RESULTS AND DISCUSSION

Microbiological studies:

I. Microbial counts:

The total plate counts, lactic acid bacteria, yeasts counts, lipolytic microorganisms counts, total pectinolytic bacteria counts, cellulose decomposing bacteria counts as well as coliform counts were carried out during fermentation and storage periods in brines of pickled olives. These brines were treated with different preservatives. The application of these preservatives was either individually or in combinations between them. The added olives were either previously treated with NaOH or non-treated with alkali. Counting of lactic acid bacteria was to evalute the course of fermentation, while other countings were to determine predominance of microorganisms which would result in spoilage and softening problems.

1. Total bacterial counts:

A. Individual preservatives:

Data present in Table (1) illustrated by Fig. (1-A & B) show the densities of total microbial counts in the brines of treated and untreated olives with NaOH during fermentation and storage periods.

Brines of untreated olives with NaOH show a fairly higher

Table (1): Total bacterial counts in olives brines treated with natural and synthetic individual preservatives (counts x 10^4/ml.).

Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter
0	9.63	9.63	9.63	9.63	35.0	8.0	8.0	8.0	47.0
15	510.0	400.0	37.0	114.0	1770.0	405.0	330.0	32.0	360.0
30	515.0	510.0	85.0	99.0	1330.0	2200.0	300.0	54.0	810.0
60	570.0	360.0	37.8	210.0	350.0	250.0	220.0	90.0	570.0
90	297.0	234.0	29.5	228.0	310.0	472.0	112.0	60.0	965.0
180	465.0	518.0	1.5	187.0	510.0	465.0	137.3	514.5	220.0
270	50.0	3.0	1.0	37.0	30.0	56.0	3.0	78.6	188.0

Table (2): Total bacterial counts in olives brines treated with combination of natural and synthetic preservatives (counts x 10^4/ml.).

Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter
0	9.63	9.63	9.63	35.0	35.0	8.0	8.0	47.0	47.0
15	510.0	400.0	0.025	57.0	2.3	405.0	136.0	44.6	332.0
30	515.0	510.0	0.033	19.0	5.39	2200.0	14.0	109.5	150.0
60	570.0	360.0	0.01	32.0	6.5	250.0	2.1	71.0	25.0
90	294.0	234.0	0.04	24.0	3.52	472.0	0.7	58.8	57.0
180	465.0	518.0	0.066	13.0	7.0	465.0	11.0	38.2	123.0
270	50.0	3.0	0.054	13.0	5.0	56.0	19.0	3.1	5.6

Table (3): Total bacterial counts in brined whey treatments (counts x 10^4/ml.).

Treat-ments /Days	Without NaOH			With NaOH	
	Pilot	Control	Whey	Control	Whey
0	9.63	9.63	85.0	8.0	150.1
15	510.0	400.0	148.0	405.0	346.0
30	515.0	510.0	1254.0	2200.0	1557.0
60	570.0	360.0	1360.0	250.0	2215.0
90	294.0	234.0	240.0	472.0	220.0
180	465.0	518.0	260.0	465.0	448.0
270	50.0	3.0	13.0	56.0	69.0

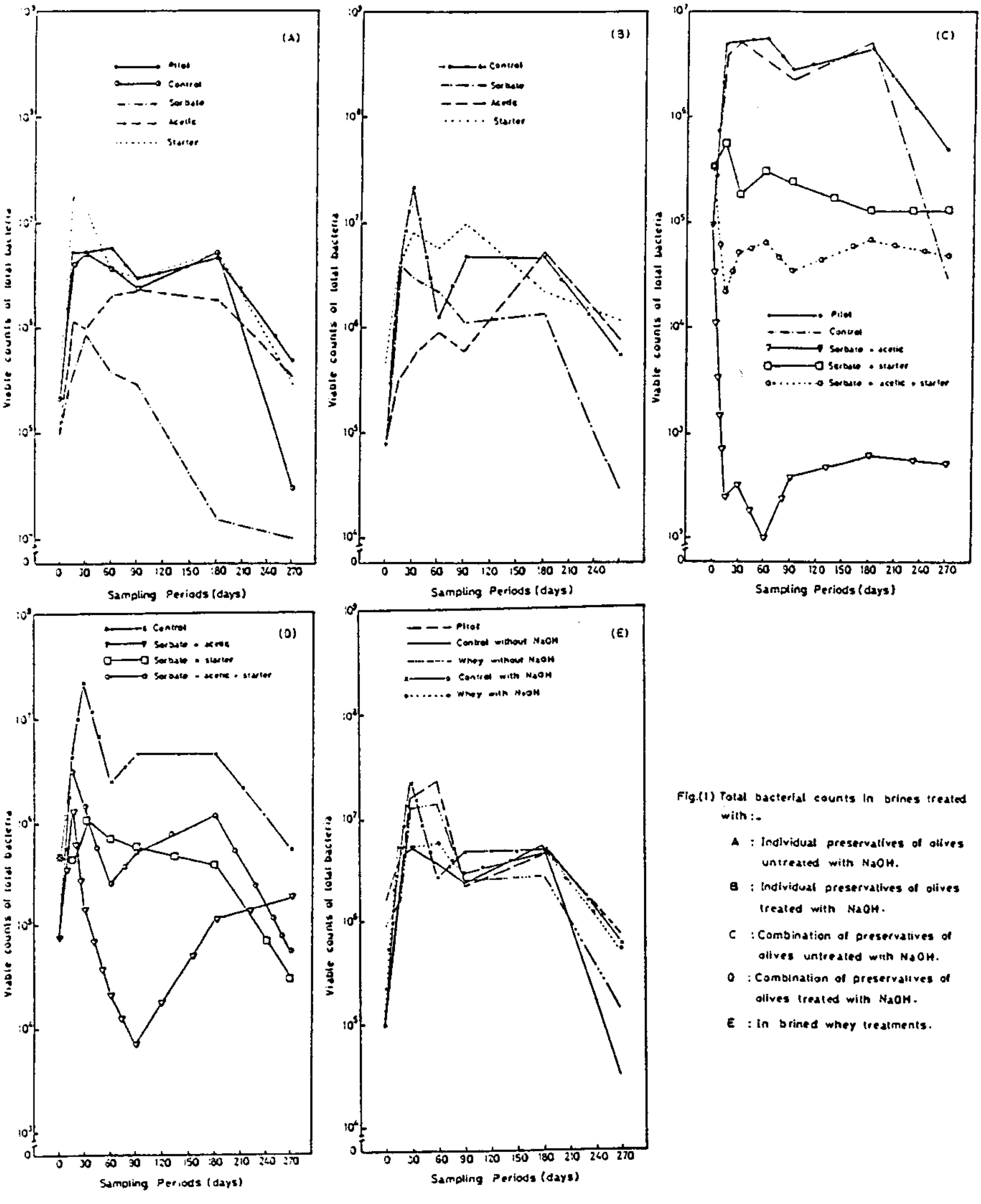


Fig.(1) Total bacterial counts in brines treated with :-

A : Individual preservatives of olives untreated with NaOH.

B : Individual preservatives of olives treated with NaOH.

C : Combination of preservatives of olives untreated with NaOH.

D : Combination of preservatives of olives treated with NaOH.

E : In brined whey treatments.

densities in pilot and control experiments all over the experimental period than all preservatives treatments, except the brine treated with starter. This treatment showed higher growth rate than pilot and control up to 30 days sample. This was expected since the starter inoculum contains high numbers of bacteria besides the available nutrients in the whey used for the preparation of the starter. Also, it was found experimentally (Tables 43 and 52) that the rate of release of sugars and true-proteins which diffused from the fruits in the starter treatment was greater than other treatments. Similar results were obtained by Vaughn et al. (1943), Cruess (1958) and Gonzalez (1967).

However, brine of pilot experiment exhibited higher densities than that of control. This may be due to the controlled conditions in the laboratory than that of the plant (Taha et al, 1971). The total bacterial count in the brine treated with sorbate without NaOH showed the least densities. Acetic acid treatment showed moderate counts between other treatments including pilot and control.

Brine of olives treated with NaOH recorded higher peak in control than preservatives treatments during the first 30 days of pickling. Starter brine indicated higher densities than sorbate and acetic treatments. This was due to the presence of high counts of bacteria in the inoculum together with available nutrients in the whey of the starter. Total microbial counts in the brine of sorbate showed higher density than acetic acid during fermentation periods (0-90 days), while acetic treatment showed higher density during storage periods (90-270 days). This may be explained by the recorded high acidity in acetic treatment up to the 30 days sample, while sorbate contained this high acidity during storage periods (Table 31).

