The sprouts from each treatment were packaged in disposable plastic cups (~200 ml volume) and wrapped with 2% perforated cling films. Water soaked filter paper was placed along the inner sides of plastic cup to maintain high humidity inside. There was ~100 g sprouts per pack and the packs were stored in dark at room (30±3 ˚C) and low (7±0.5 ˚C) temperature conditions maintained in a B.O.D. incubator. The sampling for various parameters was done regularly at 24 h interval up to 72 h at room and 120 h at low temperature conditions.

Parameter analyzed

Analysis: Physico-chemical parameters for **e**ach treatment and control were assessed for sprout length, sprout weight, microbial and sensory quality.

Sprout length and weight

Length of the sprouts was measured by taking the mean of hypocotyls length of 10 sprouts and expressed in cm. Weight was measured by taking the mean of ten sprouts without seed coat and was expressed in gram.

Microbial analyses

Ten gram sprouts were dipped in 90 ml of distilled water for 1 h and then water samples were diluted by serial dilution technique and 0.1 ml aliquot of the appropriate dilution was transferred to plate contained solidified potato dextrose agar and Nutrient agar. The plates were incubated in a BOD incubator at 30 ˚C for 48 h. The colonies were counted and results were expressed as log cfu/g.

Sensory evaluation

Sensory evaluation of experimental samples were conducted at different intervals of storage by semi trained taste panel of 10 trained judges and were evaluated for appearance, odour and taste. Overall acceptability (OA) of sample was calculated as mean score given to it by a judge for these parameters. The judges scored the quality characteristics of each sample on nine-point hedonic scale. The product with an overall score of 5 or above was considered acceptable.

Statistical analysis

Three replicates of each treated samples were used for analysis. The data obtained in the present investigation were subjected to analysis of variance (ANOVA) technique and analyzed according to two factorial completely randomized designs (CRD). The critical difference (CD) value at 5% level was used for making comparison among different treatments during storage.

RESULTS AND DISCUSSION

Sprout length

There was a progressive increase in the sprout length with increasing storage period both at room

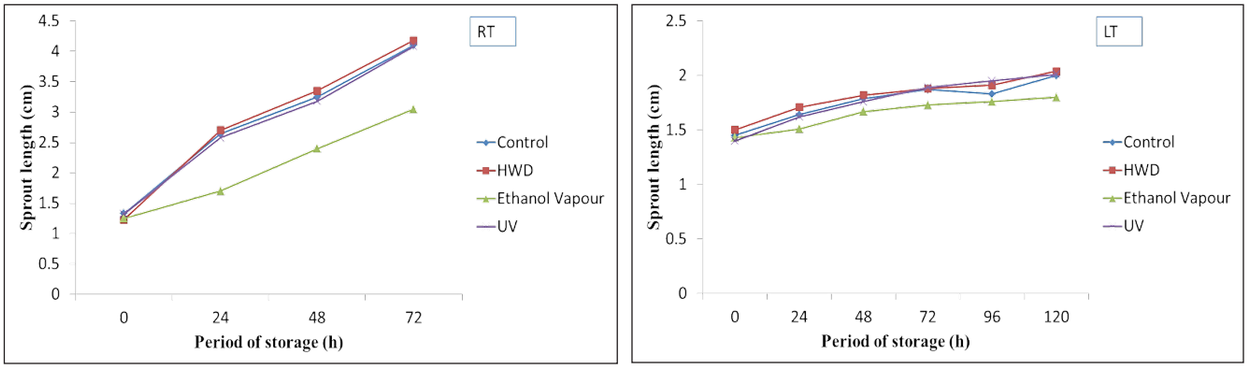

Fig. 1: Effect of different treatments on sprout length (cm) of chickpea sprouts during storage at room (RT) and low temperature (LT)

