Journal of Science and Technology, 4(1): 125-135, July 2014

PREPARATION AND PROCESSING OF OLIVES BY CHEMICAL PRESERVATION

MD JAVED HOSSEN[1], ROKEYA BEGUM[*2] MOST. MOBINA SULTANA[3], MD. AZIZUL HAQUE[2] and M. N. ISLAM[1]

[1]Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh-2202. [2]Department of Food Technology and Nutritional Science, Mawlana Bhashani Science and Technology University, Tangail-1902. [3]Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract

The present study was conducted to preserve mature green olive by three types of preservatives such as sodium benzoate, potassium meta-bisulphate and sorbic acid at different concentration (750, 1000 and 1250 ppm). At the same time the green olive was treated using different level of lye solution (0.5, 0.75 and 1%) to reduce the oleuropein, an undesirable bitter chemicals (glycoside compound) present in olive. The treated olive was further processed into four different sets of pickles using various spices. The preservation of olive was continued for a year, with visual observation of mold and yeast growth as well as bacterial count with 1 month interval. Preserved olive and prepared pickles were then analyzed for proximate composition, microbiological status, sensory attributes and overall storage stability. The lowest bacterial load ($2.60x10^4$) was found and the growth of mold and yeast was observed most lately after 12 months in only sorbic acid treated pickles at a concentration of 1250 ppm. Pickle prepared from olive treated with 1% lye solution was highly acceptable to the panelist as well as better storage stability.

Keywords: Preservation, Processing, Olive, Chemical preservatives

Introduction

The olive *(Oleu europaea)* locally known as "Jalpai" a shrub, belong to the *family Oleaceae*. It is one of the most economic and popular fruit in Bangladesh, which grow throughout the country. About 304 acres of land are producing about 143311 M tones of olive per year. Around 58% of these total production have been using for traditional processing and consumption and the rest has gone to be spoiled although olive have valuable nutrient contents. Since these olives are perishable in nature, it is easily spoiled and has necessary to processing and preservation for future use and utilization. It is mentioned that the loss of fruit during handling, transportation and storage is estimated at about 20 to 25 % due to inadequate infrastructure for storage (BBS, 2007).

Olive is a good source of nutrient. Ripe olives contain 56% water. 13.1% water soluble solids, 24.4% oil, 4.6% total sugar, 1.65% protein, 4.44% mannite and 0.47% alcohol

[*] Author for correspondence: rokeya15@yahoo.com

perceptible (Cruess, 1958). Preservation and availability of these olives throughout the year will reduce the burning issue of malnutrition and food safety of Bangladesh.

Pickle is a processed food of fruit and vegetable preserved by natural salt, oil, spices etc. Pickle is widely acceptable and usable food in Bangladesh, India and Pakistan. On pickling the olive composition becomes 63.4 % water, 6.5% water soluble solids, 26.45% oil, 0.10 % total sugars, 1.56% protein, 0.94 % mannite and 0.43% alcohol perceptible solids (Cruess, 1958). The quality of the pickles produced on the commercial scale is quite lacking of export quality and scientists are reluctant to work on their quality development of export earning capability products. Various types of fruits and vegetable are used in the preparation of pickles products with export potential. It is necessary to manufacture these products as the stipulated quality standards. The popular common pickles manufactured by various industries available in Bangladesh market are mango pickle, mixed fruit pickle, olive pickle, chalta pickle and so on.

Olive is a perishable fruit and spoils within a week after picking. Due to its low shelf life farmer fetch problem and at the same time industrial scale processing of olive is greatly meager. For this reason farmer loss their interest to grow it more though but it has a very good potentiality for making value added high quality pickles for export. Oleuropein a glucosidic compound, which is bitter in taste, may affect the quality olive pickles. So it is needed to reduce its oleuropein content to a certain level for its bitter taste. Keeping above views in mind the study was undertaken to achieve the best suitable way of enhancing the shelf-life by chemical preservatives and reducing bitterness by lye treatment.