Total microbial counts in brines of NaOH treated olives showed definite increase than untreated. This may be due to the release of considerable amount of "oleuropein" during soaking of the fruits in NaOH solution and to the great diffusion of the nutrients to the brine. from the tissues of the fruits treated with NaOH. These results are in line with those of Mark et al. (1956), Cruess (1958), and Frazier (1967).

Microbial densities during fermentation period showed higher counts, but storage periods indicated clear decreasing counts. This may be due to the great diffuse of the nutrients during the first periods and to the accumulation of the inhibitory substances during storage period. This is in agreement with the findings of Herra and Castro (1949), Hirsch and Grinsted (1951) and Vitavskaya et al. (1984).

B. Combination of preservatives:

It was found from results given in Table (2) illustrated by Fig. (1-C and D) that the densities of total microbial counts were sharply reduced than that of individual preservatives (Table 1). This was expected for the great inhibitory effect of these combinations on the proliferation of bacteria. Results also indicate that the growth was pronouncly increased in pilot and control than other treatments.

Brine of sorbate+starter without NaOH showed higher densities than other treatments. This may be explained by the presence of the nutrients of the whey used in the preparation of the starter incoulum. Also, this may be deduced to the population of the starter. Brine of sorbate + acetic + starter showed lower densities than that of sorbate + starter. This may be due to the effect of acetic on sorbate right after application. Brine of sorbate + acetic + starter exhibited higher densities than sorbate + acetic treatment. This may be deduced to the stimulative effect of the whey nutrients and to the microbial population of the inoculum. Brine of sorbate + acetic showed the lowest densities among other treatments. This may be due to the effect of acetic acid on sorbate directly upon the application. This phenomenon was assured by Bandelin (1958) who stated that the activity of sorbate increases as the pH of the medium declines.

Brines of olives treated with NaOH showed higher peaks and increase in counts than brines of untreated olives. This may be due to the removal of most of the "oleuropein" and to the nutrients diffused greatly after lye treatment. Sorbate + acetic + starter for these olives showed the highest peak among other treatments. This may be deduced to the great diffuse of the nutrients especially true-proteins to the brine (Table 53). This enriched substrate enhanced the growth of the lactics starter (Table 5). The densities of sorbate + starter treatment exhibited moderate level; lower than sorbate + acetic + starter and higher than sorbate + acetic treatment. On the otherhand, sorbate + acetic which appeared temporary increase during 15 days sample showed the lowest densities than other treatments thereafter.

Microorganisms in brines of olives treated with NaOH generally exhibited higher counts than that of untreated. The greater diffuse of nutrients (Tables 44 and 53) after lye treatment, enhanced the proliferation of microbial flora giving high peaks on the 15 days sample. Thereafter, noticeable decrease occurred due to the effect of sorbic acid.

C. **Whey treatments:**

Table (3) reports the total bacterial counts in whey treatments which are illustrated by Fig. (1-E). Data indicate the great efficiency of whey components in increasing the microbial densities, since they were significantly enhanced than all treatments including pilot and corresponding controls.

Whey treatment of olives treated with NaOH recorded slightly higher counts than that of untreated olives. This may be explained by the lower amount of "oleuropein" content (Table 72) and great supplement of the diffused nutrients from the fruits (Tables 45 and 54).

However, brined whey treatments showed decline phase during last period of pickling and storage periods. This may be deduced to the accumulation of acids (Table 33) and inhibitory substances produced by lactics. This was recorded by earlier investigators including Dahiya and Speck (1968), Gilliland and Speck (1977) and Gibbs (1987) who found that inhibitory compounds produced by lactic acid bacteria inhibited spoiling bacteria.

2. Lactic acid bacteria counts:

Lactic acid bacteria are chiefly responsible for the desirable fermentation of brined olives. Also, lactics play an important role in controlling the fermentation and extending storage periods through their production of inhibitory substances (Gibbs, 1987). Therefore, some brines were fortified by application of lactics starter.

A. Individual preservatives:

From results tabulated in Table (4) and illustrated by Fig. (2-A and B) it can be observed that starter brine

Table (4): Lactic acid bacteria counts in olives brines treated with natural and synthetic individual preservatives (counts x 10^4/ml.).

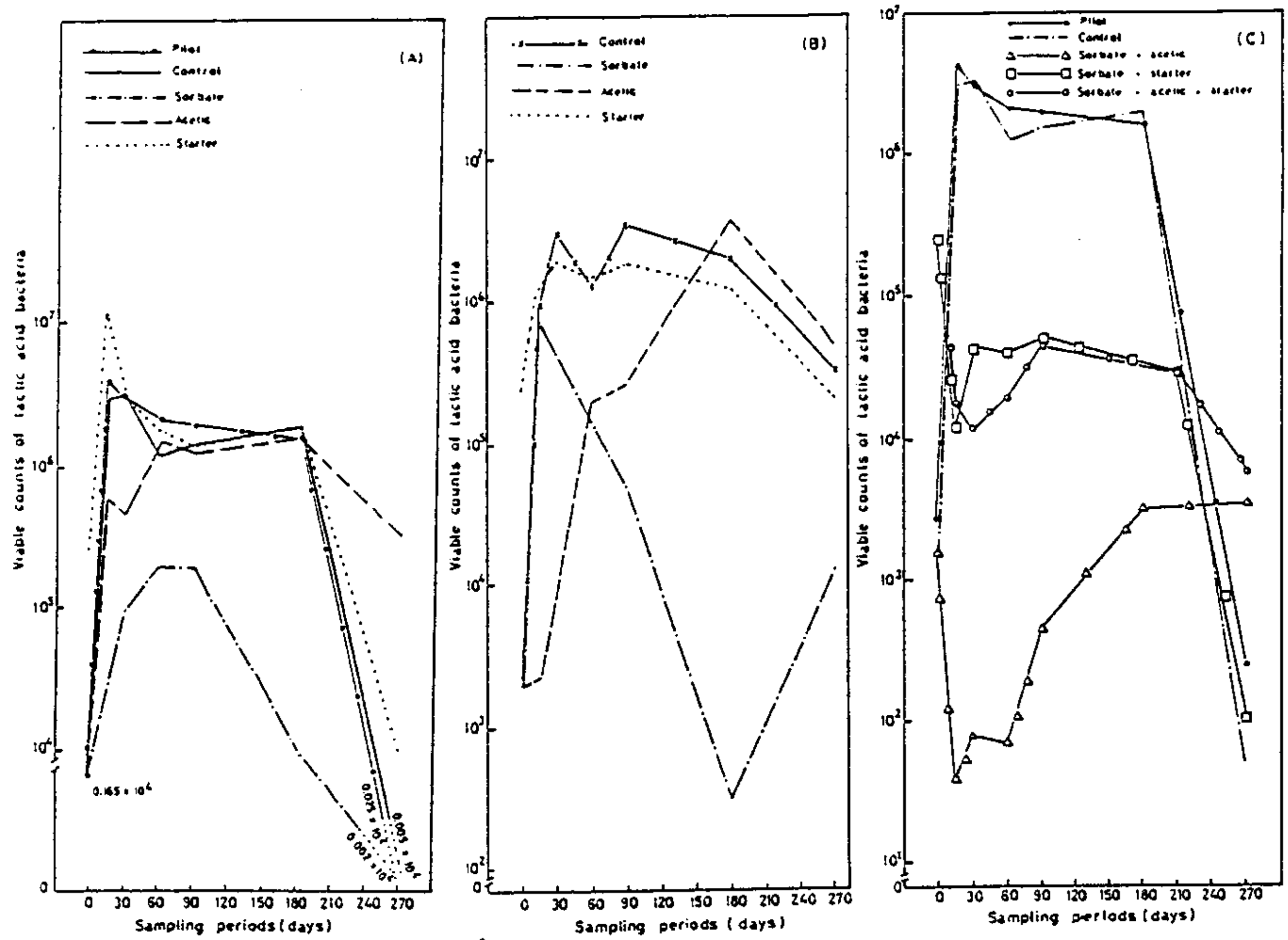
Treat- ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter
0	0.165	0.165	0.165	0.165	25.0	0.2	0.2	0.2	23.0
15	410.0	300.0	3.38	60.0	1160.0	92.0	72.0	0.2	120.0
30	302.0	323.0	9.03	47.0	295.0	300.0	39.3	0.7	196.6
60	211.0	121.0	19.43	148.0	183.0	120.0	14.0	20.0	144.0
90	198.0	147.0	19.2	152.2	140.0	349.0	5.0	26.48	183.0
180	155.0	190.0	0.55	160.0	200.0	200.0	0.03	376.0	120.0
270	0.025	0.005	0.002	32.0	1.0	32.0	1.14	48.0	20.33

Table (5): Lactic acid bacteria counts in olives brines treated with combination of natural and synthetic preservatives (counts x 10^4/ml.).

