EFFECT OF PROCESSING TECHNIQUES ON QUALITY, SENSORY AND HISTOLOGICAL ATTRIBUTES OF WATERCRESS (NASTURTIUM OFICINALE R.BR.)

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ABSTRACT: The effect of processing techniques on postharvest quality of watercress stored at ambient temperature was evaluated. For this purpose, following parameters such as moisture loss, total soluble solids, ascorbic acid, titratable acidity, total sugar, β-carotene, ash, crude fiber and sensory characteristics like colour, flavour, texture, taste and overall acceptability were studied at an interval of 3 days for a total period of 12th days. Results showed that the moisture loss, pH, ascorbic acid, total sugar, β-carotene, ash, crude fiber values were decreased with time while titratable acidity increased at the end of storage. The organoleptic attributes such as colour, flavour, texture, taste and overall acceptability were showed decreasing trend in all treatments. Maximum retention in mean scores in blanched + polyethylene was observed as compared to control. Results of scan electron microscopy also showed that blanched sample was proved best in maintaining the firmness of watercress leaves at last day of storage. Whereas, the control sample was decay at the 6th day of storage and unable to use further.

Keywords: Watercress, Ascorbic acid, β-carotene, sensory attributes, Scan electron microscopy.

(Received 1/30/2019 Accepted 14.03.2020)

INTRODUCTION

Watercress *(Nasturtium officinale R.Br.)* is a dark green leafy vegetable, perennial plant and native in Western Asia, Europe, Ethiopia, many African regions, mainland Africa, Madagascar and other Indian Ocean islands etc. (Sadeghi *et al*., 2019; Spínola *et al*., 2017). Watercress is a low calories vegetable with a large quantity of nutrients protein, minerals (Ca, Mg, P, Fe and Zn), vitamins (thiamin, riboflavin, niacin and ascorbic acid) polyphenols and carotenoids (Sakil *et al*., 2019; Klimek-Szczykutowicz *et al*., 2018). It provides flavour, taste, colour and aesthetic appeal (Mepba *et al*., 2007). It plays a vital role in health point of view through prevention of many types of diseases such as cancer of the colon, lung, rectal, oral cavity, breast, antigastric ulcers, anticardiovascular problems and cataract (Sadeghi *et al*., 2014; Freitas *et al*., 2013). It also helps to prevent itching of the skin, scurvy, scorbutic stimulant, laxative and serve as an antioxidant (Clemente, 2019; Sakil *et al*., 2019; Schuchard *et al*., 2019). It also used in raw (salad) and cooked form (soup) (Pichmony *et al*., 2018). These are available in large quantity in Azad Jammu and Kashmir but peoples of this area are unaware of its nutritional values. However, these dark leafy vegetables are going to be wasted due to many factors such improper care at harvest, harvesting at immature form, packaging without sorting and grading, inadequate conveyance, distant and time-consuming market, etc. (Kader, 1992). It is a highly perishable vegetable with a shelf life for 5 days at room temperature (Silveira *et al*., 2014; Rui *et al*., 2009). Therefore, watercress required those treatments which can help to prevent it postharvest losses and increased its storage life at ambient temperature by using postharvest techniques such as processing (cooking and blanching) and polyethylene bags. These techniques may help to maintain the fresh state of vegetable by reduction of metabolic activities which are related to maturation and senescence (Pinela *et al*., 2016). As before many scientists used these techniques to increase the shelf life of different vegetables (Verdugo *et al*., 2018; Gonçalves *et al*., 2009). Blanching helped to retain its colour and inactivate enzymes while cooking increased its digestibility and organoleptic attributes whereas polyethylene bags aid in the reduction of weight loss, drying process and also in the retention of high humidity (Pinela *et al*., 2016). The objectives of this were to evaluate the influence of techniques on quality properties of watercress at ambient temperature during storage and best treatment was confirmed with the histological study of the stored sample at last day.

