EFFECT OF MICROWAVE HEAT AND SODIUM BENZOATE ON THE QUALITY OF CARROT PICKLES DURING STORAGE AT AMBIENT TEMPERATURE

Sajad Mir[1*], Amir Gull[1], Gazala Akhtar[1], Raja Jeelani[1], Tariq Ahmad Ganaie[1], Rayees Ahmad Bakshi[1], Sajad Mohd Wani [2], F.A. Masoodi [1]
[1]Department of Food Technology, University of Kashmir, J&K, India
[2]Division of Food Science and Technology, SKUAST-K, J&K, India
*E-mail: mirsajad004@gmail.com

Abstract
Carrot pickle is a traditional fermented food produced all over the world. The continuous fermentation during marketing and storage resulting in over acidification, softening, undesirable aroma, and color. This study was conducted to develop fermented vegetable pickle from carrot added with spices and salt (3.5%). The aim of the study was to investigate the effect of treatments such as microwave heating for 2.5, 3.5 and 4.5 min *and sodium benzoate at concentrations 350, 450 and 550 ppm on desirable quality attributes such as microbial load (log_{10} cfu/gm, texture, Acidity (% lactic acid), pH, LABs and sensory attributes of fermented carrot pickle during storage period of 30 days. Results indicate that microwave treated samples showed decrease in pH value from 5.68 to 4.83, 5.75 to 4.85 and 5.63 to 4.34, respectively. Microwave treated carrot pickle also showed significantly lower microbial count and titratable acidity value than samples treated with sodium benzoate. Texture analysis also showed decrease in pickle firmness during storage, but sodium benzoate treated samples showed highest decline than microwave treated samples. Color analysis showed increase in L* value in all treated samples during entire storage than control. Sensory evaluation indicated significantly higher overall acceptability score for microwave treated sample (2.5 min) than control. From the present findings it is conclude that microwave treatment could be employed to extend the shelf life and preserve the organoleptic attributes of carrot pickle.*

Keywords: fermentation, acidity, pH, color, microwave, LABs

Received: 26.03.2020 Received in revised form: 20.05.2020 Accepted: 29.05.2020

1. INTRODUCTION

Carrot (*Daucus carota*) belonging to the family *Umbelliferae* is one of the popular root vegetables grown throughout the world. It is rich in α and β- carotene, vitamins like thiamine, riboflavin, niacin, vitamin C, folic acid and minerals. These are a good source of carbohydrates and minerals especially Ca, p, Fe and Mg. In recent years, the consumption of carrot and its products have increased steadily due to their recognition as an important source of natural antioxidants besides, anticancer activity of β-carotene being a precursor of vitamin A (Basu *et al.,* 2001). In order to make continuous supply of the nutritious and phyto-chemicals rich vegetables a need is felt to prevent them from immediate spoilage. Thus processing intervention was needed in order to prevent large scale loss of the vegetables especially carrot. Fermentation is most effective way of conserving perishable vegetables. Pickle generally, carrots are pickled by lactic acid fermentation. Various processing methods have been applied to preserve and enhance the storage life of vegetables. Fermentation is one of the biochemical process in which changes are brought about in organic substrates by the action of microorganisms resulting in the conversion of degradable food components into more stable forms. Fermentation not only inhibits the growth of pathogens but also improves its safety (Adams and Mitchell, 2002). It also improves its nutrient content, bioavailability and organoleptic properties of foods (Van Boekel *et al.,* 2010; Poutanen *et al.,* 2009, Marilley and Casey, 2004; Smit *et al*., 2005; Lacroix *et al.,* 2010; Sicard and Legras, 2011). The capability to store vegetables and protect them from spoilage made fermentation an important method of preservation. Lactic acid fermentation result in products with a longer shelf life compared to fresh vegetables. It has

been found that fermentation increases acidity of foods and inhibits spoilage of food products. The aim of the present study was to utilize sodium benzoate and microwave treatment for control of over acidification of the pickle in order to enhance its shelf life and consumer's acceptability during storage and marketing.