Treat- ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter
0	0.165	0.165	0.165	25.0	25.0	0.2	0.2	23.0	23.0
15	410.0	300.0	0.004	1.2	1.8	92.0	10.0	21.0	66.0
30	302.0	323.0	0.008	4.4	1.2	300.0	0.4	20.33	38.0
60	211.0	121.0	0.007	4.0	2.0	120.0	0.1	11.1	8.7
90	198.0	147.0	0.046	5.0	4.9	349.0	0.0024	0.23	2.0
180	155.0	190.0	0.32	3.0	2.895	200.0	8.0	0.12	8.57
270	0.025	0.005	0.341	0.010	0.57	32.0	9.5	0.03	2.4

Table (6): Lactic acid bacteria counts in brined whey treatments (counts x 10^4ml.).

Treat- ments /Days	Without NaOH			With NaOH	
	Pilot	Control	Whey	Control	Whey
0	0.165	0.165	25.0	0.2	11.0
15	410.0	300.0	68.0	92.0	273.0
30	302.0	323.0	753.3	300.0	764.0
60	211.0	121.0	603.3	120.0	860.0
90	198.0	147.0	200.0	349.0	600.0
180	155.0	190.0	177.5	200.0	30.0
270	0.025	0.00 5	8.0	32.0	7.0



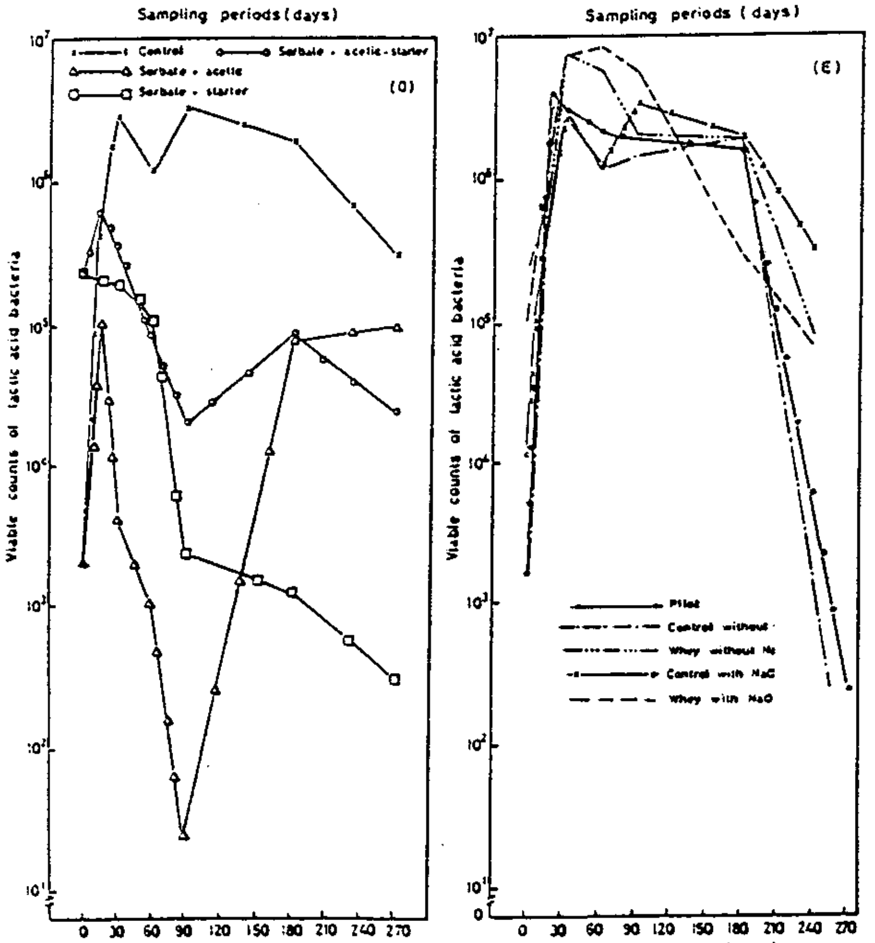


Fig.(2) Lactic acid bacteria counts in brines treated with :

A : Individual preservatives of olives untreated with NaOH.

B : Individual preservatives of olives treated with NaOH.

C : Combination of preservatives of olives untreated with NaOH.

D : Combination of preservatives of olives treated with NaOH.

E : In brined whey treatments.

of olives untreated with NaOH quickly reached higher levels than all treatments including pilot and control 15 days after commencement. However, pilot experiment reported higher densities than starter treatment throughout other fermentation periods, while control exhibited slightly lower colony counts than starter treatment in the same periods. During storage periods brines of pilot, control and starter indicated the same regression rate. Brine treated with acetic acid showed apparent lower fermentation activity up to 30 days then the lactic acid bacteria counts tended to increase to the level of the three aforementioned brines. Yamamoto et al. (1984), found that acetic acid inhibited all spoilage microorganisms except lactic acid bacteria at 0.5% acidity, which is the same results obtained in this experiment but later on the 60th day sample thereafter. Acetic acid brine showed relatively higher counts than pilot, control and starter brines during storage periods, since the lactic acid population decreased slightly in acetic acid brines than the other treatments. However, it can be generally observed that starter, pilot, control and acetic acid brines recorded the highest figures, since they showed apparently lactic acid fermentation activity. Sorbate brine can effectively monopolize the fermentation, since it reached the lowest figure within fermentation periods. Also, this brine indicated nearly complete decrease during periods of storage. This can be attributed to the acids formed during fermentation which accelerated the antimicrobial action of sorbate.

Brines of olives treated with NaOH reported higher densities than that of untreated.

Inis observation can possibly be explained by potential effect of the nutrients greatly leached with treated olives (Tables 43 and 52) than untreated.

Control brine of treated olives showed higher lactics densities than all individual preservatives treatments. Acetic brine showed a 30 days lag period, then began their activity to reach the highest peak in the 180th day sample. On the otherhand, brines of control, starter and acetic reported regression in numbers after reaching their peaks. This may be due to the exhaustion of fermentable carbohydrates (Table 44); also, This is probably due to the accumulation of fermentation inhibitory substances. Sorbate brine recorded their highest level after 15 days then showed progressive reduction thereafter. This may be deduced to the stimulative effect of the increasing amounts of acids (Table 31) on the antimicrobial action of sorbate.

B. **Combination of preservatives:**

The effect of the combination of preservatives on lactic acid bacteria represented in Table (5) and illustrated by Fig. (2-C and D) showed the same trend as total count concerning the lower count than individual preservatives. This is due to the synergistic interaction of acids applied or formed and sorbate on proliferation of lactics. This is in accordance of the results obtained by Restaino et al. (1982) who reported that combinations of either citric or lactic with 0.2% sorbate at pH 5.5, reduced the growth rate of **L. plantarum** and an unidentified **Lactobacillus.**

Sorbate + starter brine of olives untreated with NaOH showed the highest densities. This is probably attributed to the stimulative effect of the enriched brine of the whey on the proliferation of lactics and population cells of the starter. Sorbate + acetic + starter brine reported slightly lower colony counts than that of sorbate + starter brine. This may be due to the initial acidity of acetic which potentiated the antimicrobial action of sorbate on fermentation activity. Brine treated with sorbate + acetic showed the lowest counts all over the experimental period. This may be deduced to the efficiency of sorbate in the presence of acetic. Also, this may be due to the absence of the supplementation of whey nutrients and microbial population of the starter.

Brine of olives treated with NaOH recorded the highest level of lactic density in sample of sorbate + acetic + starter brine collected 15 and 30 days after application. This treatment also, showed the highest densities during the storage period. Although brine of sorbate + starter showed the same high counts as sorbate + acetic + starter at the commencement, they decreased gradually during the fermentation period. The decrease of lactic acid bacteria in this treatment continued showing the lowest level in the storage period. Sorbate + acetic brine indicated the least densities during the fermentation period, then the counts was slightly enhanced thereafter to surpass that of the sorbate + starter during the storage period.

Brines of treated olives by NaOH showed higher densities than untreated. This may be explained by great diffuse of the fermentable compounds from the fruits.

During early fermentation period, brines of olives untreated with NaOH reported low levels. Thereafter, they showed slight increase during the last periods of pickling, while brines of treated olives showed low density followed by progressive decrease.