MATERIALS AND METHODS

Fully mature green watercress vegetable was directly collected from farmer's field and transferred to the laboratory of Food Science and Technology in Faculty of Agriculture, Rawalakot. The sample was washed, dried and subjected to following treatments: control (T_1), fresh + polyethylene (T_2), cooked (100^{o}C for

5 minutes) + polyethylene (T_3) and blanched (100^oC for 1 minute) + polyethylene (T_4) and analyzed for the following parameters during storage.

Moisture loss percentage: Moisture content of green vegetables was determined by using the method of AOAC (2005) in an oven at 550^oC and calculated by the following:
Moisture loss (%) = W_1-W_2/Original Sample x100

pH: pH meter was used according to the method of AOAC (2005) to determine the pH of sample juice.

Titratable Acidity %: Titratable acidity of the sample was evaluated according to the method of AOAC (2005) through the use of titer 0.1N NaOH until pink colour appears and calculated by using the formula:

$$\text{Acidity\%} = \frac{0.1 \times \text{equivalent weight of acid} \times 1\text{N NaOH} \times \text{titer} \times 10}{10}$$

Ascorbic acid (mg/ 100ml of vegetable juice): About 10ml of juice was titrated against 2.6-dichlorophenol indo-phenol to pink colours through the method of AOAC (2005).

β-carotene: About five grams of fresh sample was taken, crushed in 15ml acetone and extract was put in separating funnel. Two layers appeared in the funnel. The upper layer was collected and noted its optical density at 452 nm according to the method of AOAC (2005).

Total sugar: About 5ml Fehling solution A and 5ml Fehling solution B was used to determine the total sugar by using the standard method of AOAC (2005).

Ash content: Muffle furnace used to evaluate ash of the sample according to the standard method (AACC 2000).

Crude fiber: Defatted sample of vegetable was taken in a beaker and neutralized with 200 ml H_2SO_4 (0.25N) and 200ml NaOH. Residues were put in the oven for drying and record the reading of crude fiber (AACC 2000).

Sensory Evaluation: Colour, flavour, texture, taste and overall acceptability were evaluated by using nine point hedonic scales as designated by Larmond (1977).

Histological Properties: scan electron microscopy has been used to analyse the effect of blanching and cooking on leafy vegetables of watercress. For this purpose, the last day of the stored sample of control, blanched and cooked sample has been dried as stated by Canet and Tortosa (1990).

Statistical Analysis: Two-factor factorial and complete randomized design were used to analyze the obtained data (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Moisture loss (%): Table-1 showed the percentage loss of moisture contents in stored watercress vegetables for 12th days. The data revealed a decreasing trend with time in all treatments. The mean value of moisture loss (%) from the first day 93 to 26 at 6th day of storage in control sample and 55 at 9th day in fresh packed in polyethylene bags, 64 and 75 at 12th day in the blanched and cooked sample. This reduction might be due to high transpiration, respiration rate in vegetables. Present results are also correlated with the previous studies of Maroof *et al*. (2019) and Farida *et al.* (2008) as they stated by their work that processing and storage decreased the moisture content in vegetables. All treatments depicted significant among each other except T_1 and T_2 whereas T_3 and T_4 at par. Higher retention of moisture content in T_4 and T_3 was due to the polyethylene packaging which provides provision of the modified atmosphere with lower evaporation rate are in line with Maroof *et al*. (2019) and Artemio *et al*. (2002).

pH: Gradually decreased in pH values were depicted in Table-1 during storage. The pH 6.96 to 4.01, 6.96 to 4.91, 6.61 to 5.22, 6.61 to 5.59 was noted at the 1st to last day of storage in control and treated samples, respectively. These results could be related to the increase of organic acids, namely malic acid, and reduced glucose levels, probably due to fermentative processes (Pinela *et al*., 2016). Present work is coincidence with the previous investigation of Maroof *et al*. (2019) and Pinela *et al*. (2016).

