EFFECT OF VARIOUS COMBINATIONS OF SODIUM CHLORIDE AND SUCROSE CONCENTRATIONS ON THE QUALITY OF PLUM PICKLE DURING STORAGE

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Abstract
In Bangladesh there were no standard processing practices followed by producers, traders and processors; as a result, the physical and nutritional properties of the plum deteriorate significantly. In this regard, it is important to develop a processing technique for plums such as plum pickle for future commercial uses. For the preparation of plum pickles, different concentrations of sodium chloride and sucrose were used in all six treatments in order to standardize the processing conditions of plum pickles. During storage, the pH was slightly lowered and the acidity was increased. Taking the pickle color into account, the highest lightness was found in a sample containing 3% sodium chloride plus 12% sucrose, and the lowest lightness was found in the plum pickle treated with 5% sodium chloride plus 12% sucrose. The microbial growth of the plum pickle was noted at the end of storage and the load (CFU) varied between 7×10^{-2} and 32×10^{-1}. Overall acceptance remained the highest attribute for the combination of 4 to 5% NaCl plus 12% sucrose treated plum pickle, and the rating was 9.0. Therefore, the plum pickle treated in 4 to 5% NaCl plus 12% sucrose performed better when considering the overall quality, color and acceptance up to 12 months of storage. The results of the study will be useful for the production and post-harvest management of the newly released plums in Bangladesh.

Keywords: plum pickle, acidity, color, microbial count, overall acceptability.

Received: 26.09.2021 Reviewed: 08.11.2021 Accepted: 09.11.2021

1. INTRODUCTION

Due to various health benefits, plum (*Prunus domestica*) plays an important role in our diet and is believed to be a natural remedy for various diseases (Sabarez and Price, 1999). At higher moisture levels it becomes very fragile, making it unfit for human consumption within 3-4 days (Sharma and Lal, 1999). The fact that plum production is increasing due to the improvement in horticultural practices and production technologies. But the inadequacies in handling, storage, transportation and marketing pose a greater threat during the glut season, leading to high post-harvest losses and bringing low prices to farmers. The correct utilization of these valuable fruits is still unorganized and primitive in Bangladesh. Therefore, processing and preservation would be required to obtain a representative value from the plum producer. Preparing pickles would be a real and most convenient way to process plums. Especially, women in our country made pickles according to their method.

The term pickle is derived from the Dutch word pekel, which means brine. In South Asia it is called Achar. There are numerous names like Achar in Punjabi, Hindi, Bengali; Uppinakaayi in Kannada, Lonacha in Marathi, Orukai in Tamil, Oragaya in Telugu, which are mostly made from different types of fruit and vegetables (Hassan and Raghuram, 2001). Pickles are generally always homemade in South Asia, and every district, village and family have its own secret recipes that are strictly protected and passed on from mother to daughter. The popular pickling medium is mustard oil (Premi *et al.*, 2002). Pickles are an extensively suitable and serviceable appetizer as used in our country. When the components are worn in appropriate amounts, the pickles would be preserved for a longer duration

without any deterioration (Srivastava and Kumar, 2002).

Pickles are made through the natural fermentation of fruits and vegetables and also have nutritional value; Pickles are also used to accompany dishes and as flavor enhancers (Joshi and Bhat, 2000; Savitri and Bhalla, 2007). Pickles are preserved as an edible product and seasoned with acetic acid in a solution of NaCl. Other ingredients such as salt, sugar, acid and spices are often used for the complementary effect in pickle preparation. The presence of different spices varies in their uncontaminated effect, mustard oil is one of the active ingredients; pepper and turmeric powder with little effect (Desrosier, 1977).

As an agricultural country in Bangladesh, whose economic development depends on the achievement of higher efficiency in food production and the optimal use of the available food supply. Therefore, there are good opportunities to produce fruit pickles on a commercial scale (Sultana *et al.*, 2014). In this regard, the overall goal of research is to optimize the state of preparation and to preserve plum pickles for long-term consumption. The specific research objectives are to determine the optimal combinations of sodium chloride and sucrose for the preparation of plum pickle; to determine the nutritional quality and microbial growth of fresh and stored pickle; and finally, the organoleptic tasting to assess the acceptability and shelf life of the developed plum pickle.

