

Original Research Article

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Sensory Attributes of Sunflower Microgreens with Storage under Ethanol Vapour and Organic Acid Treatments

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ABSTRACT

Sunflower microgreens hold potential to bring fresh food to consumers with minimal input and maximal nutritional benefit. The study involved use of GRAS treatments to increase the shelf life of sunflower microgreens. Microgreens were treated to 5 treatments, viz. ethanol vapour (EV), citric acid spray (CA), ascorbic acid spray (AA), citric acid+ethanol spray (CA+E) and citric acid+ascorbic acid spray (CA+AA) and distilled water as control, under LDPE packaging. They were evaluated organoleptically for color and appearance, taste, aroma, texture and overall acceptability by a team of semi-trained professionals using 9-point hedonic scale. CA+AA and control maintained highest quality of microgreens with respect to taste, texture, aroma and overall acceptability. EV and CA+E had an adverse effect on the quality during later stages of storage with production of off-odour and loss of taste and color. Thus organic acid treatments can be used to improve the shelf-life of sunflower microgreens without adversely affecting the sensory properties.

Keywords

Sunflower,
Microgreens,
Ethanol vapour,
Organic acid

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Introduction

Microgreens are young and tender leafy greens available in varying palette of colors, textures and flavors. They have three basic parts: a central stem, pair of cotyledonary leaves and very young first pair of true leaves. They require minimal input for growth and have a growth period of 6-10 days (Dalal 2016; Dalal *et al.*, 2019). Crops with easy

germination have potential to be consumed as microgreens. They can be grown at homes and urban setups with constraint for space. Microgreens contain higher concentrations of bioactive compounds such as vitamin C, vitamin K, vitamin E, beta-carotene and carotenoids than their mature counterparts (Xiao *at al.*, 2014a,b). They can thus be referred to as “functional foods”. Owing to their high nutrition potential and ease of

production, they also have potential to serve as a wholesome food in space for astronauts (Johnson, 2019).

Sunflower seeds contain 24% to 30% protein and are rich in 8 essential amino acids. Sunflower microgreens, however, are a richer source of vitamins, protein and amino acids than the dry seeds due to action of enzymes that takes place while germination. The concentration of essential amino acids, especially tryptophan and lysine increases greatly during germination (Balasaraswathi and Sadasivam, 1997). Sunflower microgreens are also rich in fibre, protein, total phenols (caffeic and protocatechuic acids), essential fatty acids and vitamins A, B complex, C, D and E and have high antioxidant capacity (Pajak *et al.*, 2014; Dalal *et al.*, 2019). They also contain minerals such as calcium, phosphorous, iron, iodine, potassium, magnesium and the trace elements zinc, manganese, copper and chromium (Tony F., 2014).

Sensory attributes are crucial in determining the acceptance of fresh produce among consumers. The outer appearance (color, smooth surface free from cuts, blemishes), aroma, texture and flavor determines the overall acceptability (Barrett *et al.*, 2010). Color and appearance help in the first buy, while organoleptic properties such as flavor, aroma, mouthfeel determine the subsequent purchases (Francis *et al.*, 2012; Barrett *et al.*, 2010). Contemporary consumers are more aware about the health benefits of fresh foods and pay more attention to the nutritional aspects of the food they consume. Thus, nutritional and sensory properties, both play an important role in consumer acceptance. And microgreens have them both.

Like any other fresh leafy produce, sunflower microgreens have a short shelf life of 1-2 days. Applications of various GRAS (generally regarded as safe) chemicals like

ethanol vapours, various antioxidants like citric and ascorbic acids and their combinations have been reported to extend the shelf life of minimally processed fruits and vegetables (Goyal *et al.*, 2014; Chandra *et al.*, 2012). MAP (modified atmosphere packaging) has been shown to extend the shelf life of fresh produce as it lowers respiration, delay ripening, prevent off-odour and flavour build-up, retard discoloration and hinder the growth of spoilage microorganisms (Xiao *et al.*, 2014a,b; Zhu and Gao, 2017).