Materials and Methods

The experiment was conducted in the Laboratories of the Department of Food Technology and Rural Industries under the faculty of Agricultural Engineering and technology, Bangladesh Agricultural University, Mymensingh. Fresh olive was collected from local market of Mymensingh. Chemicals and reagents used for analysis were collected from department laboratory.

The olive available in the market was collected, cleaned and washed properly. The olive was treated with lye solution at different level 1.0, 0.75 and 0.5% and the olive was dipped in the solution for 24, 48 and 72 hours respectively to reduce oleuropein content. The olive was washed with tap water and low concentrated acid solution.

Preparation of olive pickle

Treated olive was used for pickle preparation. Chili powder, turmeric powder, fenugreek powder, cumin powder, salt, sugar, mustard oil were pounded and garlic, ginger, green chilli separately were paste in vinegar. The olives were cooked with mustard oil in a dish. Then all spices put into the oil and heated continually until the brown colour was formed.

Then sugar and vinegar were added in the oil and cooked till oil floated on top. Finally pickle was cooled and filled into sterilized bottle and sealed airtight.

Olive was also preserved by chemical preservatives (sodium benzoate, potassium sorbate and potassium meta bisulphate) aqueous solution with the concentration of 750, 1000 and 1250 ppm and compared them with control (without preservative) sample.

Physical tests

The samples were judged separately by a team of experienced judges for organoleptic parameters like bitterness, texture, flavor, colour and overall acceptability. The panelists were asked to give numerical score 9 to 1 where 9 significances "liked extremely" and 1 "disliked extremely". But in case of texture evaluation scale was arranged as hard to soft (1 to 9) where 1 is too hard and 9 is too soft. In case of bitterness scale was arranged as 1-non bitter and 9-too much bitter. For assessing different quality parameters, products were observed at 1 month interval up to 1 year.

Chemical analysis of fresh olive and processed olive

Proximate composition like moisture content, protein, fat and ash content were measured by oven dry method, kjeldhal apparatus, solvent extraction method and muffle furnace respectively. Vitamin C content was measured by titration method. pH was measured with the help of a pH meter (HANNA instruments, HI 8424, Microcomputer pH meter). Oleuropein content of olive was measured by potentiometric titration method. All the methods described by Ranganna (1994).

Microbiological tests

For viable count of microorganism present in olive pickle, standard plate count method was followed according to the "Recommended method for the microbiological examination of food". Samples were tested for one year at one month interval. The growth of mold and yeast were observed by visual observation. The spoilage caused by mold also observed with continuous observation for a year with one month interval. Gassy spoilage may be occurred during preservation of olive. This abnormality was characterized by the development of blisters resulting from accumulation of gasses which caused separation of skin from the flesh of the olives and by the formation of fissures or gas pockets which extended to the pit of the fruit.

Data analysis

All data found from the experiment were statistically analyzed using one way and two ways Analysis of Variance (ANOVA) at a 0.05 significance level. Duncan's Multiple Range Test (DMRT) was used to compare treatment means, if a significance difference was detected at a 0.05 level of significance.

Results and Discussion

The mature green olive was preserved by three types of preservatives such as sodium benzoate, potassium meta-bisulphate and sorbic acid. The green olive was also treated using different level of NaOH (lye solution) to reduce the oleuropein, an undesirable bitter chemicals (glycoside compound) present in olive. The treated olive was further processed into four different sets of pickles using with various spices.

Proximate composition of olive

The proximate composition of fresh olive was moisture 118.5% (db), protein 1.9%, oil 21.5%, vitamin-C 45 mg/100gm, and total solid 46.6%. The study showed that the moisture content (in dry basis) was decreased and ash content was increased to the increasing dose of added preservatives. At the same time the total solid content of the olive was increased with the increasing dose of preservatives. Lowest total solid content found in control sample (45.9%) and highest in the sample treated with 1250 ppm of sodium benzoate (49%) (Table 1). Preservatives might enter into the flesh of the olive by the process of osmosis and may increase the solid content thus decrease the moisture content. The pH of the preserved olive was decreased gradually with the increasing dose of preservatives (Table 1). The use of preservatives revealed their active form of acid in aqueous solution. Sodium benzoate as benzoic acid, potassium meta-bisulphate as sulphurous acid and hence the pH of the preserved olive decreased.