Titratable acidity: Results given in Table-1 depicted the mean values of titratable acidity of watercress during storage with increasing manners. The mean value was recorded about 0.34% at (1st day) while 0.29% at last day (6th day) of storage in control watercress sample. This decreasing trend may be responsible to reduce the storage life of control sample which was undesirable to use on 6th day. On the other hand, treated sample showed increasing order 0.34% on the first day to 0.71% in T_2, 0.48% T_3 and 0.42% T_4 on the last day of storage. A similar study was observed by Maroof *et al*. (2019). This could be a reason to change in organic acids (salt and ester form) also in line with a previous evaluation of Maroof *et al.* (2019) and Logegaray *et al*. (2016) during storage.

Ascorbic Acid: It is an important micronutrient anticipated in different vegetables. This is concomitant with collagen synthesis, metabolic reactions and serves as an antioxidant (Pichmony *et al*., 2018). The data on ascorbic acid of watercress present in Table-1 showed mg/100g of 64 in T_1 and T_2, while 51 and 55.04 in T_3 and T_4 reduce to 18, 25, 36 and 42 during storage. The mean value of ascorbic acid in the stored sample was gradually decreased with increase in storage period are agree with the previous study of Logegaray *et al*. (2016). This might be due to the leaching of ascorbic acid into the water as confirmed with the studies of Fafunso and Bassir (1976). These results also agree with previous studies of Maroof *et al*. (2019), Pichmony *et al*. (2018), Verdugo *et al*. (2018) and Logegaray *et al*. (2016).

β-Carotene: The Results related to β-carotene summarized in Table-1. The mean values of carotene (µg/100g) at 1^{st} day of storage is 2248, 2248, 1886 and 1956 to decreased 467, 565, 945 and 1098 during at last day of storage. Oxidation by lipid peroxides may be a reason in the reduction of the β-carotene (DeMan, 1999). Table-1 has shown the highest mean value of T_4 and T_3 as compared to T_1 having minimum value. These findings are in line with Maroof *et al*. (2019) and Logegaray *et al*. (2016).

Total sugar: Data on the total sugar (Table-1) showed a decreasing trend in stored watercress. Similar behaviour was recorded in all treated samples during storage. The highest percentage of total sugar 0.98 0.98, 0.79, 0.98 observed at 1^{st} day storage and lowest sugar percentage 0.23, 0.45, 0.5, 0.62 at 6^{th} day in control, 9^{th} in fresh packed sample and 12^{th} day in blanched and cooked sample in storage, This reduction might be due to high organic acid, slower the metabolic process or slow change in polysaccharides (Adewusi and Falade, 1996). This study is in line with Gao-feng *et al*. (2009) and Wang (2006).

Ash: Decreasing trends of ash mean values were observed in the stored sample of watercress as indicated in (Table-1). The amount of ash in all treatments 0.23, 0.31, 0.22 0.22 at 1^{st} day to reduced 0.17, 0.18, 0.19 and 0.2 at last day of storage was depicted in Table-1. This reduction might be due to an increase in storage duration or might be due to water absorption cause a low amount of ash (Lewu *et al*. 2009). These consequences are agreed with Eugene *et al*. (2003). Table-1 depicted that the T_3 and T_4 have maximum mean values of ash followed by T_2 and minimum ash was observed in T_1. This might be due to the gradual alteration of mineral contents. These results are in line with Maroof *et al*. (2019) and Shahnaz *et al*. (2003).

Crude fiber: The general decreasing trend was observed in crude fiber content of all treated watercress sample in storage (Table-1). In Table-1, 3.33, 3.33, 3 and 3 mean values were noted at 1^{st} day and 2.0, 2.22, 2.40 and 2.50 on 12^{th} day during storage. This might be happening due to the environmental factors that effect before harvesting or possibly due to the thermally induced hydrolysis of carbohydrates within the cell wall (Rickman *et al*., 2006). A decrease in the crude fiber values was observed during storage as stated by Maroof *et al*. (2019) also correlated with present findings. Maximum value was found in T_4 and T_3 followed by T_2 as compared to control had 2.35 minimum fiber mean value. Highest fiber mean value showed in in $T_{4,}$ T_3, T_2 and minimum fiber value appeared in control (Table-1). Present findings were coincidence with the study of Rickman *et al*. (2006) and Shahnaz *et al*. (2003) as they described that superficial modification in fiber content in processing might have been endorsed to fluctuations in moisture content.