2. MATERIALS AND METHODS

2.1 Collection of plums and formulation of plum pickle

The plum (*Prunus domestica*) fruits having optimum maturity and firm texture were gathered from the Spices Research Centre and were transported through plastic crates to the laboratory of Postharvest Technology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur. After sorting, plums were washed with clean water and dried under a ceiling fan. The following ingredients were used during the preparation of plum pickle:

Item	Quantity
Plum	1.0 kg
Garlic	30.0 g
Ginger	60.0 g
Chilli powder	20.0 g
Turmeric dust	12.0 g
Mustard powder	25.0 g
Cumin powder	205.0 g
Fenugreek powder	5.0 g
Mustard oil	400 ml
Acetic acid	15 ml

Srivastava and Kumar (2002) explained that salt and sugar were more prominent ingredients among the formulations of a pickle. The sufficient amount of acetic acid and mustard oil are the effective component in pickle formulations which described by Etehells *et al.* (1973). There were six treatments for the preparation of plum pickles. They are: T_1= plum with 3% sodium chloride and 10% sucrose; T_2= plum with 3% sodium chloride and 12% sucrose; T_3= plum with 4% sodium chloride and 10% sucrose; T_4= plum with 4% sodium chloride and 12% sucrose; T_5= plum with 5% sodium chloride and 10% sucrose; and T_6= plum with 5% sodium chloride and 12% sucrose.

Preparation of plum pickle

The following flowchart indicated the plum pickle preparation process as shown in Figure 1.

2.2 Measurement of pH

A glass electrode from EUTECH Instruments, Selangor, Malaysia was used for the pH analysis in a plum pickle. The 5 g sample diluted with 45 ml of distilled water was taken out for measurement.