Table 1. Composition of fresh olive and preserved olive

Component (%)	Samples									Fresh olive
	Sodium benzoate (ppm)			KMS (ppm)			Sorbic acid (ppm)			
	750	1000	1250	750	1000	1250	750	1000	1250	–
Moisture Content (db)	114.5	108.3	104.0	115.0	108.7	104.5	113.6	108.3	104.9	118.5
Total solid										
Total solid content	46.6	48.0	49.0	46.5	47.9	48.9	46.1	46.0	46.2	45.9
Ash	1.65	1.69	1.71	1.65	1.70	1.73	1.65	1.66	1.65	1.63
Oil content	21.5	21.0	21.5	21.5	21.5	21.5	21.2	21.5	21.3	21.50
pH content	3.45	3.40	3.35	3.45	3.41	3.35	3.30	3.20	3.10	3.50

Table 2. Degradation of Vitamin C with storage time in different dose of preservative

Time (Month)	Vitamin C content (mg/100g)								
	Sorbic acid(ppm)			Sodium benzoate(ppm)			KMS (ppm)		
	750	1000	1250	750	1000	1250	750	1000	1250
0	3.80	3.82	3.85	3.80	3.80	3.80	3.81	3.81	3.85
1	2.99	3.02	3.10	2.99	3.00	3.00	3.00	3.02	3.12
2	2.07	2.14	2.30	2.05	2.07	2.20	2.10	2.14	2.31
3	1.09	1.25	1.25	1.11	1.09	1.20	1.13	1.25	2.25
4	0.09	0.41	0.5	0.048	0.18	0.45	0.18	0.48	0.52

Storage effect on vitamin-C was observed during the storage period. Vitamin-C was measured at the interval of l month throughout the storage time. The result is shown in Table 2. It is apparent from the table that the degradation level of Vitamin-C was very *high* with the storage time and the rate of degradation remained almost the same in sodium benzoate, KMS and sorbic acid 750 ppm preserved olive. A little retention of vitamin-C was observed at higher dose of preservatives.

Microbial examinations

Bacteria, yeast and molds might cause spoilage of olives, reduce the shelf life of the products. All processed and green olives as well as preserved olives that undergone to the lactic acid fermentation, are subjected to microbial examination. The well-known spoilage types caused by micro-organisms are gassy fermentation and tissue softening. Total viable count of bacteria was performed by the Standard Plate Count method (S.P.C) of the preserved sample at one month interval. The total number of bacteria was counted by multiplying of the colony forming unit (cfu) with dilution factor. In the control sample the bacterial load was very high compared the samples treated with respect to other preserved sample. The lowest load was found after 1 year storage in sorbic acid at a concentration of 1250 ppm solution. The bacterial count were 3.20×10^4, 3.05×10^4 and 2.60×10^4 in the sorbic acid treated olive pickle at a concentration of 750, 1000 and 1250 ppm, respectively (Table 3).

Table 3. Total Bacterial Count of the preserved olive with one month interval for one year