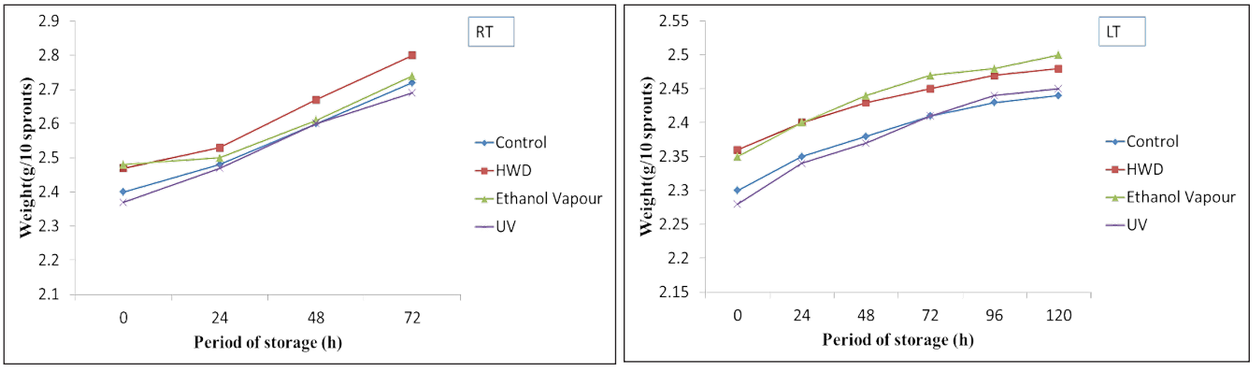

Fig. 2: Effect of different treatments on fresh weight (g/10 sprouts) of chickpea sprouts during storage at room (RT) and low temperature (LT)

and low temperature (Fig. 1). There was however, no significant difference in the sprout length under various treatments, except in ethanol treatment where reduced growth was observed during storage. Interactions between treatment and storage were found to be significant. Sprout length under various treatments ranged from 1.25–4.18 cm and 1.50–2.04 cm during storage period of 72 h at room temperature and 120 h at low temperature, respectively. Inhibition of sprout length was observed due to suppression of ethylene synthesis by ethanol vapour treatment. Results of present investigation were in accordance with those reported earlier Arora *et al*. (2017). The ethanol vapour treatments inhibited the sprout length of moth bean during storage. Similarly, Asoda *et al*. (2009) recorded that post-harvest ethanol vapour treatment with ethanol pads inhibits ethylene production and prolongs the shelf-life of harvested broccoli.

Sprout weight

There was a progressive increase in the sprout weight with increasing storage period both at room and low temperature (Fig 2). There was however, no considerable difference observed in the sprout weight under various treatments. Interactions between treatment and storage were found to be non-significant. Sprout weight under various treatments ranged from 2.37 to 2.80 g/10 sprouts and 2.28 to 2.50 g/10 sprouts during storage period of 72 h at room temperature and 120 h at low temperature, respectively.

Total plate count (TPC)

There was a progressive increase in total plate count with increasing storage period at both the temperatures (Fig 3). However, there was no considerable difference observed in total plate count under various treatments. Total plate count under various treatments ranged from 2.10 to 3.42 log cfu/ml during storage period of 48 h at room temperature and from 2.10 to 3.50 log cfu/ml during storage period of 120 h at low temperature. The results of present investigation was in confirmation with the findings of Goyal and Siddiqui (2014), where no significant effect of ethanol, hot water dip and UV-irradiation was observed on total plate count of mung bean sprouts during storage. Similarly Wang *et al*. (2014) found that ethanol vapour and hot water had no persistent effect on microbial loads over 12 d on fresh-cut sunchoke (*Helianthus tuberosus* L.) tubers. However, several studies are available on UV-C as a method to preserve the quality of different fruits and vegetables. Kulkarni and Karadbhajne (2015) studied the effect of UV radiation on quality and shelf-life of fresh cut fruits. The UV radiation treatment improved the quality and shelf-life of fresh cut fruits and it was found to be highly efficient non thermal preservation technique for fresh cut fruits. Similarly Fernández-Suárez *et al*. (2013) studied the effect of UV-C on the bacterial diversity of Ataulfo mangoes and observed UV-C irradiation reduced the microbial load on the surface of mangoes immediately after treatment and the structure of bacterial communities was modified during storage.

Sensory evaluation

The Sensory score of appearance decreased significantly in all the treatment at room (up to 72 h) and low temperature (up to 120 h) storage condition (Table 1).

Table 1: Effect of different treatments on organoleptic score (9 point hedonic) for color and appearance of chickpea sprouts during storage

Treatments	Period of storage (h)						
	0	24	48	72	96	120	Mean
	Room Temperature						
Control	8.0	7.1	6.3	4.4	-	-	6.5
HWD	8.5	7.5	6.9	5.2	-	-	7.0
Ethanol	8.0	7.2	6.5	4.5	-	-	6.6
UV	8.0	7.2	6.5	4.6	-	-	6.6
Mean	8.1	7.3	6.6	4.7	-	-	
C.D. at 5%	Treatments (T) = 0.35; Storage (S) = 0.40; TxS = 0.75						
	Low Temperature						
Control	8.0	7.7	7.2	6.5	6.0	5.4	6.8
HWD	8.5	8.3	8.0	7.3	6.9	6.1	7.5
Ethanol	8.0	7.8	7.1	6.4	6.0	5.4	6.8
UV	8.0	7.7	7.2	6.5	6.0	5.5	6.8
Mean	8.1	7.9	7.4	6.7	6.2	5.6	
C.D. at 5%	Treatments(T) = 0.21; Storage (S) = 0.27 ; TxS = 0.49						