2. MATERIALS AND METHODS

Plant material

Carrots were purchased from local market of Hazratbal, Srinagar. Carrots free from physical damage and other defects were used for preparation of the product.

Chemicals

The chemicals used for physico-chemical and microbial analysis were obtained from HIMEDIA, India. All the chemicals used were of analytical grade and purity of 99%.

Preparation of carrot pickle

The carrots were thoroughly washed under running water to remove the dirt. The carrots were peeled and tops were cut off. Washed carrots were shredded into pieces (2-3 cm in length and 1 cm thick) and weighed. Carrot slices were exposed to sunlight for few hours with periodic turnings in order to remove the surface moisture. The carrots slices were then mixed with specific quantity of spices and 3.5 % of the salt was added to it. Fermentation was carried out in previously sterilized containers at 22^{o}C. The samples were monitored continuously until desirable acidity was achieved. The fermented product was subjected to sodium benzoate and microwave treatments. Sodium benzoate was added to three samples at concentrations of 350, 450 and 550 ppm, respectively, while as the other three samples was subjected to microwave treatment for 2.5, 3.5 and 4.5 min. The treated product was then filled into glass bottles separately and was labeled as T1, T2, T3, T4, T5 and T6, respectively. One lot kept as untreated was used as control (C). The product prepared was analyzed after 15, 20, 25 and 30 days of fermentation for chemical analysis.

Microbial analysis

Microbial analysis was carried out by the method as described by American Public Health Association (APHA, 1984).

Sensory analysis

The sensory analysis of the fermented product was done by using 9- point hedonic scale for attributes like, flavour, sourness, firmness and colour.

Physicochemical analysis

The pH of the samples was determined by pH meter (HI 2215 pH/ORP meter). Acidity of the samples was determined by titrating against standard alkali (0.1N NaOH) using phenolphthalein as indicator and results are expressed as percent lactic acid.

Texture analysis

The texture of the fermented pickles was done by 5-blade Kramer share cell (HDP/KS5) using texture analyzer (Stable Micro system, Model TA.XT plus, England). Texture profile analysis (TPA) was performed in duplicate. The conditions of texture analysis were as follows: test speed 3 mm/sec, post- test speed 10 mm/sec, maximum load 50kg, distance 25mm and trigger type 'button'.

Surface color measurement

The color values of the samples were measured by a Hunter Color Lab (Mini Scan XE Plus, model No. 45/0-L, Hunter Associates Laboratory, Reston, VA). The measurements were expressed in L*, a*, and b* values. Three replicates measurements were performed and results were averaged.

Statistical analyses

The statistical analyses were performed using the IBM SPSS statistics 21 (SPSS Inc., USA). The differences among the treatments were evaluated statistically by one-way analysis of variance (ANOVA) and Duncan's multiple tests. All data were two sided at the 5% significance level and are reported as means ± standard deviations (SDs).

3. RESULTS AND DISCUSSION

Microbial analysis

The values of the microbial count (log_{10} cfu/g) for the different samples are shown in the Figure 1. The LAB count (log_{10} cfu/g) in the control sample was found to increase rapidly reaching to a value of 8.30 at the 15-day of fermentation and continued to increase to 8.80 till 30- day fermentation. Similar trend in microbial load was recorded in all samples treated with benzoate. But in case of microwave treated samples with there was a significant decrease in microbial count. After 30 days, the samples treated with 350, 450 and 550 ppm sodium benzoate had microbial counts (log_{10} cfu/g) of 8.70, 6.98 and 6.35, respectively. Whereas the corresponding values for samples treated with 2.5, 3.5 and 4.5 min microwave were 5.13, 5.10 and 5.00, respectively. Thus, in there was decrease in microbial load which resulted in non-significant change in the pH value throughout the storage period. The observation revealed that microwave treatment had better control on microbial population as compared to sodium benzoate treatments. (Hariharan *et al.*, 2014; Arenzana *et al.*, 2012; Jankovic *et al.*, 2014**)**.