Month	Total count									Control
	Sodium benzoate (ppm)			KMS (ppm)			Sorbic Acid (ppm)			
	750	1000	1250	750	1000	1250	750	1000	1250	
1	1.2×10^4	1.1×10^4	1.0×10^4	1.0×10^4	1.0×10^4	1.0×10^4	1.2×10^4	1.1×10^4	1.0×10^4	1.5×10^4
2	1.4×10^4	1.35×10^4	1.2×10^4	1.2×10^4	1.2×10^4	1.2×10^4	1.3×10^4	1.2×10^4	1.15×10^4	2.0×10^4
3	1.52×10^4	1.45×10^4	1.3×10^4	1.5×10^4	1.4×10^4	1.3×10^4	1.45×10^4	1.35×10^4	1.3×10^4	2.8×10^4
4	1.75×10^4	1.68×10^4	1.45×10^4	1.75×10^4	1.65×10^4	1.5×10^4	1.6×10^4	1.5×10^4	1.45×10^4	3.2×10^4
5	1.89×10^4	1.85×10^4	1.6×10^4	2.0×10^4	1.8×10^4	1.65×10^4	1.76×10^4	1.65×10^4	1.58×10^4	1.5×10^5
6	2.1×10^4	1.95×10^4	1.85×10^4	2.3×10^4	2.0×10^4	1.8×10^4	1.85×10^4	1.76×10^4	1.67×10^4	2.5×10^5
7	2.5×10^4	2.3×10^4	2.0×10^4	2.7×10^4	2.3×10^4	2.0×10^4	2.0×10^4	1.95×10^4	1.78×10^4	3.2×10^5
8	2.8×10^4	2.5×10^4	2.3×10^4	2.9×10^4	2.5×10^4	2.3×10^4	2.2×10^4	2.12×10^4	1.85×10^4	1.5×10^6
9	3.0×10^4	2.7×10^4	2.6×10^4	3.1×10^4	2.9×10^4	2.6×10^4	2.5×10^4	2.2×10^4	1.95×10^4	3.2×10^6
10	3.2×10^4	3.0×10^4	2.85×10^4	1.1×10^5	3.2×10^4	3.0×10^4	2.7×10^4	2.5×10^4	2.1×10^4	1.5×10^7
11	1.6×10^5	3.2×10^4	3.1×10^4	1.7×10^5	1.12×10^5	3.2×10^4	3.0×10^4	2.9×10^4	2.3×10^4	2.9×10^7
12	2.1×10^5	1.1×10^5	3.2×10^4	1.5×10^5	1.68×10^5	1.0×10^5	3.2×10^4	3.05×10^4	2.6×10^4	3.2×10^7

In case of KMS preservatives the bacterial load was decreased 750 ppm to 1250 ppm preserve olive and higher than the sorbic acid and sodium benzoate preserve olive in

same concentration and bacterial load was 1.50×10^5, 1.68×10^5 and 1.00×10^5 in 750, 1000 and 1250 ppm, respectively. The bacterial load was significantly increased with increasing of storage period, whereas bacterial load was decreased with the increasing of the concentration of preservatives.

The growth of mold and yeast were observed visually. Olive as a high acidic fruit, the chance of spoilage by yeast and mold is very high. Table 4 showed that mold and yeast growth delayed in the high dose of preservatives. In control sample the initiation of the growth of mold observed at the 1st month whereas the growth of mold in 750 ppm sodium benzoate preserved olive in 5th month. The mold growth was delayed with increasing of preservatives concentration. The growth of mold was observed in 5th, 7th and 9th of sodium benzoate 750, 1000 and 1250 ppm preserved olive whereas in 6th, 8th, and 10th month mold was observed in KMS 750, 1000 and 1250 ppm preserved olive. Hence the growth of mold was observed in sorbic acid 1250 ppm solution preserve after 1 year.

Table 4. Observation of yeast and mold growth

Months	Yeast And Mold observation									
	Sodim Benzoate(ppm)			KMS (ppm)			Sorbic Acid (ppm)			Control.
	750	1000	1250	750	1000	1250	750	1000	1250	
1	No	No	No	No	No	No	No	No	No	Mold
2	No	No	No	No	No	No	No	No	No	growth
3	No	No	No	No	No	No	No	No	No	
4	No	No	No	No	No	No	No	No	No	
5	Mold	No	No	No	No	No	No	No	No	
6	growth	No	No	Mold	No	No	No	No	No	
7		Mold	No	growth	No	No	No	No	No	
8		growth	No		Mold	No	Mold	No	No	
9			Mold		growth	No	growth	No	No	
10			growth			Mold		Mold	No	
11						growth		growth		
12									Mold growth	

Effect of NaOH on oleuropein content

Olive has a bitter compound named oleuropein, which must be eliminated during processing of olive. The olives were treated with sodium hydroxide solution to remove the bitterness. Figure 1 showed that the oleropein content in fresh olive was 0.8%. After treated with 0.5, 0.75 and 1% lye solution the oleropein content in olive reduced to 0.57, 0.35 and 0.14%, respectively.