HWD= Hot water dip; -Observation were not recorded due to spoilage of samples

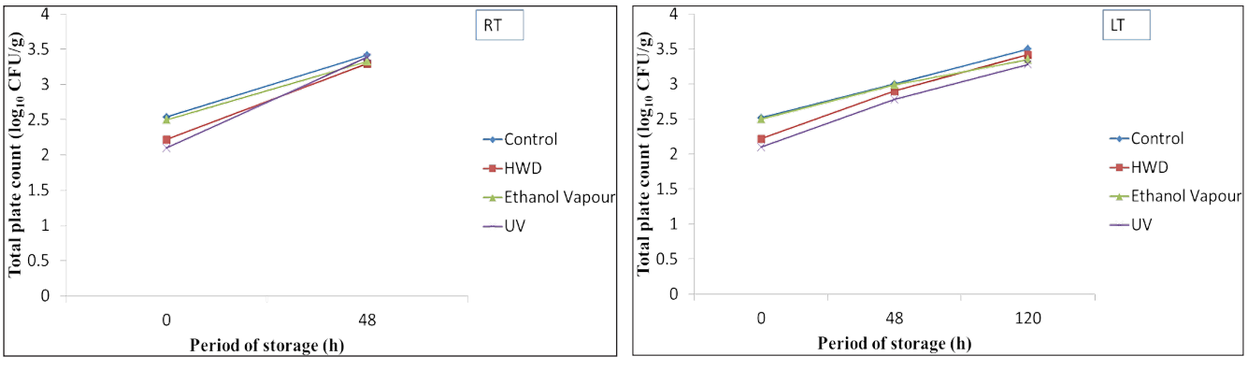

Fig. 3: Effect of different treatments on total plate count (log_{10}cfu/g) of chickpea sprouts during storage

The various treatments did not affect the appearance score of sprouts throughout the storage period, except HWD treatment showing significant improvement in the organoleptic score over the control. Interactions between treatment and storage were also found to be significant. During storage, the organoleptic score (out of 9) for appearance ranged from 8.5 (at initial period) to 4.4 (at the end of storage) and 8.5 to 5.4 amongst various treatments at room and low temperature respectively. A significant decrease of taste was observed in all the treatment and control with advancement of storage condition (Table 2).

Table 2: Effect of different treatments on organoleptic score (9 point hedonic) for taste of chickpea sprouts during storage

Treatments	Period of storage (h)						
	0	24	48	72	96	120	Mean
	Room Temperature						
Control	8.0	6.7	5.7	4.5	-	-	6.2
HWD	8.3	7.3	6.3	5.0	-	-	6.8
Ethanol	8.0	6.5	5.3	4.0	-	-	6.0
UV	8.0	6.7	6.0	4.2	-	-	6.2
Mean	8.1	6.8	5.8	4.4	-	-	
C.D. at 5%	Treatments(T) = 0.44; Storage (S) = 0.44; TxS =NS						
	Low Temperature						
Control	8.0	7.3	7.2	6.4	6.1	5.5	6.8
HWD	8.3	7.9	7.9	7.3	6.9	6.0	7.4
Ethanol	8.0	7.4	7.1	6.1	6.0	5.2	6.6
UV	8.0	7.4	7.2	6.4	6.1	5.5	6.8
Mean	8.1	7.9	7.4	6.7	6.2	5.6	
C.D. at 5%	Treatments(T) = 0.48; Storage (S) = 0.52; TxS =NS						

HWD= Hot water dip; -Observation were not recorded due to spoilage of samples

There was no significant effect of various treatments on the taste score of sprouts throughout the storage period, except HWD treatment. Interactions between treatment and storage were found to be non-significant. The score for taste ranged from 8.3 to 4.0 and 8.3 to 5.2 among the various treatments at room (up to 72 h) and low temperature (up to 120 h) storage respectively. Similar to appearance and taste, sensory score of odour was significantly decreased in all the treatments at both the storage temperature (Table 3). The score for odour was 8.6 at starting day of storage and 4.0 at 72 h at room temperature and 8.5 to 5.2 up to 120 h of low temperature of storage.