While ample research data is available for sensory properties of fresh cut fruits and vegetables, limited studies have been published about sensory properties of microgreens. This work is attempt to throw some light on sensory attributes of sunflower microgreens with storage time and how organoleptic qualities might differ with chemical treatments.

Materials and Methods

Sunflower (*Helianthus annuus* L.) seeds of variety "64-A-57 Pioneer" were procured from Department of Oilseeds Technology, CCS HAU, Hisar for growing microgreens. The chemicals used in this investigation were analytical grade reagents from Sigma-Aldrich Pvt. Ltd. New Delhi (India).

Growing conditions, treatments and storage

The seeds of sunflower were washed with tap water to remove adhering dirt and soaked in tap water for 24 h. Wet seeds were evenly distributed over the wet surface of vermiculite filled in plastic trays kept in shade house at $25 \pm 5^\circ$ C. The crop was kept moist until harvest and no fertilizer/pesticide was applied. Microgreens were harvested after 7 days of growth, washed with tap water and subjected to the treatments at room temperature:

Treatment	Concentration and duration (min)
Ethanol vapour treatment (EV)	100 % for 3.5 minutes
Citric acid spray treatment (CA)	0.5% w/v (100 ml/kg)
Ascorbic acid spray treatment (AA)	0.5% w/v (100 ml/kg)
Citric acid + Ethanol treatment (CA+E)	0.5% w/v + 40% v/v resp. (100 ml/kg)
Citric acid + Ascorbic acid spray treatment (CA+AA)	0.25% w/v each (100 ml/kg)

The duration and concentration of vapour and spray treatment was calculated and decided after pre-trials. Sunflower microgreens were treated to varying concentrations of sprays and varying time periods of vapours and the ones with the best sensory results was chosen for final testing.

The vapour chamber was saturated with the ethanol vapour and microgreens were subjected to EV treatment for given 3.5 min. For spray treatments of CA, AA, CA+E and CA+AA, solutions of required strength were prepared and sprayed on microgreens. The excess of solution was drained out and the microgreens were allowed to dry in air for 30 min. Water was taken as control. The microgreens from each treatment were packed either in 0.05% perforated LDPE bags. Filter paper soaked with water was placed at the bottom of the bag to maintain high humidity. Packs were stored for 16 days at low temperature (10 ± 1 °C) maintained in B.O.D. (Biological oxygen demand) incubator having three replicates with sampling at every 4th day.

Sensory analysis of sunflower microgreens

Sunflower microgreens were subjected to sensory evaluation for color, texture, taste, aroma and overall acceptability attributes by 10 semi trained panellists using 9-point Hedonic scale. The overall rating was obtained by averaging the score given by the panellists.

Statistical analysis

The data obtained in the present investigation were subjected to analysis of variance

(ANOVA) techniques and analysed according to three factorial completely randomized design (CRD). The critical difference (CD) value at 5 per cent level was used for making comparison among different treatments during storage period.

Results and Discussion

Color and appearance

Table 1 shows the color and appearance scores of sunflower microgreen subjected to chemical treatments over a period of 16 days. Color and appearance score decreased progressively with storage from 7.81 on zero day to 5.0 on 16th day of storage. The microgreens were of acceptable color and appearance till 4th day of storage in all the treatments, except control which maintained color and appearance till 12th day. Treatments had a significant effect on color and appearance, with CA maintaining best color and appearance apart from control. The interactions between various treatments and storage were found to be significant. The decrease in color and appearance of sunflower microgreens can be due to degradation of pigments with time. Chlorophyll and carotenoids have been reported to get degraded with storage period, even at low temperature (Xiao *et al.*, 2014a,b). Similar results were reported by Xiao *et al.*, (2014b)

in radish microgreen stored under MAP at low temperature.