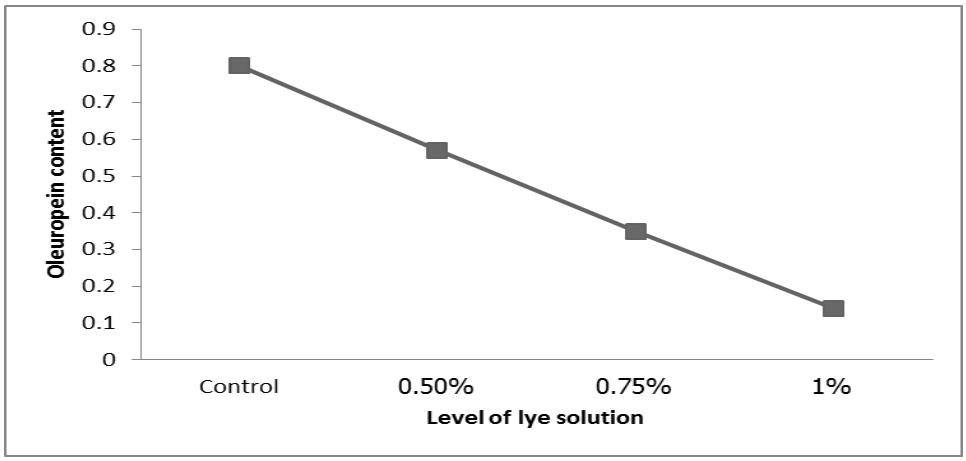

Fig. 1. Oleuropein content in olive after different treatment

Composition of olive pickles

The olive pickles were analyzed immediately after processing for proximate composition. The table 5 showed that the moisture content of the sample A to D decreased, the highest moisture content in the sample A (130.5%) and the lowest in the sample D (1324.0%).

Table 5. Composition of olive pickles

Sample	Moisture content (%) db	Total solid (%)	Ash (%)	Protein (%)	Oil Content (%)	pH
Sample A	130.5	34.55	1.85	2.11	27.5	3.30
Sample B	128.0	36.80	1.87	2.10	26.9	3.30
Sample C	126.5	43.50	1.88	2.12	27.0	3.30
Sample D	124.0	39.50	1.91	2.10	26.5	3.30
Sample E	130.0	36.50	1.70	1.98	25.60	3.30

Sample A - control sample(untreated sample), Sample B -treated with 0.5 % lye solution, Sample C - treated with 0.75 % lye solution, Sample D - treated with 1 % lye solution Sample E- pickle collected from market.

Ash content also differed with treatment. However, the composition remained very closer to the prepare samples and slightly differ with sample which collected from the market.

Acceptability of olive pickle

The result revealed that the bitterness of the sample was gradually decreased with lye solution treatment. Sample D (treated with 1% NaOH solution) was found the lowest bitter score (2.7^{d}). The level of bitterness was high in sample A ($7.3^{^\circ}$) and E (7.7^{a}) and decreased with the increased level of lye solution treatment (Table 6).