Sensory evaluation

The score obtained for different attributes of the samples are presented in Table 1. The result shows that the sensory quality of the control sample received highest rating from the panelists. The sensory quality of the samples treated with 50 ppm benzoate also received same score as control from the panelist. Among samples treated with microwave 2.5 min received significantly higher sensory scores from the panelists than the other samples. These results are in accordance with the previous studies (Turantas *et al.*, 1999). The samples that received microwave treatment for 3.5 and 4.5 min. received the lowest scores due to the degradation of texture and the slight cooked appearance of color by microwave heating.

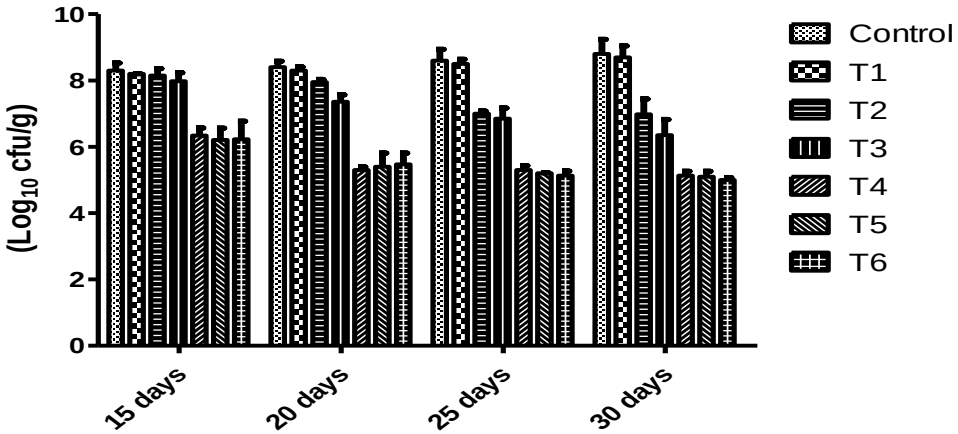

Fig.1. Microbial load of carrot pickle during storage

Table 1. Overall acceptability of fermented carrot at different storage periods

Treatment	15 day	20 day	25 day	30 day
C	6.9±0.01^{a}	6.8±0.08^{d}	7.7±0.15^{g}	7.3±0.05^{b}
T1	6.3±0.08^{f}	6.6±0.02^{b}	5.4±0.10^{d}	7.3±0.08^{a}
T2	6.5±0.15^{d}	6.7±0.02^{f}	5.8±0.04^{f}	5.9±0.15^{a}
T3	6.6±0.02^{b}	6.9±0.01^{c}	6.3±0.05^{b}	6.4±0.03^{c}
T4	7.3±0.15^{g}	7.8±0.03^{g}	7.9±0.40^{e}	7.9±0.15^{d}
T5	6.6±0.05^{b}	7.4±0.01^{c}	7.7±0.03^{g}	6.2±0.03^{e}
T6	6.9±0.02^{c}	6.7±0.05^{f}	6.2±0.04^{c}	5.9±0.04^{f}

Values are means ±SD and different letters within a colum

pH value

The results obtained for the pH value are shown in the Figure 2.

The initial pH value of the raw sample was 6.6-6.8 and apparently decrease in all fermented samples. Several studies had reported such a decreasing trend in the pH values of the pickles during storage (Hariharan *et al.*, 2014; Dhanapal *et al.*, 1994). In case of control the pH value decreased from 5.72 -3.64, 30 day of fermentation. It was found that in the samples treated with microwave or 2.5, 3.5 and 4.5 min. the pH decreased from (5.68-4.83), (5.75-4.85) and (5.63-4.34), respectively during storage.

The samples treated with the sodium benzoate at the concentration of 350and 450 ppm did not showed any significant decrease in the pH value during the fermentation. However, in case of sample treated with sodium benzoate at 550 ppm showed a significant change in the pH value during fermentation (Fig. 2).

The pH value decreased from 5.79 at 15 day of fermentation to 3.96 at 30 day of fermentation.