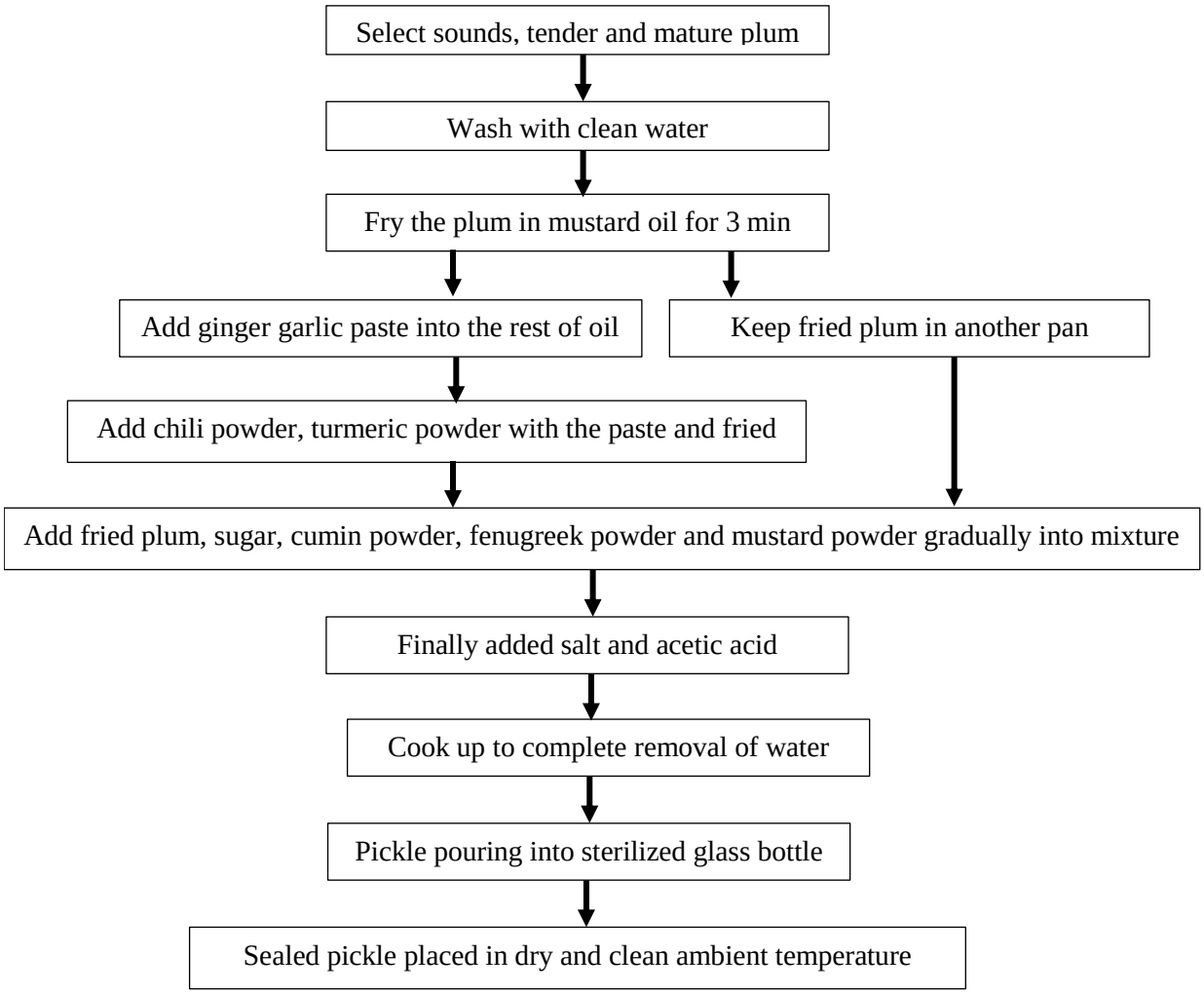

Figure 1: Sequence of the flowchart for the preparation of plum pickles

2.3 Measurement of titratable acidity

The titratable acidity was measured according to Autotitration-814, USB sample processor, Switzerland. Briefly, 10 g of plum pulp were homogenized, filtered and one to two drops of phenolphthalein (0.1%) were added to the filtrate as an indicator and finally titrated against 0.1 N NaOH until the endpoint color was pink (pH 8.1). Titratable acidity results can be analyzed as the percentage of citric acid per 100 g fresh weight.

2.4 Measurement of product appearance/color

A tristimulus colorimeter (Model: CR-400, Minolta Corp., Japan) was used to determine the color of plum pickle. 10^0 standard observers were used for the reference system, with L (brightness), a * (-green to + red) and b * (-blue to + yellow) being the color coordinates. The method has been extensively described by Pervin *et al.* (2021).

2.5 Microbial count

The microbial load of the plum pickle was determined using plate count agar. The microbial load count was performed every two months for 12 months of storage. During the counting process, a 10g pickle sample was homogenized with 90ml peptone-water buffer solution and then 10µL suspension in plate counting agar (PCA) medium were inoculated by 10-fold serial dilution. Incubated at 37^0C for 24 hours in an incubator (Model: SHC-4A1). Various bacterial colonies grown in this medium were counted. The following formula was used for the number of colonies in cfu/g:

$$\text{Colony For min g Unit}\left(\frac{\text{cfu}}{\text{g}}\right)=\frac{\text{No. of colony}\times\text{Dilution}\times\text{Time of dilution}}{\text{Sampale inoculated to plate / media}}$$

2.6 Sensory evaluation

The sensory evaluation of the plum pickle took place every 2 months during storage with a sensory taste questionnaire, which was evaluated by sensory experts. The individual treatment was assigned as a letter code in order to avoid prejudice between the panelists. The samples were offered to the panelists in a different order in order to avoid preferring the order among the panelists. The plum pickle was rated by 10 experienced panelists who were asked to rate the samples based on external plum color, off-flavor, firmness, sweet and sour balance, and overall acceptance using a 9-point hedonic scale.

3. RESULTS AND DISCUSSION

3.1 pH of plum pickle during storage

The influence of sodium chloride and sucrose concentrations on the pH values of a plum pickle during storage is shown in Table 1. In terms of the effect of sodium chloride concentration, the initial pH is 2.96 was found the highest in the 5% sodium chloride and the lowest was 2.81 in the 3% salt-treated samples. The tendency to decrease the pH value continued even after 12 months of storage. For effect of sucrose concentration, initially, the highest pH of 2.89 was observed at 12% sucrose treated pickle followed by 2.86 for 10% sucrose treated pickle. Regarding the treatment interaction between sodium chloride and sucrose, initially, the highest pH of 2.97 was observed in treatment T_6 and the pH of 2.79 was lowest in treatment T_1. However, the pH was slowly decreased in stored pickles for storage duration of 12 months. Initial value of plum pickle pH was higher than that of the final product and similar results were reported by Panwar (1996) in karonda pickle, and Sharma (2002) in a lime pickle. The higher solute concentrations increase the pH of plum pickle, while the bacteria's fastest growth is in acidic circumstances; this investigation was similar to Pundir and Jain (2010) and Felix (2014).

Table 1: Influence of sodium chloride and sucrose concentrations on the pH of plum pickle during storage