Colour: Table-2 showed the colour scores of watercress during the storage period. The first day of stored samples of watercress recorded the mean scores in control and fresh was 8, while blanched and cooked indicated the value 7. Colour scores were decreased up to 6^{th} day (4) in T_1, 9^{th} (5.21) in T_2 and 12^{th} day (5.08 and 5.09) in T_3 and $T_{4,}$ respectively. The green colour is a significant property for the visual perception of watercress freshness (Pinela *et al*., 2016). Change in colour could be due to climatic factors that effect before harvesting or due to low pH of medium with enzymatic activity. The green colour of vegetables may also be due to the conversion of chlorophyll (bright green) to pheophytins (olive brown) which is unattractive to the punter (Pichmony *et al*., 2018). These results are in line with Maroof *et al*. (2019). All treatments depicted significant difference among them. Maximum retention of the colour score was observed in T_4, T_3 and T_2 due to proper storage of sample in polyethylene bags. These results are confirmed with previous scientists Logegaray *et al*. (2016), Silveira *et al*. (2014) and Elsa *et al*. (2009) they stated that the colour retention was recorded in packed vegetables.

Flavour: Mean values of watercress flavour were given in Table-2. Results showed a decreasing trend in flavour scores during the storage period. Maximum scores were obtained (8 and 7) at 1^{st} day of storage in all treatments and minimum 4 in control at 6^{th} day while 6 in T_3 and T_4 observed at 12^{th} day of storage. This might be due to the conversion of ethylene gas into CO_2 and H_2O (Wills *et al*., 1989). Present results are agreed with Maroof *et al*. (2019) and Char *et al*. (2012).

Texture: Data related to the texture of watercress decreased was storage increased (Table 2). This reduction was recorded first to last of storage in all sample might be due to the degradation of pectic substances which are responsible for the firmness of fruits and vegetables. Maximum texture colour was obtained in T_4 the 12^{th} day of storage while the minimum texture score was noted in the control sample at 6^{th} day of 2.34 unable to use as a diet. Retention of texture could be a reason for the slow conversion of pectin substance to soluble forms. Present results are agreement with previous work of Maroof *et al*. (2019) and Char *et al*. (2012).

Taste: Mean values of taste were decreased in stored watercress with the passage of time (Table 2). The reduction in taste score could be due to a change in phenolic compound or degradation carbohydrate into simpler compounds (Kays, 1991). Highest mean values were recorded in all treated samples at 1st day that decreased at the end of storage. Table 2 depicted maximum mean values in T_4 at 12th day and minimum in T_1 at 6th day because was decay. Maintaining its taste quality might be due to leisurely variations in complex carbohydrate of vegetables. Present data are in agreement with studies of Silveira *et al*. (2014) and Batal (2006).

Overall Acceptability: Consequences relating to Table 2 indicated the overall acceptability of treated watercress during storage. The general trend was decreased in overall acceptability scores with the passage of time in all treatments. This trend might be due to the decline of sugars and organic acid that reason to decrease the sense of taste during storage. Table 2 displays that the maximum score was recorded in all treated sample 12th day of storage T_4 and least mean values of overall acceptability was observed in T_1 at 6th day of storage. Maximum mean scores were noted may be due to slow alteration of biological change in vegetables. These findings are in inline with the results of Logegaray *et al*. (2016), Char *et al*. (2012) and Mepba *et al*. (2007).