The same trend in the decrease of pH value in the garlic pickle has been earlier reported by Raja et al., (2016).

Titratable acidity

The values of titratable acidity obtained for the different samples are shown in the Figure (3). The value of acidity for the raw material was 0.09% as lactic acid. The values for acidity (%) of samples treated with 350, 450 and 550 ppm sodium benzoate were 0.91, 0.90 and 0.93, respectively at 15-days which increased to 1.43, 1.49 and 1.39, respectively after 30 day of storage.

The sample treated with microwave for 2.5, 3.5 and4.5 min. had an initial acidity of 1.03, 0.97 and 0.92% respectively which increases to 0.82, 0.83 and 0.84% respectively. It is evident from the results that microwave treatment had a better control on acid production than sodium benzoate and the effect can be attributed to destruction of lactic acid bacteria by Arenzana *et al.*, 2012 Jankovik *et al*, (2014).

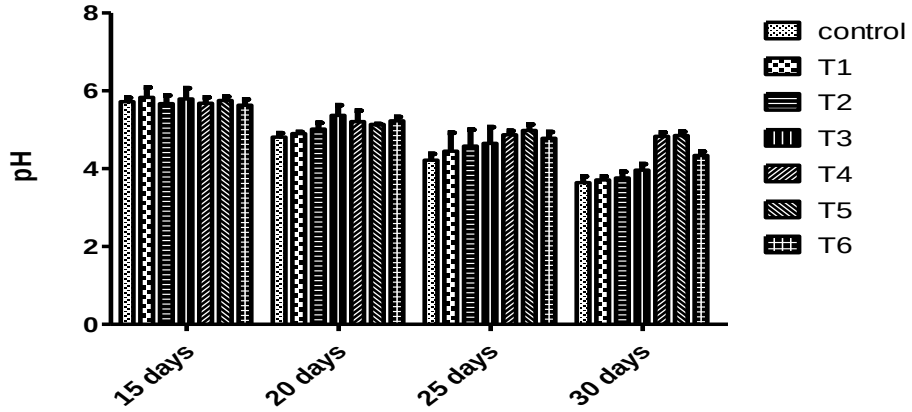

Fig.2. pH of carrot pickle during storage

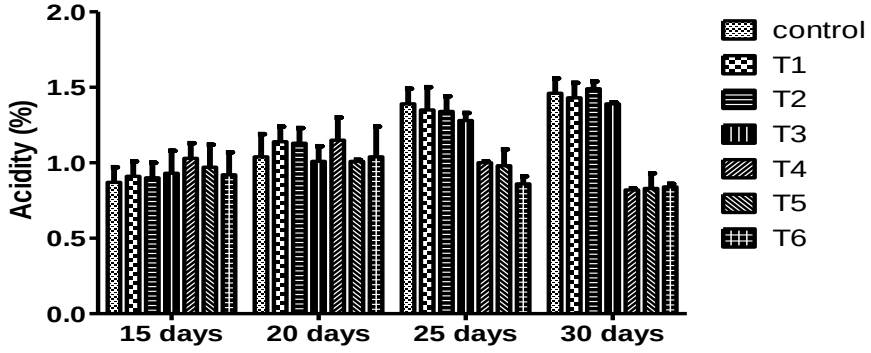

Fig.3. Acidity of carrot pickle during storage

Table 2: Texture values (Firmness) of fermented carrot at different storage periods

Treatment	15 day	20 day	25 day	30 day
C	7.7±0.15^{a}	7.3±0.05^{bc}	6.9±0.01^{a}	6.8±0.08^{a}
T1	7.3±0.08^{d}	6.6±0.02^{f}	6.3±0.08e	5.4±0.10^{f}
T2	7.0±1.4^{f}	6.7±0.02^{e}	5.9±0.15^{g}	5.8±0.04^{e}
T3	6.9±0.01^{e}	6.6±0.02^{fg}	6.3±0.05^{ef}	5.0±0.11g
T4	7.6±0.03^{c}	7.3±0.15^{b}	6.7±2.0^{b}	6.2±1.3^{dc}
T5	7.7±0.03^{ab}	7.4±0.01^{a}	6.6±0.05^{d}	6.2±0.03^{c}
T6	7.0±1.4^{fg}	6.9±0.02^{d}	6.7±0.05^{bc}	6.3±0.04^{b}