Factors/Treatments	pH content of the pickle with different storage times (months)						
	0	2	4	6	8	10	12
Sodium chloride							
3 percent	2.81b	2.77b	2.73b	2.69b	2.65b	2.59c	2.56b
4 percent	2.86ab	2.83ab	2.78ab	2.73b	2.67b	2.64b	2.61b
5 percent	2.96a	2.90a	2.85a	2.82a	2.79a	2.76a	2.68a
CV%	2.623	2.290	2.327	1.547	1.656	1.280	2.024
$LSD_{0.1\%}$	-	-	-	-	0.058	0.044	-
$LSD_{1.0\%}$	-	-	-	0.055	-	-	0.068
$LSD_{5.0\%}$	0.097	0.083	0.083	-	-	-	-
Sucrose							
10 percent	2.86	2.81	2.76	2.71b	2.67b	2.68a	2.60
12 percent	2.89	2.85	2.81	2.77a	2.73a	2.66b	2.63
CV%	2.623	2.290	2.327	1.547	1.656	1.280	2.024
$LSD_{5.0\%}$	ns	ns	ns	0.045	0.047	0.036	ns
Treatments							
T_1= 3% sodium chloride and 10% sucrose	2.79	2.75	2.71	2.67c	2.64b	2.58c	2.55
T_2= 3% sodium chloride and 12% sugar	2.82	2.78	2.75	2.70bc	2.65b	2.60c	2.57
T_3= 4% sodium chloride and 10% sucrose	2.85	2.82	2.78	2.72bc	2.66b	2.63c	2.60
T_4= 4% sodium chloride and 12% sucrose	2.87	2.83	2.77	2.74bc	2.67b	2.64bc	2.61
T_5= 5% sodium chloride and 10% sucrose	2.94	2.87	2.79	2.75b	2.72b	2.70b	2.65
T_6= 5% sodium chloride and 12% sucrose	2.97	2.93	2.91	2.88a	2.86a	2.81a	2.71
CV (%)	2.623	2.290	2.327	1.547	1.656	1.280	2.024
$LSD_{5.0\%}$	ns	ns	ns	-	0.081	-	ns
$LSD_{10.0\%}$	ns	ns	ns	0.077	-	0.062	ns

Note: The mean values ± of the triplicate determinations are carried out for all values. The mean values ± in the columns are displayed in significant result (p<0.001 to <0.1) with various letters a, b & c and ns-Non significant up to 10% level of significance.

3.2 Acidity of plum pickle during storage

Table 2 showed the effect of solute concentration on the quality of plum pickles during storage. Initially, a sodium chloride concentration of 5% resulted in a higher acidity (2.47), while the lowest (2.40) was observed at 3% NaCl. Eventually, it was increased monthly to up to 12 months of storage. Eventually it was increased monthly to up to 12 months of storage. With regard to the sucrose concentration in the pickle, the highest acid content was observed in the treated plum pickle with 12% sucrose. The treatment interaction between various sodium chloride-sucrose concentrations used pickle preparation, the highest acidity was seen in treatment T_6 containing 5% NaCl plus 12% sucrose and the lowest in the treatment T_1 containing 3% NaCl plus 10% sucrose. The reason could be the diffusion of acetic acid and the process, which resemble the first order type reaction with an identical rate constant (Iqbal and Islam, 2005; Ferdous *et al.*, 2007). The trend of increasing acidity continued during storage for up to 12 months. These changes in acidity in pickles due to lactic acid fermentation and fermentation have been notorious to increase acidity in several foods (Gupta, 1998; Fleming, 1982; Basnett, 1992). The increase in acidity during storage could be due to lactobacilli bacteria, which are formed in pickles during fermentation and convert sugar to lactic acid, as reported by Srivastava and Kumar (2002); and Rekha (2004) in Kachari pickle. The results agreed with those of Stella *et al.* (2011) in orange nectars; Touati *et al.* (2013) in fruits beverages; Touati *et al.* (2016) in fruit nectars.

Table 2: Effect of sodium chloride and sucrose concentrations on the acidity of plum pickle during storage

Factors/ Treatments	Acidity (%) content of the pickle with different storage times (months)						
	0	2	4	6	8	10	12
Sodium chloride							
3 percent	2.40b	2.49b	2.52b	2.55b	2.57b	2.60b	2.64b
4 percent	2.44ab	2.54a	2.56a	2.59b	2.62b	2.65b	2.68b
5 percent	2.47a	2.55a	2.59a	2.65a	2.70a	2.74a	2.80a
CV%	1.600	1.349	1.333	1.635	1.703	2.085	2.786
$LSD_{1.0\%}$	-	-	-	0.055	0.058	0.071	0.097
$LSD_{5.0\%}$	0.050	0.044	0.044	-	-	-	-
Sucrose							
10 percent	2.43	2.51a	2.54a	2.58	2.61	2.65	2.69
12 percent	2.45	2.54a	2.57a	2.61	2.64	2.67	2.70
CV%	1.600	1.349	1.333	1.635	1.703	2.085	2.786
$LSD_{10.0\%}$	ns	0.036	0.036	ns	ns	ns	Ns
Treatments							
T_1= 3% sodium chloride and 10% sucrose	2.39	2.48	2.51	2.54	2.56	2.59	2.62
T_2= 3% sodium chloride and 12% sugar	2.41	2.49	2.52	2.55	2.57	2.61	2.65
T_3= 4% sodium chloride and 10% sucrose	2.43	2.51	2.54	2.57	2.6	2.63	2.67
T_4= 4% sodium chloride and 12% sucrose	2.45	2.57	2.58	2.61	2.64	2.66	2.69
T_5= 5% sodium chloride and 10% sucrose	2.46	2.54	2.57	2.64	2.68	2.73	2.79
T_6= 5% sodium chloride and 12% sucrose	2.48	2.56	2.61	2.66	2.71	2.75	2.81
CV (%)	1.600	1.349	1.333	1.635	1.703	2.085	2.786
LSD	ns	ns	ns	ns	ns	ns	Ns