C. Whey treatments:

It was observed from data shown in Table (6) and illustrated by Fig. (2-E) that whey improved lactic acid fermentation. The colony counts of whey treatments recorded remarkably higher counts than all treatments except starter brine of untreated olives. This can be attributed to the whey components which built up its microbial population. Also, this may probably be explained by the high counts of lactics that whey contained at the commencement.

Brined whey of olives treated with NaOH had higher colony counts than non-treated up to 130 days then opposit trend was observed till the end of the experiment. Whey treatments showed apparent decrease in the counts of lactic acid bacteria late in the fermentation period of pickling up to the end of the storage period. This may be deduced to the accumulation of acids and inhibitory substances.

3. Yeasts counts:

Brines of pickles are characterized by potential yeast spoilage. Yeasts may deplete acidity through their metabolism, hence undisrable microorganisms will grow, while lactics were hindered. Hence, controlling lactic acid fermentation by specified preservatives, such as sorbate, indicate benefical results. This assure complete sugar utilization by lactics and considerable yield of acids. Also, this will suppress the production of pectinolytic enzymes by yeasts chiefly responsible for softening.

A. Individual preservatives:

It appears from the data given in (Tables 7, 8 and 9) that the densities of yeasts were competitive with lactics colony counts (Tables 4,5 and 6). This is possibly deduced to the ability of yeast cell to grow in high acidity supplemented by the fermentation of lactics (Frazier, 1967).

It was interesting to notice from Table (7) and Fig. (3-A and B) that brines of olives untreated with NaOH reported less densities than that of the NaOH treated olives. This can be attributed to the effect of greater diffuse of fermentable sugars (Table 43) in brines of the NaOH treated olives than untreated resulting in proliferation of yeasts. Similar results were obtained by Juven and Yigal (1970), who reported that lye treatment increased the release of sugars. Yeast colony counts in starter treated brine of olives untreated with NaOH showed the highest counts in starter treatment among all treatments including pilot and control. This treatment recorded its peak on 30 days sample. This is probably explained by superiority of brines nutrients from the whey, which enhanced yeasts growth. For the same reason starter brine indicate relative stability than other treatments within last period of pickling and at the commencement of storage. Brine of the pilot pickling showed lower densities than starter treated brine on the 60th day sample. Also pilot and control densities were lower than that of starter and acetic treatments on the 90th day sample. This may be due

Table (7): Yeasts counts in olives brines treated with natural and synthetic individual preservatives (counts x 10^4/ml.).

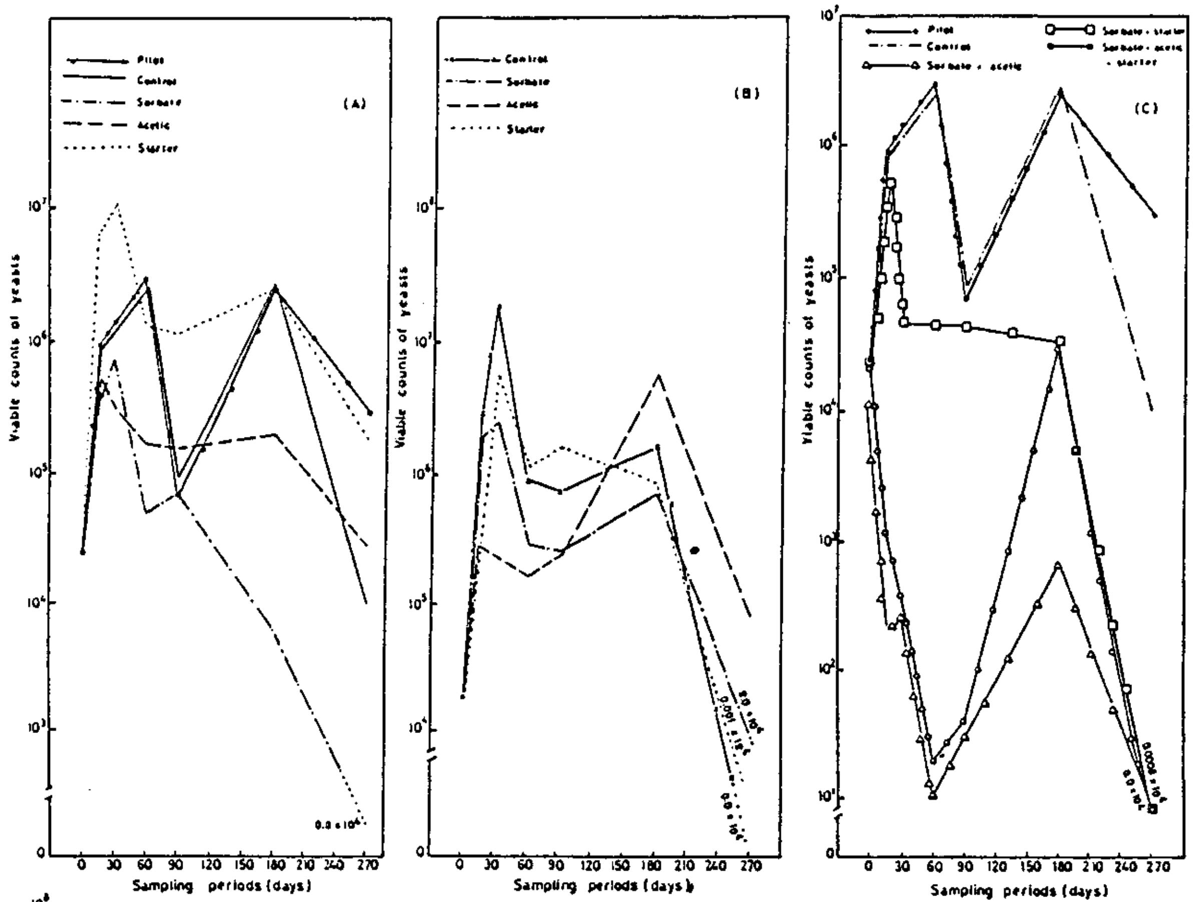
Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter
0	2.4	2.4	2.4	2.4	2.4	1.95	1.9	1.95	1.95
15	90.1	86.4	32.0	52.0	600.0	300.0	200.0	28.6	29.0
30	138.0	116.0	73.0	33.0	993.0	1860.0	260.0	23.23	605.0
60	289.0	238.0	4.9	17.0	130.0	90.0	30.0	17.0	120.0
90	7.0	9.0	6.9	15.8	116.0	75.0	26.7	25.0	166.0
180	240.0	269.5	0.6	21.1	253.0	160.0	74.0	562.0	89.3
270	30.0	1.00	0.0	2.9	19.5	0.0	0.2	8.0	0.001

Table (8): Yeasts counts in olives brines treated with combination of natural and synthetic preservatives (counts x 10^4/ml.).

Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter
0	2.4	2.4	2.4	2.4	2.4	1.95	1.95	1.95	1.95
15	90.1	86.4	0.02	52.0	0.12	300.0	120.0	16.1	300.0
30	138.0	116.0	0.0247	4.67	0.039	1860.0	11.3	14.9	110.0
60	289.0	238.0	0.001	4.5	0.002	90.0	0.1	13.7	8.0
90	7.0	9.0	0.003	4.4	0.004	75.0	0.001	8.7	47.8
180	240.0	269.5	0.066	3.3	3.0	160.0	0.0285	2.5	4.0
270	30.0	1.0	0.0008	0.0	0.0	0.0	0.0	0.0	0.0

Table (9): Yeasts counts in brined whey treatments (counts x 10^4/ml.).