Histological attribute: Results related to SEM of watercress texture of control, blanched and cooked samples given in fig.1 from a to c. Fig 1a showed that control sample consists of bulky and flaky structure. This structure was going to decrease in Fig 1b and disappeared in fig 1c. Degradation of structure in the blanched sample may be due to solubilisation of the pectin material of cell walls (Canet *et al*., 2005). Maximum softening, loosening and swelling indicated in the cooked sample due to high temperature related to change in pectin of the cell wall as supported by Stolle-Smits *et al*. (1998). Short time blanching was helpful in the retention of colour and chlorophylls as correlated with the studies of Canet *et al*. (2005).

Table 1. Quality assessment of watercress vegetables during storage.

Parameters		Effect of storage				
		S_1	S_2	S_3	S_4	S_5
Moisture Loss (%)	T_1	93.33 ± 1.09^{a}	39 ± 0.86^{l}	26 ± 0.56^{m}	0 ± 0^{n}	0 ± 0^{n}
	T_2	93.33 ± 0.89^{a}	83 ± 0.55^{c}	70 ± 0.55^{i}	55 ± 0.75^{k}	0 ± 0^{n}
	T_3	93 ± 1.78^{b}	79 ± 0.45^{e}	73 ± 0.44^{h}	70 ± 0.16^{i}	64 ± 0.67^{j}
	T_4	93 ± 0.64^{b}	81 ± 0.65^{d}	76 ± 0.45^{f}	75 ± 0.11^{g}	75 ± 0.88^{g}
pH	T_1	6.96 ± 1.01^{a}	5.51 ± 0.96^{g}	4.01 ± 0.51^{l}	0 ± 0^{m}	0 ± 0^{m}
	T_2	6.96 ± 1.96^{a}	5.93 ± 1^{d}	5.5 ± 0.93^{g}	4.91 ± 0.91^{k}	0 ± 0^{m}
	T_3	6.61 ± 1.61^{b}	5.95 ± 0.95^{d}	5.67 ± 0.57^{e}	5.3 ± 0.3^{h}	5.22 ± 0.22^{i}
	T_4	6.61 ± 1.11^{b}	6.01 ± 1.01^{c}	5.01 ± 0.81^{j}	5.5 ± 0.5^{g}	5.59 ± 0.59^{f}
Titratable Acidity (%)	T_1	0.34 ± 0.14^{h}	0.21 ± 0.08^{j}	0.29 ± 0.06^{i}	0 ± 0^{k}	0 ± 0^{k}
	T_2	0.34 ± 0.18^{h}	0.38 ± 0.11^{g}	0.49 ± 0.09^{c}	0.62 ± 0.06^{b}	0.71 ± 0.02^{a}
	T_3	0.34 ± 0.07^{h}	0.38 ± 0.05^{fg}	0.4 ± 0.04^{def}	0.47 ± 0.03^{c}	0.48 ± 0.02^{c}