Note: The mean values ± of the triplicate determinations are carried out for all values.; ns-Non significant up to 10% level of significance.

3.3 Plum pickle appearance/color

The color of plum pickles is an essential quality parameter. The color values of L (lightness), a* (redness), and b* (yellowness) of the initial and two-month interval of stored pickle up to twelve months are shown in Table 3. According to table, using 3% sodium chloride and 12% sucrose plum pickle achieved the highest brightness compared to the 4% sodium chloride and 12% sucrose pickle. The tendency towards decreasing lightness lasted up to 12 months of storage. Regarding the individual effect of NaCl and sucrose concentrations, it was observed that the highest lightness was found in the pickles treated with 3% sodium chloride and 12% sucrose. For the collaborative effects of the sodium chloride-sucrose concentrations, the highest lightness was found in the treatment T_2 and the second highest in the treatment T_4. The lightness decreased significantly with longer storage time and was observed by Kim and Joo (2004) for mushroom pickles. The reduction in lightness during storage can be caused by the degradation of pigments that occurs with the formation of cloudy compounds that blow up the brightness, and by a non-enzymatic browning reaction as described by Dutta *et al.* (2006) and Goncalves *et al.* (2007) will be explained. With color coordinates a*; the highest color coordinates were found in 5% NaCl concentrated plum pickle and the lowest were observed in the 3% concentration considering the effect of NaCl used as the treatment. In the case of sucrose concentrations, it was observed that the highest values of the color coordinate a* were found at 12% sucrose. For the treatment interactions as the level of sodium chloride-sucrose concentrations used in different treatments, the highest a* value of the color coordinates was initially found in treatment T_6 and the second highest in treatment T_4 and gradually increased to each month up to 12 months of storage. In the case of the color coordinates a*, the pickle color was initially very light red, which slowly increased until the end of the storage period; similar results have been reported by Park *et al.* (2003) for cucumber pickle. For the color coordinates b*, it was observed that the highest values were found in the 3% sodium chloride concentrated pickle and the lowest in the 5% NaCl due to the effect of the sodium chloride concentrations treatments. With regard to the sucrose concentrations, the pickle treated with 12% sucrose showed the highest values of the color coordinates b*. In the case of treatment interactions of dissolved concentrations, initially, the highest color coordinates b* values were initially found in treatment T_2, followed by treatment T_4 and gradually it was increased monthly during storage. The color of the plum pickle became light yellow to yellow in terms of color coordinates b* after 12 months of storage. The b* values were increased with prolonged storage time and similar findings were made by Son et al. (2003) on the preparation of turnip pickles. This could be due to the breakdown of carotenoids present in the plum tissue during storage (Miranda *et al.*, 2009). Therefore, the browning phenomenon progresses over time, which can be seen from the changes in the L, a* and b* values.

3.4 Microbial count

The effects of the sodium chloride and sucrose concentration on the germ count of a plum pickle during storage are shown in Table 4. Initially, no bacterial load was visible in the sample due to the higher dilution. The microbial growth of the plum pickle from different treatments was not observed up to ten months of storage. However, it was observed that the microbial growth of the plum pickle varied between 7×10^{-2} to 32×10^{-1} for high to low concentrations, and the final pH found in the treated pickle. It was an acceptable limit for human consumption in different treatments after twelve months of storage. It was found that the lactic acid bacteria count increase with a lowered pH value as well as with the concentration of the dissolved substances and the end of the fermentation after twelve months of storage. It was in the same agreement with the research by Doyle *et al.* (2001) who described an increase in the number of lactic acid bacteria, favored by the free of oxygen, falling pH value and solute content

Table 3: Effect of sodium chloride and sucrose concentrations on the color parameters of a plum pickle during storage