Taste

Taste scores of sunflower microgreen during storage subjected to treatments is presented in Table 2. Taste scores declined progressively

with storage with 8.57 on zero day to 5.14 on 16th day. They showed acceptable scored till 8th day in all treatments. CA+AA exhibited the highest taste score on 8th day followed by EV and control. The interactions between treatments and storage were found to be significant whereas interaction between treatments were non-significant.

Table.1 Effect of treatments and storage on taste of microgreens

Storage period (days)	Treatments						Mean
	Control	EV	CA	AA	CA+E	CA+AA	
0	8.00	8.00	8.00	7.71	7.57	7.57	7.81
4	7.29	7.00	7.29	7.57	7.71	7.29	7.36
8	7.11	5.29	6.29	5.29	5.29	5.29	5.69
12	7.00	5.00	5.71	5.86	5.29	5.00	5.64
16	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Mean	6.88	6.06	6.46	6.29	6.17	6.03	
CD at 5%	Treatment: 0.213		Storage: 0.194		Treatment × storage: 0.476		

Table.2 Effect of treatments and storage on color and appearance of microgreens

Storage period (days)	Treatments						Mean
	Control	EV	CA	AA	CA+E	CA+AA	
0	8.43	8.43	9.00	8.57	8.57	8.43	8.57
4	8.00	7.43	7.29	8.00	8.00	8.00	7.79
8	7.57	7.57	7.43	7.43	7.29	7.71	7.50
12	6.00	6.00	6.29	6.43	6.29	6.43	6.24
16	5.00	5.00	5.43	5.43	5.00	5.00	5.14
Mean	7.00	6.89	7.09	7.17	7.03	7.11	
CD at 5%	Treatment: NS		Storage: 0.179		Treatment × storage: 0.439		

Table.3 Effect of treatments and storage on texture of microgreens

Storage period (days)	Treatments						Mean
	Control	EV	CA	AA	CA+E	CA+AA	
0	8.57	8.57	8.57	8.57	8.57	8.57	8.57
4	7.29	7.29	7.29	7.29	7.29	7.29	7.29
8	6.71	6.57	7.00	7.00	7.00	7.00	6.88
12	6.00	6.00	7.29	6.29	6.43	6.43	6.41
16	5.00	4.29	4.29	4.29	4.71	4.29	4.48
Mean	6.71	6.54	6.89	6.69	6.80	6.71	
CD at 5%	Treatment: 0.209		Storage: 0.191		Treatment × storage: 0.468		

Table.4 Effect of treatments and storage on aroma of microgreens

Storage period (days)	Treatments						Mean
	Control	EV	CA	AA	CA+E	CA+AA	
0	8.00	8.29	8.00	8.00	8.29	8.00	8.10
4	7.00	7.43	7.00	7.00	7.00	7.00	7.07
8	6.00	6.00	6.00	6.00	6.29	5.71	6.00
12	6.00	5.71	6.00	6.00	6.29	5.57	5.93
16	5.00	4.71	5.00	5.00	5.00	5.00	4.95
Mean	6.40	6.43	6.40	6.40	6.57	6.26	
CD at 5%	Treatment: 0.129		Storage: 0.118		Treatment × storage: 0.288		

Table.5 Effect of treatments and storage on overall acceptability of microgreens

Storage period (days)	Treatments						Mean
	Control	EV	CA	AA	CA+E	CA+AA	
0	8.25	8.32	8.39	8.21	8.25	8.14	8.26
4	7.39	7.29	7.21	7.46	7.30	7.39	7.38
8	6.75	6.36	6.68	6.43	6.46	6.43	6.52
12	6.25	5.68	6.32	6.14	6.07	5.86	6.05
16	5.00	4.75	4.93	4.93	4.93	4.82	4.89
Mean	6.73	6.48	6.71	6.64	6.60	6.53	
CD at 5%	Treatment: 0.144		Storage: 0.132		Treatment × storage: 0.372		

The changes in taste can be due to degradation of bioactive compounds in tissue with time and production of degradation intermediates with slight off-flavors. Dalal *et al.*, (2020) reported similar trends in taste of sunflower microgreens, however, with different packaging material.