	T_4	0.34 ± 0.04^{h}	0.37 ± 0.03^{g}	0.39 ± 0.02^{efg}	0.41 ± 0.01^{de}	0.42 ± 0.01^{d}
Total Sugar (mg/100g)	T_1	0.98 ± 0.32^{a}	0.57 ± 0.11^{i}	0.23 ± 0.01^{m}	0 ± 0^{n}	0 ± 0^{n}
	T_2	0.98 ± 0.74^{a}	0.78 ± 0.32^{e}	0.51 ± 0.19^{k}	0.45 ± 0.08^{l}	0 ± 0^{n}
	T_3	0.79 ± 0.23^{a}	0.79 ± 0.13^{d}	0.68 ± 0.12^{g}	0.56 ± 0.11^{j}	0.5 ± 0.06^{k}
	T_4	0.98 ± 0.52^{a}	0.89 ± 0.34^{b}	0.83 ± 0.32^{c}	0.74 ± 0.23^{f}	0.62 ± 0.05^{h}
Ascorbic Acid (mg/100g)	T_1	64 ± 1^{a}	41 ± 0.9^{k}	18 ± 0.8^{n}	0 ± 0^{p}	0 ± 0^{p}
	T_2	64 ± 0.78^{a}	48 ± 0.45^{b}	38 ± 0.35^{e}	25 ± 0.30^{m}	0 ± 0^{o}
	T_3	51 ± 1.78^{f}	50 ± 1.6^{g}	45 ± 1.6^{j}	42.07 ± 1.5^{j}	36 ± 1.4^{l}
	T_4	55.04 ± 1.9^{d}	49 ± 1.4^{g}	43 ± 1.3^{h}	55.04 ± 1.9^{d}	42 ± 1.2^{i}
Beta-carotene (µg/100g)	T_1	2248 ± 148^{a}	904 ± 179^{m}	467 ± 55^{p}	0±0q	0±0q
	T_2	2248 ± 117^{a}	1001 ± 16^{k}	831.7 ± 104.3^{n}	565 ± 94^{o}	0±0q
	T_3	1886 ± 683^{c}	1243 ± 13^{f}	1132 ± 164^{h}	1075 ± 83^{j}	945 ± 165^{l}
	T_4	1956 ± 100^{b}	1656 ± 633^{d}	1356 ± 69^{e}	1203 ± 38^{g}	1098 ± 110^{i}
Ash (%)	T_1	0.23 ± 0^{ab}	0.2 ± 0.03^{fgh}	0.17 ± 0.05^{j}	0 ± 0^{k}	0 ± 0^{k}
	T_2	0.31 ± 0.12^{ab}	0.24 ± 0.1^{a}	0.19 ± 0.07^{ghi}	0.18 ± 0.05^{ij}	0 ± 0^{k}
	T_3	0.22 ± 0.1^{bcd}	0.22 ± 0.06^{cde}	0.21 ± 0.07^{def}	0.21 ± 0.02^{ef}	0.19 ± 0.07^{hi}
	T_4	0.22 ± 0.1^{bc}	0.22 ± 0.02^{cde}	0.22 ± 0.03^{cde}	0.2 ± 0.01^{fg}	0.2 ± 0.1^{fgh}
Crude Fiber (%)	T_1	3.33 ± 0.79^{a}	3 ± 0.65^{cd}	2.0 ± 0.88^{cd}	0 ± 0^{e}	0 ± 0^{e}
	T_2	3.33 ± 1.43^{a}	3.3 ± 0.34^{cd}	2.92 ± 1.07^{cd}	2.22 ± 0.63^{d}	0 ± 0^{e}
	T_3	3 ± 1.23^{cd}	3 ± 1.66^{cd}	2.89 ± 0.04^{cd}	2.72 ± 0.15^{cd}	2.40 ± 1.85^{cd}
	T_4	3 ± 0.6^{abc}	2.92 ± 0.63^{bcd}	2.90 ± 0.18^{cd}	2.66 ± 1.35^{cd}	2.50 ± 0.69^{cd}