Factors/ Treatments	Color parameters of the pickle with different storage times (months)						
	0	2	4	6	8	10	12
Lightness (L)							
Sodium chloride							
3 percent	21.78a	21.11a	18.9a	17.12a	16.03a	14.75a	13.65a
4 percent	20.12b	19.43b	17.82b	15.86b	14.54b	13.78b	12.52b
5 percent	17.64c	16.47c	15.81c	13.87c	12.43c	11.10c	9.83c
CV%	1.671	1.625	1.640	1.699	1.700	1.736	1.755
$LSD_{0.1\%}$	0.427	0.397	0.369	0.341	0.313	0.295	0.271
Sucrose							
10 percent	16.55b	16.09b	14.88b	13.26b	12.35b	11.46b	10.54b
12 percent	23.14a	21.91a	20.14a	17.97a	16.31a	14.96a	13.46a
CV%	1.671	1.625	1.640	1.699	1.700	1.736	1.755
$LSD_{0.1\%}$	0.348	0.324	0.302	0.279	0.256	0.241	0.221
Treatments							
T_1= 3% sodium chloride and 10% sucrose	19.51c	19.29d	17.46c	15.25d	14.41d	13.65b	12.17c
T_2= 3% sodium chloride and 12% sugar	24.04a	22.93a	20.34a	18.98a	17.64a	15.84a	15.13a
T_3= 4% sodium chloride and 10% sucrose	16.65d	16.49e	15.14d	13.81e	12.91e	11.78c	10.91d
T_4= 4% sodium chloride and 12% sucrose	23.59a	22.36b	20.5a	17.91b	16.16b	15.78a	14.12b
T_5= 5% sodium chloride and 10% sucrose	13.48e	12.48f	12.03e	10.72f	9.72f	8.94d	8.54e
T_6= 5% sodium chloride and 12% sucrose	21.8b	20.45c	19.58b	17.02c	15.14c	13.25b	11.12d
CV (%)	1.671	1.622	1.640	1.699	1.695	1.743	1.748
$LSD_{0.1\%}$	0.603	0.561	0.521	0.481	0.442	0.419	0.382
Coordinates (a*)							
Sodium chloride							
3 percent	10.42c	10.73b	10.10c	11.27c	11.40c	11.44c	11.60c
4 percent	11.13b	11.38a	11.55b	12.10b	12.14b	12.51b	12.66b
5 percent	11.53a	11.60a	11.94a	12.59a	12.95a	13.43a	13.90a
CV%	1.616	1.657	1.744	1.852	2.003	2.130	2.181
$LSD_{0.1\%}$	0.229	0.239	0.258	0.286	0.313	0.341	0.357
Sucrose							
10 percent	9.64b	9.88b	10.13b	10.92b	11.15b	11.54b	11.95b
12 percent	12.41a	12.58a	12.86a	13.05a	13.18a	13.37a	13.50a
CV%	1.616	1.657	1.744	1.852	2.003	2.130	2.181
$LSD_{0.1\%}$	0.187	0.195	0.210	0.233	0.256	0.279	0.291
Treatments							
T_1= 3% sodium chloride and 10% sucrose	9.02	9.50	10.01d	10.51d	10.66c	10.71d	10.97c
T_2= 3% sodium chloride and 12% sugar	11.81	11.95	11.98c	12.02b	12.14b	12.17a	12.23b
T_3= 4% sodium chloride and 10% sucrose	9.80	9.97	10.14d	10.78d	10.73c	11.04d	11.21c
T_4= 4% sodium chloride and 12% sucrose	12.46	12.78	12.95b	13.41a	13.54a	13.97a	14.14a
T_5= 5% sodium chloride and 10% sucrose	10.09	10.17	10.24d	11.47c	12.05b	12.87a	13.66a
T_6= 5% sodium chloride and 12% sucrose	12.97	13.02	13.64a	13.71a	13.85a	13.98a	14.14a
CV (%)	1.623	1.666	1.740	1.853	2.004	2.130	2.181
$LSD_{0.1\%}$	ns	ns	0.364	-	-	0.483	0.505
$LSD_{1.0\%}$	ns	ns	-	0.404	0.443	-	-
Coordinates (b*)							
Sodium chloride							
3 percent	16.43a	19.81a	22.17a	23.10a	25.62a	27.76a	28.75a
4 percent	15.78b	19.59a	20.90b	21.78b	23.84b	24.93d	25.80b
5 percent	15.34c	19.27b	20.73b	21.65b	23.39c	23.68c	24.78c
CV%	1.329	1.172	1.146	1.197	1.182	1.213	1.254
$LSD_{0.1\%}$	0.271	-	0.313	0.341	0.369	0.397	0.427
$LSD_{1.0\%}$	-	0.295	-	-	-	-	-
Sucrose							
10 percent	13.26b	17.42b	18.65b	19.81b	23.32b	24.75b	26.06b
12 percent	18.43a	21.69a	23.87a	24.54a	25.23a	26.16a	26.82a
CV%	1.329	1.172	1.146	1.197	1.182	1.213	1.254
$LSD_{0.1\%}$	0.221	0.241	0.256	0.279	0.302	0.324	0.348
Treatments							
T_1= 3% sodium chloride and 10% sucrose	13.40d	17.61	18.91c	20.01c	24.16bc	26.91	28.12b
T_2= 3% sodium chloride and 12% sugar	19.46a	22.01	25.42a	26.18a	27.07a	28.61	29.38a
T_3= 4% sodium chloride and 10% sucrose	13.25d	17.43	18.64cd	19.78c	23.02d	24.12	25.37d
T_4= 4% sodium chloride and 12% sucrose	18.30b	21.74	23.15b	23.78b	24.65b	25.74	26.22c
T_5= 5% sodium chloride and 10% sucrose	13.13d	17.23	18.41d	19.65c	22.79d	23.21	24.69e
T_6= 5% sodium chloride and 12% sucrose	17.54c	21.31	23.05b	23.65b	23.98c	24.14	24.87de
CV (%)	1.324	1.177	1.142	1.193	1.182	1.213	1.254
$LSD_{0.1\%}$	0.382	ns	0.442	0.481	-	ns	-
$LSD_{1.0\%}$	-	ns	-	-	0.522	ns	0.603