Table 6. Evaluation of sensory attributes (colour, flavor, bitterness, texture and overall acceptability) of olive pickles

Sensory attributes	Test No.	Sample A	Sample B	Sample C	Sample D	Sample E	LSD
	1	7.3[a]	6.5[b]	4.4[c]	2.7[d]	7.7[a]	0.684
	2	7.2[a]	6.0[b]	4.4[c]	2.8[d]	7.7[a]	0.680
Bitterness	3	7.2[ab]	6.5[b]	5.6[c]	3.0[d]	7.5[a]	0.726
	4	5.6[b]	6.4[a]	5.4[b]	2.9[c]	7.1[a]	0.726
	5	-	-	-	-	-	-
	1	7.9 [a]	7.2 [b]	6.3[c]	5.3 [d]	7.5 [ab]	0.44
Texture	2	7.1 [b]	7.1 [b]	7.4 [ab]	8.0 [a]	6.8 [b]	0.736
(hardness)	3	6.9 [b]	7.3 [ab]	7.2 [ab]	8. 0 [a]	7.0 b	0.868
	4	5.5[b]	6.5 [a]	6.7[a]	7.1[a]	5.6[b]	0.647
	5	7.9 [ab]	7.2 [c]	7.3 [c]	8.2 [a]	7.5 [b]c	0.614
	1	8.3 [a]	7.7 [b]	6.7[c]	6.1 [d]	7.9[ab]	0.567
	2	6.9 [b]	7.3 [ab]	7.2 [ab]	8.1 [a]	7.O [b]	0.868
Colour	3	5.9[cd]	6.8[bc]	7.1[ab]	7.9[a]	5.8[d]	0.924
	4	5.8[b]	6.2[b]	6.3[b]	7.1[a]	5.1[b]	0.763
	5	4.1 [b]	5.5[a]	5.8[a]	5.8[a]	4.5[b]	0.925
	1	7.9 [ab]	7.2 [c]	6.3 [d]	8.2 [a]	7,5 [bc]	0.614
	2	6.9 [b]	7.3 [ab]	7.2 [ab]	8.1 [a]	7.0[b]	0.868
Flavour	3	6.2[b]	6.9[a]	7.1[a]	7.1[a]	6.0[b]	0.687
	4	5.5[b]	6.5[a]	6.7[a]	7.1[a]	5.6[b]	0.647
	5	3.2[ab]	4.0 [a]	3.6[a]	2.3[b]	2.3[b]	0.952
	1	6.1 [d]	6.7 [bc]	7.2 [b]	7.9[a]	6.5 [cd]	0.564
Overall	2	4.5[d]	6.2 [b]	6.6 [b]	8.3 [a]	5.6 [c]	0.847
acceptability	3	5.8[c]	6.5[b]	7.3[a]	7.9[a]	5.7[b]	0.606
	4	5.9[b]	6.0 [b]	6.3[b]	7.1[a]	5.8[b]	0.691
	5	3.4[ab]	3.3[b]	4.1[ab]	4.3[a]	2.0[C]	0.893

Mean of 10 scores for each sensory characteristics

Mean in column followed by the same letter are not significantly different at 95% confidence level ($p < 0.05$). The panel test was arranged with the interval of three month for a year. 1st test: Day of preparation; 2nd test: after three month storage; 3rd test: after six month storage; 4th test: after nine month storage; 5thtest: after a year storage.

Significant difference was observed in texture, colour, flavor and overall acceptability among the samples tasted. In the first test sample D was slightly harder (Table 6) than other sample and after three months storage it became softer and thus scored the highest score (8.0[a]) by the panelist. During the treatment of live cell wall was changed and turned into harder (Araujo *et al.*, 1994). Further softening of olive resulting from the destruction of pectic substances in the olive may have physical or chemical causes or may be lactic acid fermentation (Frazier and westhoff, 2006). In case of colour sample A and E were more acceptable and sample D scored the lowest (6.1). It is apparent from the results that the sample D was more acceptable than the other sample in case of flavor (8.2[a]) and overall acceptability (8.3[a]). Sabatini and Marsilio (2008) also observed that the acceptable flavor of olive improved owing to lye solution treatment. After one year storage all pickle lost their acceptability to the panelist due to off-flavour produced.