Values are means ±SD and different letters within a column indicates significant differences ($p<0.05$) among samples by Duncan's test

Table 3. Color value of fermented carrot during storage

Sample	Attributes	15 days	20 days	25 days	30 days
Control	***L****	36.54^{c}	39.90^{a}	37.41^{b}	36.38^{cd}
	a*	-1.77^{a}	-1.22^{d}	1.43^{c}	1.63^{b}
	b*	7.96^{d}	8.93^{c}	10.33^{b}	11.30^{a}
T1	***L****	37.82^{d}	39.94^{c}	40.31^{a}	41.22^{ab}
	a*	-1.54^{d}	-1.58^{b}	1.43^{c}	1.98^{a}
	b*	7.81^{cd}	8.99^{c}	10.91^{b}	11.21^{a}
T2	***L****	38.5^{6d}	40.08^{bc}	40.88^{b}	42.17^{a}
	a*	-2.64^{a}	-1.86^{c}	1.62^{d}	2.46^{ab}
	b*	8.06^{d}	9.66^{c}	11.21^{ab}	11.55^{a}
T3	***L****	40.43^{cd}	40.87c	41.68^{b}	42.80^{a}
	a*	-2.76^{d}	-2.63c	2.16b	2.59a
	b*	8.76^{d}	9.42c	11.75^{ab}	11.89^{a}
T4	***L****	42.45^{cd}	42.67^{bc}	42.92^{b}	44.18^{a}
	a*	-2.96^{b}	-3.07^{a}	2.48c	2.76^{cd}
	b*	8.48^{d}	9.86^{c}	11.86^{b}	12.65^{a}
T5	***L****	48.26^{dc}	48.37^{c}	48.96^{b}	49.06^{a}
	a*	-3.03^{d}	-3.67^{ba}	3.13c	3.67^{a}
	b*	9.21^{d}	9.88^{c}	11.91^{b}	12.87a
T6	***L****	53.75^{d}	55.38^{cb}	55.65^{ba}	55.98^{a}
	a*	-3.39^{d}	-3.64^{c}	3.50^{b}	3.76^{a}
	b*	9.57^{dc}	9.81^{c}	12.15^{b}	12.99^{a}

Texture

The values of the texture of control sample and samples treated with microwave and sodium benzoate is presented in the Table 2. All samples showed decrease in firmness during the storage. The texture of the samples treated with sodium benzoate showed the highest decline in firmness during storage. It decreased from 7.3 to 5.4N, 7.0 to 5.8N and 6.9 to 5.0N for the sample treated with 550 ppm 350 and 450 ppm sodium benzoate. However, the microwave treated samples did not show any significant difference in the texture with respective to control sample from 15-day fermentation to a period of 30-day fermentation.

Color value of fermented carrot

The results obtained for the colour value of fermented carrot is shown in the Table (3). From the data it is clear that the value of *L** decreased from 36.54 (day15) to 36.38 (day 30) in case of control sample. During the 30 day storage, the *L** values of all treated samples increased. However, there is no significant change in *a** and *b** values between control and treated samples. This result was similar to the previous study on Peruvian carrot (Tribst *et al.*, 2016). It is observed that treated samples could result in a noticeable visual difference in color.

4. CONCLUSIONS

Over acidification of the pickles was a challenging problem in front of food processors. Minimal processing techniques were applied in this perspective in order to minimize this problem and to enhance the storage life for consumer acceptability. Microwave treatments to fermented carrot gave satisfactory bacterial load reduction than sodium benzoate treatment. The present study on controlling the fermentation rate by microwave treatment will serve as a guide in the production of safe fermented foods and to select the better process for future application. However, there is need for the more depth research in this direction for controlling fermentation, extending shelf life of fermented vegetables and improving consumer acceptability.