Treat-ments /Days	Without NaOH			With NaOH	
	Pilot	Control	Whey	Control	Whey
0	2.4	2.4	4.0	1.95	5.0
15	90.1	86.4	96.0	300.0	69.0
30	138.0	116.0	500.0	1860.0	836.0
60	289.0	238.0	660.0	90.0	170.0
90	7.0	9.0	30.0	75.0	64.0
180	240.0	269.5	79.3	160.0	148.0
270	30.0	1.0	3.33	0.0	8.0



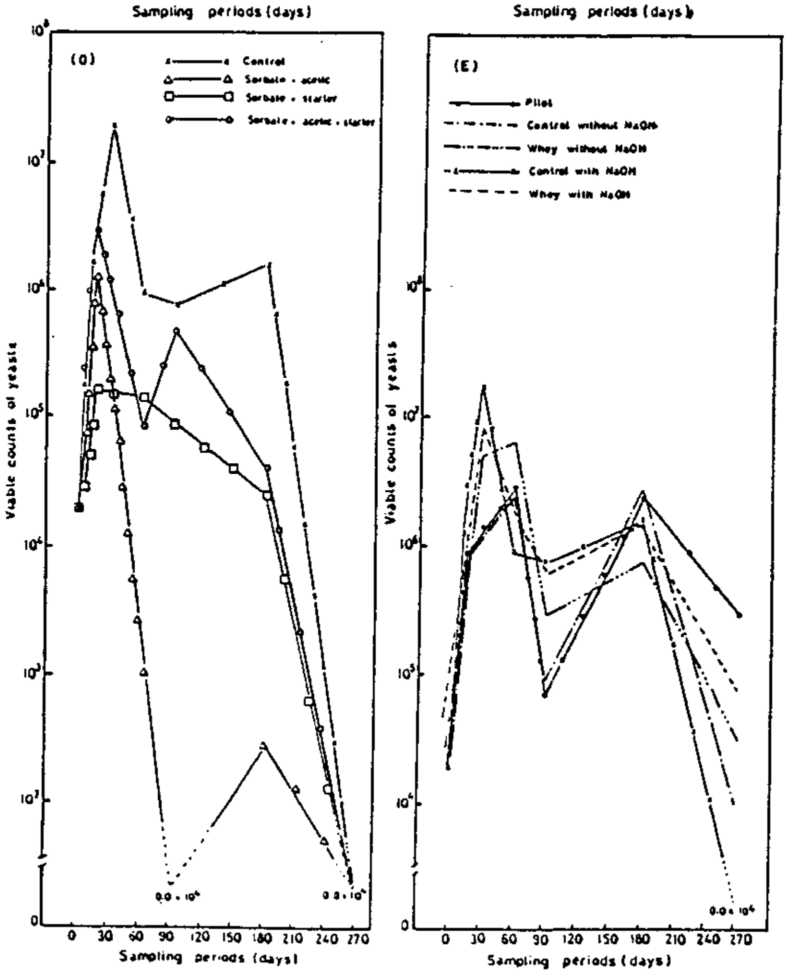


Fig.(3) Yeasts counts in brines treated with:

A : Individual preservatives of olives untreated with NaOH.

B : Individual preservatives of olives treated with NaOH.

C : Combination of preservatives of olives untreated with NaOH.

D : Combination of preservatives of olives treated with NaOH.

E : In brined whey treatments.

to the low pH level recorded within this sample (Table 28). Yeasts counts showed considerable sensitivity to acetic acid. This treatment reported apparent decrease in colony counts than control brine. Sorbate brine showed the least densities, since it showed the greatest reduction during last periods of pickling and storage periods. Therefore, this treatment indicated the greatest efficiency in yeast inhibition and controlling the fermentation. These results are in agreement with those of Legakis (1968) who reported that the addition of 0.1% sorbic acid to the brine after the first phase of lactic acid fermentation (pH 4.5) strongly inhibited the growth of yeasts. During storage period the yeasts counts showed different degrees of degradation. This degradation is probably due to the exhaustion of the essential nutrients and/or deduced to enhancement of inhibitory substances.

Control brine of olives treated with NaOH reported high densities of yeasts than preservatives treated brines in samples collected after 15 and 30 days. This assure the pronounced inhibitory effect of individual preservative treatments. Starter treated brine indicated the highest counts early in the pickling period followed by stable densities than other brines during intermediate periods (60-210 days). This observation could be explained by stimulative effect of the whey components for the growth of yeasts. Sorbate treated brine recorded higher counts than acetic brine during the fermentation period, while acetic reached higher values than sorbate brine during the storage period samples. This may be explained by the greater effect of acetic at the commencement of fermentation when the concentration of volatile acids was higher. On the otherhand, the magnitude of the inhbitory effect of sorbate appeared with the increasing of acidity in the brine. However, In all treatments densities lost their high level during storage periods. This may be deduced to the accumulation of inhibitory substances or the exhaustion of the essential nutrients.

b. Combination of preservatives:

Table (8) illustrated by Fig. (3-C and B) reflect the severe decrease in yeast densities in brines of combination of preservatives than that of individual ones, and also than pilot and control. This was deduced to the effect of supplemented acids in transfering of sorbate to sorbic which had more pronounced efficiency against yeasts than sorbate. The results stated above were previously observed by several investigators; Sheneman and Costilow (1955), Bandelin (1958) and Bell et al. (1959), who found that the activity of sorbate increases as the pH of the medium declines.

In brines of olives untreated with NaOH it was noticed that sorbate + starter brine recorded a peak during the sample collected on 15 days then the yeasts counts declined but still higher than other treatments. In the same time other preservatives treatments showed great reduction in the 15th day sample. This increase in sorbate + starter treatment is due to stimulative effect of whey components on the proliferation of yeasts and may be due to the absence of the effect of acetic acid on sorbate. The delayed lactic acid production as a result of the starter proliferation, enhanced the effectiveness of sorbate which appeared in the noticeable decrease thereafter. In the storage period, sorbate + acetic + starter brine showed moderate counts, , lower than sorbate + starter and higher than sorbate + acetic brine . This is probably due to the effect of acetic on sorbate at the commencement in the presence of the whey components. Sorbate + acetic treatment appeared to be the greatest inhibitor for yeasts population all over the experimental time. This may be due to the effect of initial acidity of acetic on sorbate in the absence of whey ingredients.

The effect of soaking the olive fruits in lye solution is clearly demonstrated in the data of yeasts counts in brines of combined preservatives. In all cases proliferation of yeasts was enhanced showing high peaks on the 15th day sample in NaOH treated olives instead of reduction in untreated. This may be deduced to the great leaching of fermentable sugars during this period (Table 44).

Sorbate + acetic + starter brine showed the highest densities than other preservatives treated brines. Sorbate + starter brine reported colony counts lower than densities of sorbate + acetic + starter brine and higher than densities of sorbate + acetic brine.

C. **Whey treatments:**

Table (9) illustrated by Fig. (3-E) recorded higher peak of yeasts counts in whey treatment of olives untreated with NaOH than pilot and control brines on 60 days samples. In contrary, whey of treated olives showed lower peak than control on the 30th day samples. The peaks in whey treatments were followed by regression in numbers till the end of experimental periods. This probably is due to the accumulation of inhibitors which were introduced into the brine by the way of lactics fermentation and diffusion of fruits inhibitors. Also, whey treated brine treatments reported higher colony counts than all brines treated with preservatives. Whey of olives treated with NaOH indicated higher densities than brines of untreated on the 30th day samples.

4. **Lipolytic microorganisms:**

spoilage of pickling brines with lipolytic microorganisms impair fats quality of the fruits which could potentially affect the pickles taste. This render the olives inedible. The counts of these organisms appeared in order of several thousands per ml. indicating their importance in spoilage of pickles.

A. **Individual preservatives:**

Data tabulated in Table (10) and illustrated by Fig. (4-A and B) assure the highest densities of lipolytic microorganisms in starter brine than other treatments of olives untreated with NaOH including pilot and control at 15 days sample. This probably was deduced to the nutrients supplementation of the whey. Pilot densities was slightly higher than control colony counts.especially after 15 days samples. Densities of lipolytic microorganisms in acetic acid treated brine exhibited considerable resistant against acetic acid, since the densities were quite lower than control. On the contrary, lipolytic microorganisms reported the greatest sensitivity to sorbate. However, these resistance and sensitivity were probably explained by the prodominance of yeasts in lipolytic flora.

After 30 days samples and till the end of experimental period regressions in numbers were observed in all treatments including pilot and control. This may be due to the introduction of fermentation inhibitors and fruits antimicrobial substances. Sorbate and starter brine indicated the greatest decrease within the same time.

Table (10): Lipolytic bacterial counts in olives brines treated with natural and synthetic individual preservatives (counts x 10^2/ml.).