Microbial examination of pickle

The total numbers of viable bacteria in different samples at different storage periods have been shown in Table 7. The total viable bacteria slightly increased with the increasing of storage periods for all products. After ten month storage the bacterial load was increased rapidly. The bacterial load was differing with the lye solution treatment. The bacterial load of the samples A was the highest ($3.00x\ 10^7$cfu/g) and gradually decreased sample B to D. The lowest bacterial load found in sample D ($3.1Ox10^5$). It may be due to bacterial inhibitor component aglycone and elnolic acid compound which produced during the hydrolysis of oleuropein (Fleming *et al.*, 1973).

Table 7. The total viable bacterial count of olive pickles during storage 1 month interval for a year

Months	Total count (cfu/gm)				
	Sample A	Sample B	Sample C	Sample D	Sample E
1	$3.01x10^4$	$1.10\ x10^4$	$1.12\ x10^4$	$1.10\ x10^4$	$2.95\ x10^3$
2	$3.12\ x10^4$	$1.50\ x10^4$	$1.40\ x10^4$	$1.30\ x10^4$	$3.1\ 1\ x10^3$
3	$1.20\ x\ 10^5$	$2.25\ X10^4$	$1.80\ x\ 10^4$	$1.50\ x\ 10^4$	$3.16\ x\ l0^3$
4	$3.10\ x10^5$	$2.80\ x10^4$	$2.20\ x10^4$	$1.90\ x10^4$	$1.10x10^4$
5	$1.00x10^6$	$3.20x10^4$	$2.70x10^4$	$2.20x10^4$	$1.90x10^4$
6	$1.20x10^6$	$1.10x10^5$	$3.20x10^4$	$2.50x10^4$	$2.50x10^5$
7	$2.20x\ 10^6$	$1.50\ x\ 10^5$	$1.00\ x\ 10^5$	$2.90\ x\ 10^4$	$3.18\ x\ 10^5$
8	$3.20\ x10^6$	$2.00\ x10^5$	$1.35\ x10^5$	$3.20\ x10^4$	$1.50\ x10^5$
9	$1.20\ x10^7$	$2.50\ x10^5$	$2.20\ x10^5$	$1.00\ x10^5$	$2.90\ xl0^6$
10	$2.10\ x\ 10^7$	$3.20x\ 10^5$	$2.80\ X10^5$	$1.50\ X10^5$	$3.17\ x\ 10^6$
1 1	$2.80\ x10^7$	$1.15\ x10^6$	$3.10\ x10^5$	$1.80\ x10^5$	$1.25x10^7$
12	$3.00x10^7$	$3.18\ x10^6$	$1.10\ x10^6$	$3.10\ x10^5$	$2.50\ x10^7$

The pickles were store at room temperature and were in visual observation for its mold and yeast growth. There were no mold and yeast growth upto 8th month storage. After 8th month sample E was spoiled. Sample A. B and D were spoiled by mold after 10th month of storage. Sample C was spoiled after 11th month.

Table 8. Observation of mold and yeast growth (visual observation)

Month	Visual of observation yeast and molds				
	Sample A	Sample B	Sample C	Sample D	Sample E
1	No yeast and mold	No yeast and mold	No yeast and mold	No yeast and mold	No yeast and mold
2	Do	Do	Do	Do	Do
3	Do	Do	Do	Do	Do
4	Do	Do	Do	Do	Do
5	Do	Do	Do	Do	Do
6	Do	Do	Do	Do	Do
7	Do	Do	Do	Do	Do
8	Do	Do	Do	Do	Do
9	Do	Do	Do	Do	Mold observed
10	Mold observed	Mold observed	Do	Mold observed	Do
11	Do	Do	Mold observed	Do	Do

Observation of sensory attributes

The sensory attributes of olive pickles were observed for 1 year at 1 month interval. The colour of sample A, B and E was greenish whereas sample C and D was slightly blackish in 1st month. After 3 months storage the colour of sample C and D turned to its original colour may be due to the lactic acid fermentation of the pickles. After the 10th month the colour of pickle become gray may be caused by mold growth in the pickle. The flavour of all samples remained acceptable up to 10th month storage period after that off-flavour produced in all samples. It may be due to rancidity of oil used in pickle or by the butyric acid producing during lactic acid fermentation. The softening of olives is usually caused by the activity of protolytic microorganisms. Bacteria, mold and yeast all have been incriminated in the problem. The lactic acid fermentation also softened the texture of olive pickle, which was desired for treated slightly hard sample. After 7th month storage the sample A (control) and E (collected from market) became very soft and loss their acceptability whereas sample B, C and D were soft.