S_1= 1st day, S_2=3th day, S_3 =6th day, S_4=9th day, S_5=12th day and means followed by the same alphabets are not significantly different from one another based on alpha 0.05.

Table-2. Sensory attributes of watercress vegetables during storage.

Parameters		Effect of storage				
		S_1	S_2	S_3	S_4	S_5
Colour	T_1	8 ± 1.75^{a}	5.12 ± 1.25^{i}	4 ± 0.12^{i}	0 ± 0^{j}	$\mathbf{0\pm0^{j}}$
	T_2	8 ± 1.75^{a}	7.3 ± 2.3^{b}	6.5 ± 2.25^{fg}	5.21 ± 2.29^{i}	$\mathbf{0\pm0^{j}}$
	T_3	7 ± 1.5^{b}	6.8 ± 1.2^{c}	6.77 ± 2.73^{ef}	6.56 ± 0.54^{fg}	$\mathbf{5.08\pm3.12^{i}}$
	T_4	7 ± 0.4^{b}	6.82 ± 1.18^{c}	6.19 ± 1.31^{e}	6.05 ± 1.95^{e}	$\mathbf{5.09\pm1.41^{i}}$
Flavour	T_1	8 ± 1.12^{a}	6.33 ± 0.66^{cde}	4 ± 0.52^{g}	0 ± 0^{h}	$\mathbf{0\pm0^{h}}$
	T_2	8 ± 2.22^{a}	7.14 ± 1.16^{b}	6.38 ± 1.06^{c}	5.02 ± 0.55^{f}	$\mathbf{0\pm0^{h}}$
	T_3	7 ± 1.12^{b}	6.36 ± 1.49^{cd}	6.36 ± 3.19^{cd}	6.15 ± 0.79^{cde}	$\mathbf{6.01\pm2.64^{e}}$
	T_4	7 ± 1.04^{b}	6.09 ± 3.35^{cde}	6.35 ± 3.1^{cd}	6.13 ± 0.76^{cde}	$\mathbf{6.03\pm0.04^{de}}$
Texture	T_1	8 ± 1.77^{a}	5.15 ± 1.29^{g}	2.34 ± 0.88^{i}	0 ± 0^{j}	$\mathbf{0\pm0^{j}}$
	T_2	8 ± 2.12^{a}	6 ± 1.44^{cde}	5.22 ± 0.44^{g}	4.37 ± 0.52^{h}	$\mathbf{0\pm0^{j}}$
	T_3	7 ± 1.11^{b}	5.82 ± 0.34^{de}	6.02 ± 0.12^{cde}	5.3 ± 2.58^{fg}	$\mathbf{5\pm0.5^{g}}$
	T_4	7 ± 0.95^{b}	6.28 ± 0.16^{c}	6.17 ± 0.51^{cd}	6 ± 0.15^{cde}	$\mathbf{5.64\pm0.64^{ef}}$
Taste	T_1	7 ± 0.42^{c}	5.67 ± 2.77^{e}	4 ± 2.28^{g}	0 ± 0^{h}	$\mathbf{0\pm0^{h}}$
	T_2	7 ± 0.77^{c}	6.13 ± 0.91^{d}	5.08 ± 0.19^{f}	5 ± 1.22^{f}	$\mathbf{0\pm0^{h}}$
	T_3	8 ± 1.14^{a}	7.43 ± 0.82^{b}	7.09 ± 2.13^{bc}	7 ± 1.15^{c}	$\mathbf{6.04\pm0.84^{d}}$
	T_4	8 ± 1.14^{a}	7.43 ± 0.82^{bc}	7.09 ± 2.13^{bc}	7 ± 1.15^{bc}	$\mathbf{6.04\pm0.84^{c}}$
Overall Acceptability	T_1	8.33 ± 1.23^{a}	5.21 ± 4.44^{g}	4 ± 2.88^{h}	0 ± 0^{i}	$\mathbf{0\pm0^{i}}$
	T_2	8.33 ± 1.26^{a}	8 ± 0.72^{b}	7.2 ± 1.04^{d}	5.01 ± 1.33^{g}	$\mathbf{0\pm0^{i}}$
	T_3	8.33 ± 0.32^{a}	8.07 ± 0.72^{ab}	7.53 ± 0.63^{c}	7.27 ± 0.78^{cd}	$\mathbf{6\pm0.7^{f}}$
	T_4	8.33 ± 1.69^{a}	8 ± 0.42^{b}	7.23 ± 0.91^{cd}	7 ± 0.57^{d}	$\mathbf{6.35\pm0.71^{e}}$