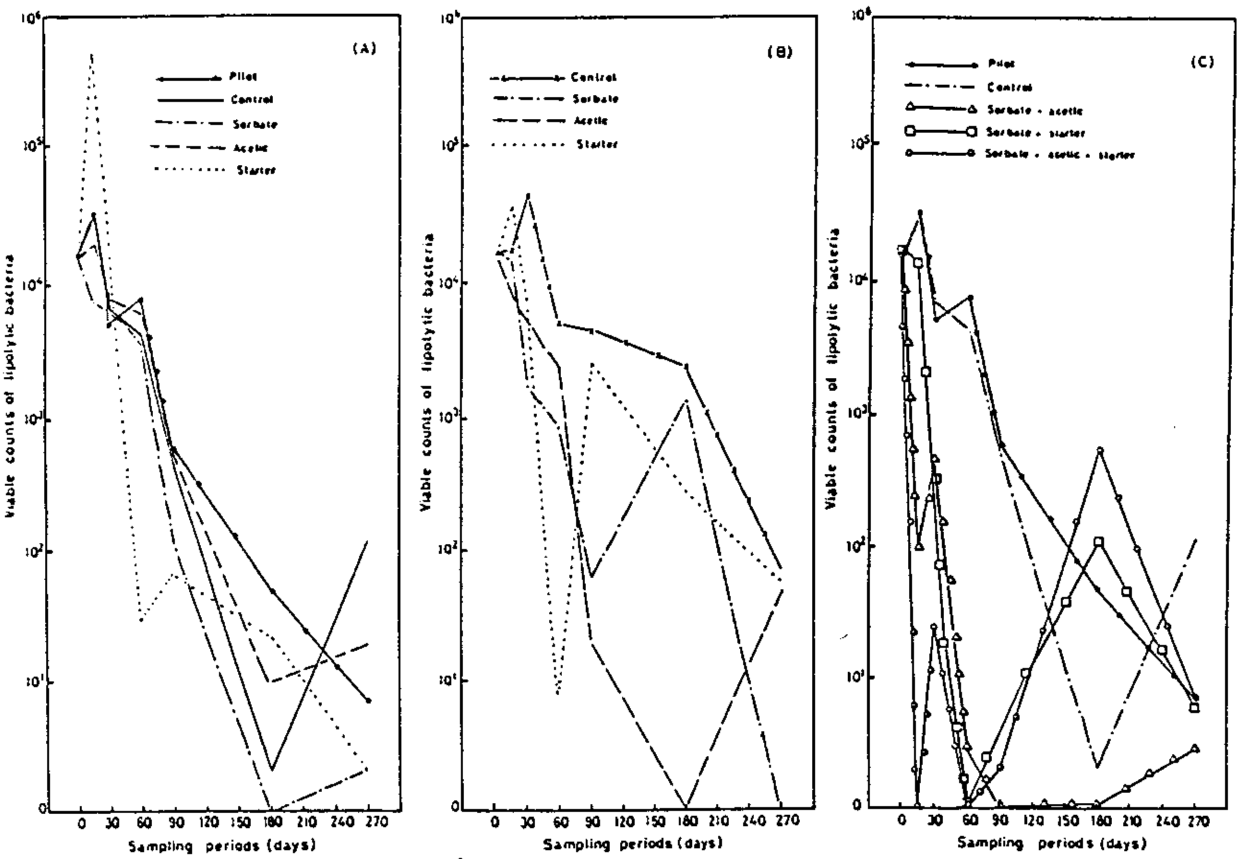
Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter
0	163.5	163.5	163.5	163.5	163.5	170.0	170.0	170.0	170.0
15	316.0	300.0	76.5	200.0	4800.0	174.0	152.0	83.0	360.0
30	52.0	68.7	68.0	79.0	140.0	430.0	18.3	51.7	80.0
60	74.0	44.0	36.0	61.0	0.3	49.33	8.7	25.0	0.08
90	6.0	4.7	1.3	5.7	0.67	45.0	0.6	0.2	25.6
180	0.5	0.02	0.01	0.1	0.23	25.7	13.6	0.01	2.8
270	0.07	1.2	0.02	0.2	0.02	0.7	0.0	0.5	0.6

Table (11): Lipolytic bacterial counts in olives brines treated with combination of natural and synthetic preservatives (counts x 10^2/ml.).

Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter
0	163.5	163.5	163.5	163.5	163.5	170.0	170.0	170.0	170.0
15	316.0	300.0	1.0	137.0	0.01	174.0	234.0	31.0	54.0
30	52.0	68.7	4.6	3.3	0.25	430.0	6.7	6.73	1.45
60	74.0	44.0	0.03	0.01	0.01	49.33	1.67	0.43	0.04
90	6.0	4.7	0.01	0.04	0.02	45.0	1.5	0.04	0.05
180	0.5	0.02	0.01	1.18	5.7	25.7	0.02	0.4	0.85
270	0.07	1.2	0.03	0.6	0.07	0.7	0.0	0.03	0.4

Table (12): Lipolytic bacterial counts in brined whey treatments (counts x 10^2/ml.).

Treat-ments /Days	Without NaOH			With NaOH	
	Pilot	Control	Whey	Control	Whey
0	163.5	163.5	730.0	170.0	670.0
15	316.0	300.0	750.0	174.0	435.0
30	52.0	68.7	1800.0	430.0	850.0
60	74.0	44.0	100.0	49.33	25.0
90	6.0	4.7	6.7	45.0	1.5
180	0.5	0.02	0.03	25.7	0.02
270	0.07	1.2	1.0	0.7	0.3



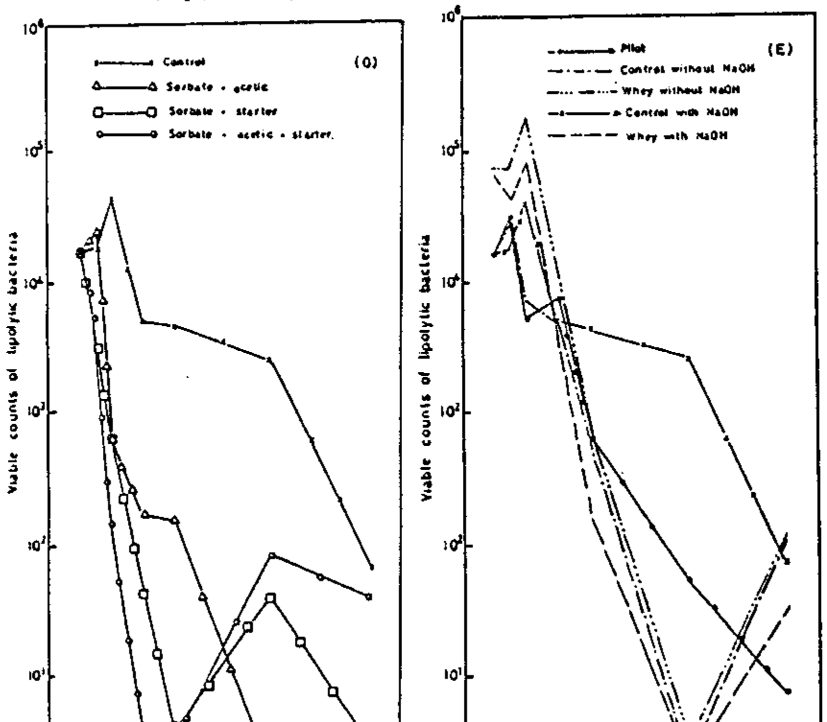


Fig.(4) Lipolytic bacterial counts in brines treated with:

A : Individual preservatives of olives untreated with NaOH.

B : Individual preservatives of olives treated with NaOH.

C : Combination of preservatives of olives untreated with NaOH.

D : Combination of preservatives of olives treated with NaOH.

E : In brined whey treatments.

Except for the starter treatment, it was generally observed that brines of olives treated with NaOH showed higher colony counts than that of untreated. Lipolytic microorganisms in control brine of olives treated with NaOH reached a higher peak than other treated brines during 30 days sample. Also, control brine was markedly higher than all treatments indicating the efficiency of the absence of the preservatives. Starter brine recorded a lower peak than control brine in the sample of 15 days. Also, this brine showed higher densities than both sorbate and acetic brines. Acetic acid brine showed higher counts than sorbate brine during fermentation periods. On the otherhand, sorbate showed higher resistant than acetic within storage time. This may be deduced to the higher acidity of acetic brine than sorbate brine during pickling, and higher acidity of sorbate brine than that of acetic acid during storage periods (Table 31).

B. Combination of preservatives:

Data recorded in Table (11) and illustrated by Fig. (4-C and D) show that the effect of the combination of preservatives on the lipolytic microorganisms exhibits the same trend previously observed concerning their deleterious effect than individual preservatives.

Brines of olives non-treated with NaOH reported lower densities than that of treated. Sorbate + starter brine of olives untreated with NaOH showed the late degradation of lipolytic flora, since the pronounced decrease retarded till the acids produced by lactics are formed in considerable amounts (Table 32). Further reasons, was the stimulative effect of the whey and the absence of acetic acid effect on sorbate. This sorbate + starter brine showed increase during storage periods. The densities of lipolytic flora in sorbate + acetic + starter brine, showed the greatest increase during storage periods. This may be due to the nutrients supplementation of the whey. Brine treated with sorbate + acetic which exhibited the greatest decrease ; exclusively showed temporary increase during 30 days samples. This drastically degradation may be due to the efficiency of initial acidity of acetic on sorbate in this whey free brine.