Table 3: Effect of different treatments on organoleptic /score (9 point hedonic) for odour of chickpea sprouts during storage

Treatments	Period of storage (h)						
	0	24	48	72	96	120	Mean
	Room Temperature						
Control	8.0	6.9	5.7	4.3	-	-	6.2
HWD	8.6	7.5	6.5	5.1	-	-	6.9
Ethanol	8.0	6.7	5.7	4.0	-	-	6.1
UV	8.0	6.9	5.9	4.3	-	-	6.3
Mean	8.2	7.0	6.0	4.4	-	-	
C.D. at 5%	Treatments(T) = 0.43; Storage(S)=0.43; TxS =0.90						
	Low Temperature						
Control	8.0	7.5	7.2	6.3	6.0	5.4	6.7
HWD	8.5	8.0	8.0	7.3	6.9	6.0	7.5
Ethanol	8.0	7.5	7.0	6.1	6.0	5.2	6.6
UV	8.0	7.5	7.2	6.4	6.0	5.5	6.8
Mean	8.1	7.9	7.4	6.7	6.2	5.6	
C.D. at 5%	Treatments(T)=0.34; Storage(S)=0.42 ; TxS = 0.76						

HWD= Hot water dip; -Observation were not recorded due to spoilage of samples

There was however, no significant effect of various treatments on the odour score of sprouts throughout the storage period, except HWD treatment showing significant improvement in the organoleptic score over control. A significant decrease in scores for overall acceptability was observed in all the treatments with progress of storage period (Fig. 4). There was no significant effect of various treatments on the overall acceptability score of sprouts throughout the storage period, except HWD treatment showing significant improvement in the overall acceptability over control. Interactions between treatment and storage were found to be significant.

During storage, the organoleptic score (out of 9) for overall acceptability was ranging from 8.5 to 4.2 and 8.5 to 5.3 respectively at room and low temperature storage conditions. The decreased organoleptic

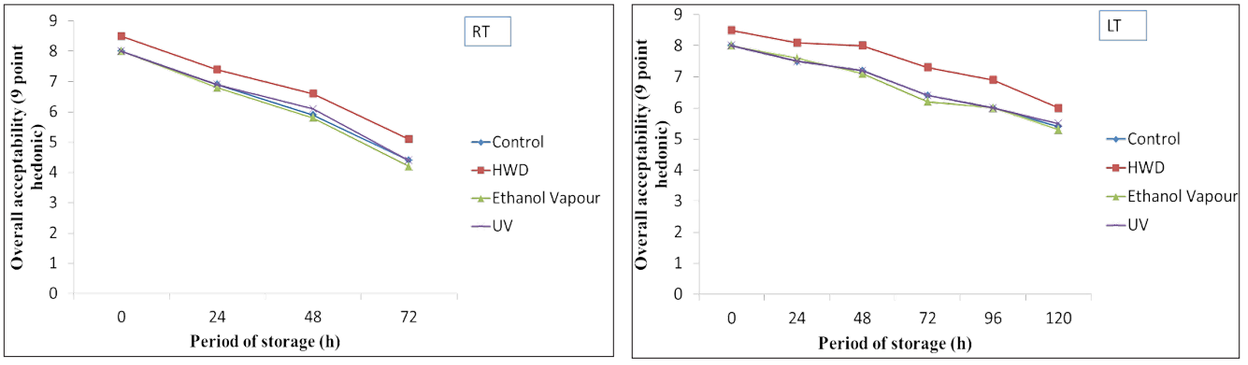

Fig. 4: Effect of different treatments on overall acceptability (9 point hedonic) of chickpea sprouts during storage at room (RT) and low temperature (LT)

scores of sprouts during storage could be the result of darkening of the root and cotyledons, development of dark streaks on the hypocotyl, and eventual development of sliminess, decay, and a musty odour as observed earlier (Lipton *et al*. 1981). In the present examination, amongst the various treatments, hot water dip treatment maintained higher sensory scores throughout the storage period. The result of present investigation are in accordance with Goyal and Siddiqui (2014) who reported that mung bean sprouts remained acceptable upto 48 h and 120 h at room and low temperature conditions, respectively. The ethanol vapour and HWD treatments significantly enhanced the shelf-life of mung bean sprouts, both at room as well as low temperature conditions of storage. The improvement in organoletic quality by HWD treatment was attributed to the inhibition of enzymatic browning and due to leaching out of metabolites during dip treatment that were giving beany off flavour. Similarly, Arora *et al*. (2017) observed that ethanol vapour and HWD treatments significantly prolonged the shelf-life of moth bean sprouts, both at room as well as low temperature conditions of storage.

CONCLUSION

It can be concluded that different treatments resulted in improvement of quality of chickpea sprouts. HWD treatment was more helpful in enhancing the shelf-life of chickpea sprouts. Ethanol vapour treatment is effective in suppressing the sprout length. HWD treatment inhibited the decay development on the surface without affecting sensory quality during the storage. However, UV-irradiation treatments did not affect sprout length, sprout weight and sensory quality of bean sprouts significantly. In the light of the findings of this study, keeping quality of chickpea sprouts can be maintained well upto 72 h at room temperature and 120 h at low temperature as against 48 and 96 h under control conditions by subjecting the sprouts to hot water dip treatment of 50 ˚C for 2 min.

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