5. ACKNOWLEDGMENTS

The authors are highly thankful to the Department of Biotechnology, Ministry of Science and Technology (IN), Govt. of India.

6. REFERENCES

[1] Adams, M., and Mitchell, R. Fermentation and pathogen control: A risk assessment approach. Journal Food Microbiology, 79, (2002), 75-83.

[2] APHA, Compendium of methods for the microbiological examination of foods, 2nd Edn., Washington, DC. American Public Health Association (1984).

[3] Arenzana, L.G., Pilar, S.L., Patrocinio, G.R., Gutierrez, A.R., Garde-Cerdan T., and Lopez-Alfaro I. Microwave technology as a new tool to improve microbiological control of oak barrels: A preliminary study. Journal of Food Control, 30, (2012), 536-539.

[4] Basu, H.N., Del Vecchio, A.J., Flider, F., and Orthoefer, F.T. Nutritional and potential disease prevention properties carotenoids. Journal of American Oil Chemists Society, 78, (2001), 665-675.

[5] Dhanapal, K., Ratnakumar, K., Jasmine, T.J., and chandran, J. Processing chank meat (*Xancus pyrum*) into pickles. Fish Technology, 31 (1994), 188-90.

[6] Hariharan, B., Singaravadivel, K., and Alagusundaram, K. Effect of food grade preservatives on the physiochemical and microbiological properties of coconut toddy during fermentation. Journal of Nutrition and Food Science, 4, (2014), 1-5.

[7] Jankovic, S.M., Milosev, M.Z., and Novakovic, M.L.J. The Effects of Microwave irradiation on Microbial Cultures. Journal of Hospital Pharmacy, 1, (2014) 02-108.

[8] Lacroix N., St Gelais D., Champagne C.P., Fortin J., and Vuillemard J.C. Characterization of aromatic properties of old-style cheese starters. Journal of Dairy Science, 93, (2010) 3427-3441.

[9] Marilley L., and Casey, M.G. Flavors of cheese products: metabolic pathways, analytical tools and identification of producing strains. Journal of Food Microbiology 90, (2004), 139-159.

[10] Poutanen, K., Flander, L., and Katina, K. Sour dough and cereal fermentation in an nutritional perspective. Food Microbiology, 7, (2009), 693-699.

[11] Raja J., Mir S.A., and Masoodi, F.A. Effect of dry salt and brine on the fermentation and colour of blanched garlic. Journal of Nutrition and Food Science, 6: (2016), 484 doi:10.4172/2155-9600.100048.
[12] Sicard, D., and Legras, J.L. Bread, beer and wine: yeast domestication in the *Saccharomyces sensu* strict complex. Comptes Rendus Biologies, 334, (2011), 229-36.
[13] Smit, G., Smit, B.A., and Engels, W.J. Flavor formation by lactic acid bacteria and biochemical flavor profiling of cheese products. FEMS Microbiology Reviews, 29, (2005), 591-610.
[14] Tribst, A.A.L., Leite, B.R.D., de Oliveira, M.M., and Cristianini, M. High pressure processing of cocoyam, Peruvian carrot and sweet potato: Effect on oxidative enzymes and impact in the tuber color. Journal of Innovative Food Science and Emerging Technology, 34, (2016), 302-309.
[15] Van Boekel, M., Fogliano, V., Pellegrini, N., Catherine Stanton, C., Scholz , G., Sam Lalljie, S., Somoza, V., Knorr, D., Jasti, P.R., Eisenbrand, G. A review on the beneficial aspects of food processing. Molecular Nutrition and Food Research, 54, (2010), 1215-1247.
[16] Turantas¸ F., Goksungur, Y., Dincer, A.H., Unluturk, A., Ulgar Guvenc¸ U., Nes¸e Zorlu, N. Effect of potassium sorbate and sodium benzoate on microbial population and fermentation of black olive. Journal of the Science of Food and Agriculture. 79, (1999),1197-1202.