Brines of olives treated with NaOH showed the greatest rate of rreduction of lipolytic microorganisms during fermentation periods like that of untreated brines. Sorbate + acetic brine exhibited the least reduction during fermentation periods. However, this treatment showed complete reduction during storage periods. This was followed by sorbate + acetic + starter treatment, which showed the greatest counts during storage periods. Sorbate + starter showed moderate counts between the abovementioned treatments.

C. **Whey treatments:**

Data reported in Table (12) and illustrated by Fig. (4-E) indicate that both brined whey treatments had remarkably higher lipolytic counts than corresponding control and pilot. Also, brine treated with whey showed higher colony counts than other treatments except the starter treated brine of olives non-treated with NaOH. This may be due to the higher colony counts at the commencement in the whey. These results are in agreement with the findings of Shelley et al. (1987), who found 205 lipolytic strains in raw milk.

It could be observed that whey treatments rendered great reduction of lipolytic flora during 60 days samples till the end of the experimental period. This may be due to the accumulation of the inhibitory fermentation substances in the brine.

5. **Pectinolytic bacterial counts:**

Pectinolytic bacterial counts were in the order of several hundred thousands indicating the importance of these microorganisms in softening of the fruits.

A. **Individual preservatives:**

Data tabulated in Table (13) illustrated by Fig. (5-A and B) indicate that pilot experiment brine exhibited the highest pectinolytic bacterial densities than all treatments of olives untreated with NaOH including control. This was

Table (13): Pectinolytic bacterial counts in olives brines treated with natural and synthetic individual preservatives (counts x 10^2/ml.).

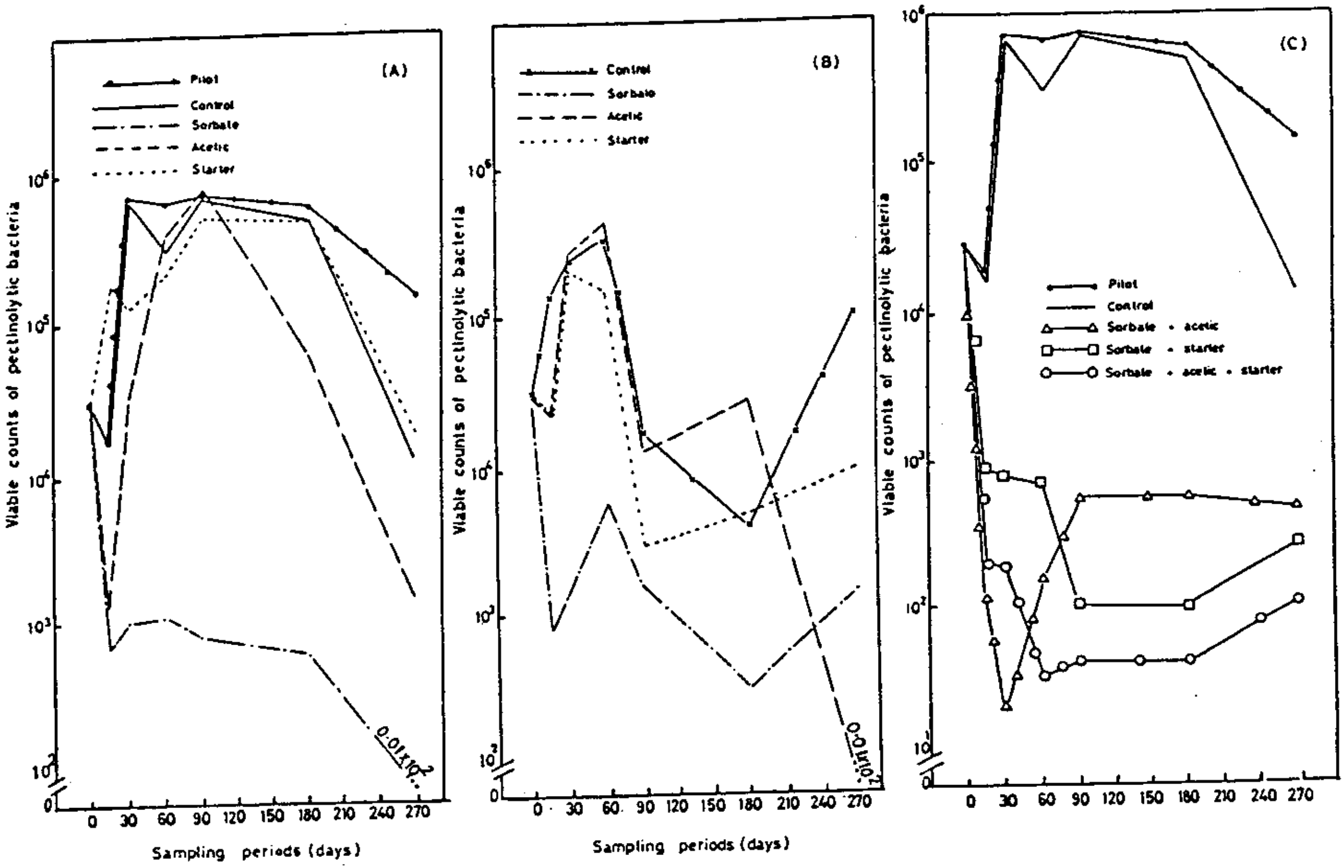
Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter
0	295.0	295.0	295.0	295.0	295.0	310.0	310.0	310.0	310.0
15	196.0	168.0	6.7	13.1	1860.	1400.0	8.0	230.0	245.0
30	7200.0	6900.0	10.6	272.0	1310.	2420.0	15.0	2780.0	2040.0
60	6750.0	3180.0	11.0	4000.0	2200.0	3350.0	60.0	4320.0	1520.0
90	7390.0	7140.0	8.0	8330.0	5280.0	170.0	16.0	132.0	30.0
180	6200.0	5120.0	5.9	644.0	5200.0	40.0	3.0	278.0	50.0
270	1500.0	135.5	0.01	14.3	180.0	1000.0	13.8	0.01	100.0

Table (14): Pectinolytic bacterial counts in olives brines treated with combination of natural and synthetic preservatives (counts x 10^2/ml.).

Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter
0	295.0	295.0	295.0	295.0	295.0	310.0	310.0	310.0	310.0
15	196.0	168.0	1.15	9.1	2.0	1400.0	12.2	1.83	0.49
30	7200.0	6900.0	0.2	8.0	1.9	2420.0	90.0	20.0	0.55
60	6750.0	3180.0	1.56	7.1	0.32	3350.0	160.0	24.0	4.9
90	7390.0	7140.	5.43	1.0	0.4	170.0	60.0	5.0	3.0
180	6200.0	5120.	5.77	0.96	0.38	40.0	260.0	79.5	0.6
270	1500.0	135.5	4.7	2.55	1.0	1000.0	54.3	0.19	0.2

Table (15): Pectinolytic bacterial counts in brined whey treatments (counts x 10^2 /ml.).

Treat-ments /Days	Without NaOH			With NaOH	
	Pilot	Control	Whey	Control	Whey
0	295.0	295.0	525.0	310.0	905.0
15	196.0	168.0	800.0	1400.0	1700.0
30	7200.0	6900.0	940.0	2420.0	1200.0
60	6750.0	3180.0	300.0	3350.0	760.0
90	7390.0	7140.0	20.0	170.0	520.0
180	6200.0	5120.0	23.0	40.0	179.0
270	1500.0	135.5	1.0	1000.0	19.5



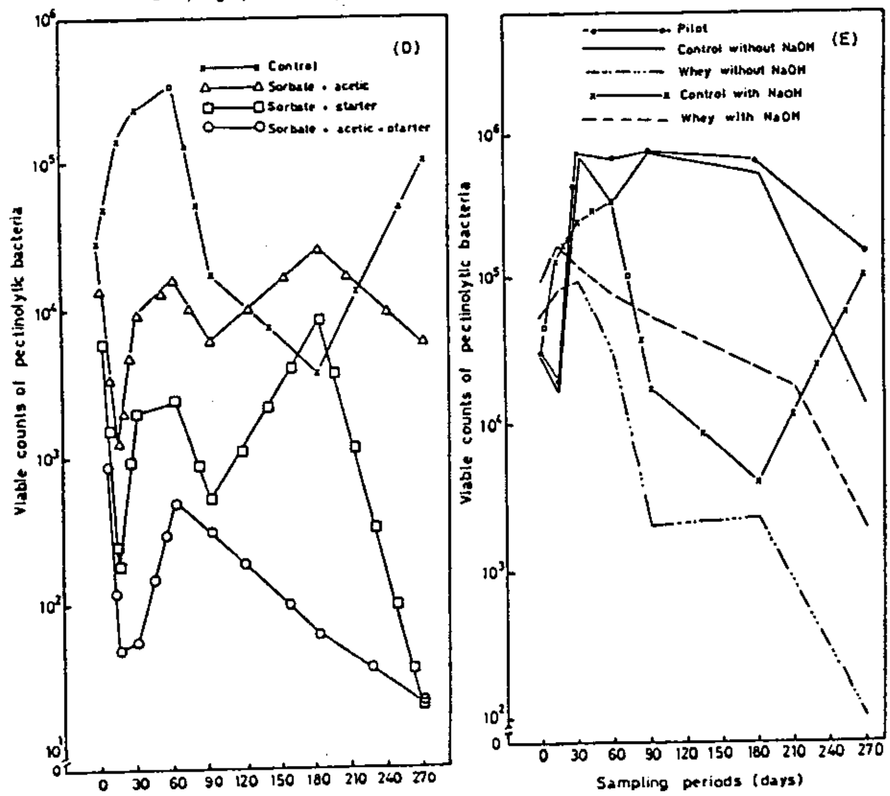


Fig.(5) Pectinolytic bacterial counts in brines treated with :

A : Individual preservatives of olives untreated with NaOH.