Texture

Texture scores of sunflower microgreens subjected to treatments during storage is presented in Table 3. There was progressive decline in texture scores of microgreens during storage from 8.57 on zero day to 4.48 on 16th day. The microgreens showed acceptable texture by 8th day of storage in all the treatments, except EV which exhibited acceptable texture till 4th day. Treatments and storage had significant effect on texture and

do did the interaction between storage and treatment. Plant materials contain a significant amount of water and other liquid-soluble materials surrounded by a semi-permeable membrane and cell wall. The texture of fruits and vegetables is derived from their turgor pressure, and the composition of individual plant cell walls and the middle lamella (Barrett *et al.*, 2010). The decrease in texture score can be attributed to loss of moisture in fresh produce with time and degradation of polysaccharide components with storage period and loss of turgor pressure with due to loss of water (Xiao *et al.*, 2014b; Zhu and Gao, 2017).

Aroma

Table 4 shows the aroma scores of sunflower microgreens subjected to treatments under

storage. Aroma scores exhibited a progressive decline with time from 8.10 on zero day to 4.95 on 16th day. Aroma scores were acceptable in all treatments upto 8th day of storage, except CA+AA which had acceptable score till 4th day only. Storage and treatment had significant effect on aroma score, and so did the interaction between the two. Chandra *et al.*, (2012) reported higher off-odour and lower sensory quality of microgreens treated with chlorine, citric acid + ascorbic acid, citric acid + ethanol and water washed samples. Xiao *et al.*, (2014b) also reported an increase in off-odour of radish microgreens under MAP during a 16-day storage period and Xiao *et al.*, (2014a) also reported similar results for radish microgreens under MAP at differing temperatures during 28-day storage. This was attributed to anaerobic respiration due to CO₂ accumulation and O₂ depletion. Zhu and Gao (2017) reported similar results in Chinese to on tender shoots under MAP storage.

Overall acceptability

Table 5 shows the overall acceptability scores of sunflower microgreens subjected to treatments under storage. The overall acceptability progressively declined from 8.31 on zero day to 6.52 on 16th day. Sunflower microgreens had acceptable score till 4th day of storage. CA+AA and CA+E had the least scores. Storage and treatments had significant effect on overall acceptability score, and so did the interaction between the storage and treatment. Treatment AA maintained highest overall acceptability of microgreens till 4th day of storage followed by CA+AA and control. The decline in overall acceptability can be attributed to decline in color and appearance, texture, aroma and taste, as evident by the above results. Microgreens, being a fresh produce lose their taste, texture and appearance with time due to irreversible internal biochemical changes. Dalal *et al.*,

(2020) reported similar trend with sunflower microgreens packed in polystyrene trays and the quality was maintained till 12th day of storage. Xiao *et al.*, (2014a,b) reported similar trends with radish microgreens stored for 16 and 24 days respectively under MAP at low temperature. Zhu and Gao (2017) also reported similar results in Chinese toon tender shoots packed under MAP and low temperature

In conclusion, sunflower microgreens present an excellent opportunity as edible fresh produce that can be consumed without processing or with minimal processing. Organic acids and washing with distilled water was sufficient to extend the shelf-life of sunflower microgreens packed in LDPE bags for 8 days. More studies are required regarding the sensory qualities, use of other GRAS chemicals and packaging materials with focus on microbiological aspect of sunflower microgreens. Use of pre-treatments like CaCl₂ can be explored to get higher biomass and Plant hormones to change the flavor profile. Flavor profile can also be altered by studying and maintaining the biochemical reactions in the microgreen tissue using films, MAP, treatments and light/dark storage. Microgreens hold a true potential to bring fresh food to the consumers with minimal input and maximum nutritional benefits.

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