Note: The mean values ± of the triplicate determinations are carried out for all values. The mean values ± in the columns are displayed in significant result (p<0.001 to <0.1) with various letters a, b, c, d, e, & f. ns-Non significant up to 10% level of significance.

Table 4: Effect of sodium chloride and sucrose concentrations on the microbial count of plum pickle during storage

Treatments	Microbial count of the pickle with different storage period (months)						
	0	2	4	6	8	10	12
T_1= 3% sodium chloride and 10% sucrose	ND	ND	ND	ND	ND	ND	32×10^{-1}
T_2= 3% sodium chloride and 12% sugar	ND	ND	ND	ND	ND	ND	8×10^{-1}
T_3= 4% sodium chloride and 10% sucrose	ND	ND	ND	ND	ND	ND	6×10^{-1}
T_4= 4% sodium chloride and 12% sucrose	ND	ND	ND	ND	ND	ND	1×10^{-1}
T_5= 5% sodium chloride and 10% sucrose	ND	ND	ND	ND	ND	ND	14×10^{-2}
T_6= 5% sodium chloride and 12% sucrose	ND	ND	ND	ND	ND	ND	7×10^{-2}

Note: ND-Not detected

3.5 Sensory evaluation

The overall acceptance of the plum pickle by the consumer depends heavily on its sensory properties. The attributes such as visual appearance, color, taste and texture are decisive for determining their level of acceptance. The organoleptic properties of plum pickle with various combinations of sodium chloride and sucrose concentrations were evaluated after a two months interval up to twelve months of storage. A comparative sensory evaluation of various quality features of the pickle according to the opinion of the 10-member taste jury is shown in Table 5. It was observed that color, aroma, taste, sweet and sour balance, bitterness and overall acceptance had a significance influence on overall acceptance. According to the table, it was found that the overall acceptance rating of 9.0 was highest for the plum pickle with 4 to 5% sodium chloride plus 12% sucrose concentration and 6.0 was lowest for the 4 % sodium chloride plus 10% sucrose pickle. As for the effect of sodium chloride concentrations, initially, the highest overall acceptance rating of 7.75 was initially observed at the 5% concentration, followed by the value of 7.0 for pickles with 4% NaCl concentration. On the other hand, the highest overall acceptance value of 8.17 when using a 12% sucrose concentration was observed only for the effect of the sucrose concentration, followed by a value of 7.17 for 10% pickle concentration even after 12 months of storage. With regard to the effect of the interaction between sodium chloride-sucrose concentrations, the highest total acceptance value of 8.50 in treatments T_4 and T_6 was examined first, followed by treatments T_1 and T_5, which ensured the second highest value of 7.0. Finally, the overall acceptance for treatments T_4 and T_6 continued to be rated highest and the rating was 9.0 (i.e., extreme), which was judged by the panelists. Panelists liked the plum pickles because of the balance of sodium chloride and sucrose percentage, less bitterness, more attractive color and overall taste, as mentioned during the evaluation. Overall acceptance of pickle for all treated samples was increased with storage time increases, and a similar investigation was found by Shim (2012) for the study of yacon pickle. For keeping quality, taste and flavor, the pickle would be good in condition after a long time of storage in the jar, but it became softer after three months, otherwise, all quality parameters remained satisfactory during storage as reported by Kumar (1985) for the development of watermelon pickle. The higher sucrose concentration, which represents the increased acceptance of pickle for taste, is particularly compromised by sweetness, as reported by Bhuiyan *et al.* (2012) on the preparation of hog plum pickle. The overall acceptance of pickles improved significantly with the longer storage period. Taste, aroma, texture, and consistency all showed perfection in their quality, but the color showed a decreasing trend that could be due to increasing browning. The increase in the organoleptic quality of a pickle during the storage period can be viewed as a continuation of the fermentation process that may have led to the softening of the pickles. A similar consequence was suggested by Gupta (1998) in oil-less mango pickle, Sharma (2002) in a lime pickle, and Rekha (2004) in Kachri pickle, Jiang *et al.* (2004) in harvested litchi fruit.