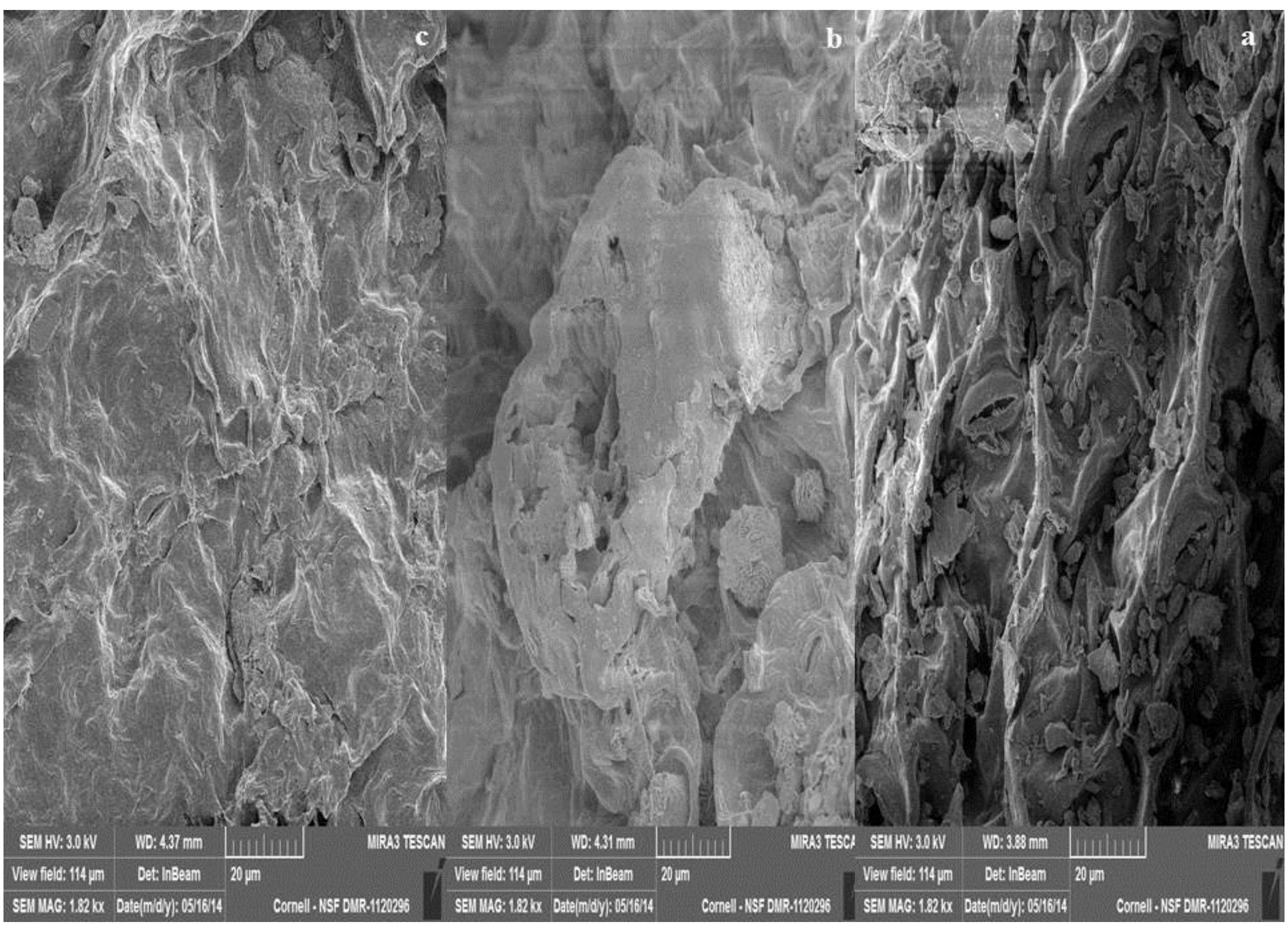

Figure-1(a-c): SEM micrograph of processed watercress

Conclusion: It was concluded that processing techniques such as blanching and cooking with polyethylene bags of watercress were proved beneficial in the retention of its quality as compared to control during storage as authenticated by scan electron microscopy studies. These techniques were helpful to increase storage life and retained their aesthetic values.

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