Table 9. Observation of sensory attributes of olive pickle

Samp.	Attributes	Month										
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
A	Colour	green	green	green	green	green	green	green	green	gray	gray	gray
	Flavour	accept	accept	accept	accept	accept	accept	accept	accept	accept	o.fla	o.fla
	Texture	soft	soft	soft	soft	soft	soft	v.soft	v.soft	v.soft	v.soft	v.soft
B	Colour	green	green	green	green	green	green	green	green	gray	gray	gray
	Flavour	accept	accept	accept	accept	accept	accept	accept	accept	accept	o.fla	o.fla
	Texture	soft	soft	soft	soft	soft	soft	v.soft	v.soft	v.soft	v.soft	v.soft
C	Colour	black	black	black	greenish	greenish	green	green	green	gray	gray	gray
	Flavour	accept	accept	accept	accept	accept	accept	accept	accept	accept	o.fla	o.fla
	Texture	s.hard	s.hard	s.hard	soft	soft	soft	soft	soft	soft	soft	soft
D	Colour	black	black	black	greenish	greenish	green	green	green	gray	gray	gray
	Flavour	accept	accept	accept	accept	accept	accept	accept	accept	accept	o.fla	o.fla
	Texture	s.hard	s.hard	s.hard	soft	soft	soft	soft	soft	soft	soft	soft
E	Colour	green	green	green	green	green	green	green	green	green	gray	gray
	Flavour	accept	accept	accept	accept	accept	accept	accept	accept	accept	o.fla	o.fla
	Texture	soft	soft	soft	soft	soft	soft	v.soft	v.soft	v.soft	v.soft	v.soft

Conclusion

The research work was accomplished for the exploration of suitable preservatives and their concentration used in olive preservation. The experiment also implies the prospect of processing and preservation of olive pickles as well as investigates to the commercial and nutritional aspect of olive pickle. The fresh olives, collected from the local market as well as the olive pickles were analyzed for proximate composition, microbiological status, quality attributes and overall storage stability of the pickle. The antimicrobial action of sorbic acid was higher than that of KMS and sodium benzoate at the similar concentration. Lay solution treatment was found to effective to reduce oleuropein content in olive which is responsible for bitter taste and improve export quality of pickle.

References

Araujo, A. J., J. M. Labavitch and A. H. Moreno, (1994). Change in cell wall of olive during processing. *J Agric. Food Chem.*, **42**(5): 1194-1199.

BBS, (2007). Monthly Statistical Bulletin. Bangladesh Bureau of Statistics Division. Ministry of Planning. Govt. of People Republic of Bangladesh. 65-69pp.

Cruess, W. V., (1958). Commercial fruits and vegetables. 4th edition. Mc Graw Hill Book. Inc. 456-457pp.

Fleming, H. P., W.M. Walter and J. L. Etchells, (1973). Antimicrobial properties of oleuro-pein and products of its hydrolysis from green olives. *J. Appl. Microbiol.*, **26**: 777-782.

Frazier, W. C. and D. C. Westhoff, (2006). Food microbiology 4th edition TATA Mcgrew Hill Pub. Co. Ltd, New Delhi. 26-29pp.

Rangana, S., (1994). Hand Book of analysis of quality control for fruit and vegetables products. The TATA McGraw, Hill Pub. Co. Ltd. 2nd edition, New Delhi.

Sabatini, N. and V. Marsilio, (2008). Volatile compounds in the table olives (Olea europaea L., Nocellara de Belice Cultivar). *J. Food Chem.*, 1522-1528pp.