Table 5: Effect of sodium chloride and sucrose concentrations on the overall acceptance of plum pickle during storage

Factors/ Treatments	Overall acceptability of the pickle with different storage times (months)						
	0	2	4	6	8	10	12
Sodium chloride							
3 percent	6.00c	6.50c	6.50c	6.50c	7.00b	7.00b	7.00b
4 percent	7.00b	7.00b	7.00b	7.00b	7.25b	7.50b	7.50b
5 percent	7.75a	7.75a	8.25a	8.25a	8.25a	8.50a	8.50a
CV%	3.421	3.421	3.264	3.264	3.864	5.833	4.442
$LSD_{0.1\%}$	0.304	0.304	0.304	0.304	0.373	0.575	0.438
Sucrose							
10 percent	6.50b	6.50b	6.67b	6.67b	7.00b	7.17b	7.17b
12 percent	7.63a	7.33a	7.83a	7.83a	8.00a	8.17a	8.17a
CV%	3.421	3.421	3.264	3.264	3.864	5.833	4.442
$LSD_{0.1\%}$	0.249	0.249	0.249	0.249	0.304	0.470	0.358
Treatments							
T_1= 3% sodium chloride and 10% sucrose	7.0b	7.0b	7.0d	7.0d	7.5b	7.5b	7.5b
T_2= 3% sodium chloride and 12% sugar	5.0d	6.0c	6.0e	6.0e	6.5c	6.5c	6.5c
T_3= 4% sodium chloride and 10% sucrose	5.5c	5.5d	5.5f	5.5f	6.0c	6.0c	6.0c
T_4= 4% sodium chloride and 12% sucrose	8.5a	8.5a	8.5b	8.5b	8.5a	9.0a	9.0a
T_5= 5% sodium chloride and 10% sucrose	7.0b	7.0b	7.5c	7.5c	7.5b	8.0b	8.0b
T_6= 5% sodium chloride and 12% sucrose	8.5a	8.5a	9.0a	9.0a	9.0a	9.0a	9.0a
CV (%)	3.421	3.421	3.264	3.264	3.864	5.833	4.442
$LSD_{0.1\%}$	0.431	0.431	0.431	0.431	0.527	0.814	0.620

Note: 1 = Dislike extremely, 2 = Dislike very much, 3 = Dislike moderately, 4 = Dislike slightly, 5 = Neither like nor dislike, 6 = Like slightly, 7 = Like moderately, 8 = Like very much, 9 = Like extremely.
The mean values ± of the triplicate determinations are carried out for all values. The mean values ± in the columns are displayed in significant result ($p<0.001$) with different letters a, b, c, d, e, and f.

4. CONCLUSION

Regarding plum pickle, it has so far been noted in the literature that Bangladesh is an inadequate producing country and almost unavailable in the local market. The plum fruits are spoiled or misused by the farmers or traders in Bangladesh owing to a lack of processing practices. Therefore, making plum pickle is one of the new ideas for long-term consumption and is used in the off-season. This research examined the impacts of pH, acidity, product color and microbial growth in a stored plum pickle, as well as conducted the organoleptic test to evaluate the processing technique of a plum pickle at different percentages of sodium chloride and sucrose found in a pickle during different treatments. The results indicated that the plum pickle stored in a glass container using 4 to 5 percent sodium chloride plus 12 percent sucrose and kept at room temperature (25-30°C) exhibited a better-quality product for long-term consumption.

ACKNOWLEDGMENTS

At first, the authors would like to express their profound deep gratitude and heartfelt thanks to the NATP Phase II, BARC Authority for providing a scholarship in the country to continue the PhD study. Then, Our thanks to the PHTD and BARI authorities for study leaves and other institutional facilities. Finally, thanks were given to the Species Research Center, BARI for supplying fresh plums for carrying out experiments.

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