B : Individual preservative of olives treated with NaOH.

C : Combination of preservatives of olives untreated with NaOH.

D : Combination of preservatives of olives treated with NaOH.

E : In brined whey treatments.

followed by control colony counts of olives untreated with NaOH. Starter treated brine reported fairly lower pectinolytic counts than pilot, and slightly lower densities than control. This treatment showed quiet higher densities than acetic brine and clear higher than sorbate treatment. This is possibly deduced to that the starter includes pectinolytic strains such as **Leuc. mesenteroides, L. brevis** and **L. plantarum.** These results were postulated by Stamer and Stoyla (1968), Juven et al. (1985) and Sakellaris et al. (1988), who found that **L. brevis** and **Leuc. mesenteroides** are able to grow on polygalacturonic acid and were active on high methoxyl pectin. Also, they found that **L. plantarum** produced extracellular polygalacturonase. Acetic acid treated brine showed moderate densities between preservatives treated brines, since its colony counts were lower than that of starter brine and sharply higher than sorbate brine. This vigorous pectinolytic densities of acetic treated brine is probably due to the presence of high counts of pectinolytic lactics which their growth was stimulated in the acidified brines (Mahmoud et al., 1972). Another reason was the moderate effect of acetic acid on yeasts (Table 7), since these yeasts includes pectinolytic yeasts (Table 22). On the otherhand, sorbate treatment exhibited drastically inhibitive effect than other treatments.

Brines of olives treated with NaOH showed lower densities than untreated, except sorbate treated brine which exhibited relatively higher counts than the corresponding treatment of unteated olives. Pectinolytic flora in control brine of olives treated with NaOH indicated the highest densities than all preservatives treated brines. Acetic acid brine densities were higher than the other preservatives. This is probably due to the considerable diffusion of fermentable sugars (Table 43). However, acetic brine showed reduction from 60 days sample to reach almost complete reduction on 270th day sample (except temporary increase on 180th day sample). This may be due to the exhaustion of the fermentable sugars and due to the increase in pH level (Table 28). Sorbate brine showed the lowest densities all over the experimental time.

Brine of olives untreated with NaOH showed fairly stable pectinolytic densities during intermediate stages (30-180 days) than that of treated olives which rendered relatively rapid reduction. This is probably due to the greater diffusion of pectin and true-protein from the olives untreated than that treated (Tables 58 and 52) which regarded as fermentable substances to these organisms within these stages.

B. Combination of preservatives:

Data in Table (14) and illustrated by Fig. (5-C and D) report that the densities of pectinolytic bacteria in brines treated with combination of preservatives were sharply decreased than that of individual ones. This is due to the deleterious effect of combination of preservatives than that of individual preservatives.

of olives treated with NaOH showed marked reduction during 15 days samples this was true for the two applied combinations. During other periods till the end of experimental period sorbate + acetic brine rendered the highest resistance than other preservatives treated brines. Sorbate + acetic + starter on the otherhand showed the greatest degradation than other treatments. Sorbate + starter brine showed moderate resistance.

C. **Whey treatments:**

Data in Table (15) illustrated by Fig. (5-E) report that whey treatments exhibited lower pectinolytic microorganisms counts than pilot and corresponding controls brines. However, whey treatments showed lower colony counts than most individual preservatives treated brines, but higher than combination of preservatives treated brines. This may be due to the effect of accumulated lactics inhibitors on pectinolytic bacterial counts which was more effective than individual preservatives (except sorbate) and less effective than combination of preservatives.

Whey treatment of olives treated with NaOH showed higher densities than untreated. This phenomenon may be deduced to the ability of these NaOH treated furits to be attacked by pectinolytic microorganisms than olives untreated with NaOH.

Whey densities showed lessstability than individual preservatives treated brines. Reduction after the 15th day sample in whey treatment of olives treated with NaOH and from 30 days sample in whey treatment of olives untreated. This reduction . is probably due to the considerable accumulation of the inhibitors.

6. Cellulose decomposing bacteria:

Cellulytic microorganisms appeared to be in order of several hundreds / ml. indicating less importance of these organisms in spoilage of pickled olives.

A. Individual preservatives:

Data in Table (16) and Fig. (6-A and B) indicate that pilot and control brines of olives untreated with NaOH showed higher cellulytic decomposers densities than brines treated with individual preservatives. Pilot brine exhibited higher colony counts than control brine. This can be explained by the high degradation of pectin in pilot fruits (Table 61) which facilitated the role of cellulytic decomposers microorganisms. Starter treated brine recorded the highest peak during 15 and 30 days samples than other preservatives treated brines during fermentation periods, thereafter sharp reduction in count was shown. This may be due to the stimulative effect of whey nutrients followed by the inhibition occurred from fermentation inhibitors. Acetic acid treated brine reported the

Table (16): Cellulose decomposing bacteria counts in olives brines treated with natural and synthetic individual preservatives (counts/ml.).

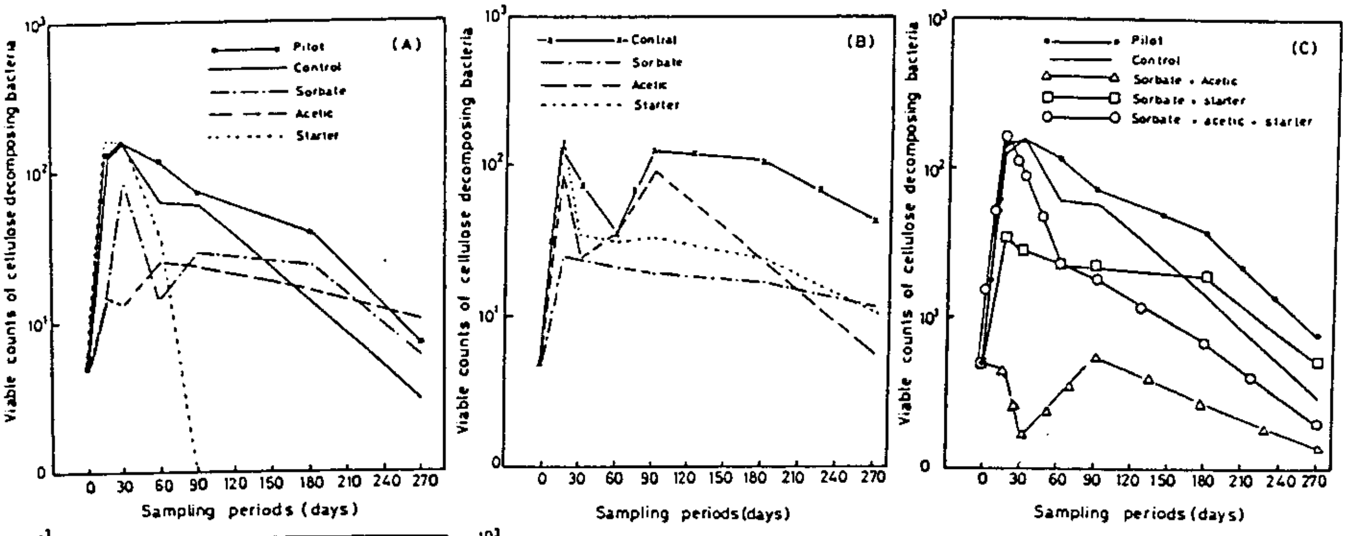
Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter
0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
15	142.0	130.0	13.0	14.0	160.0	230.0	24.0	92.0	160.0
30	153.0	160.0	81.0	13.0	160.0	79.0	23.0	24.0	35.0
60	120.0	61.0	14.0	24.0	33.0	35.0	21.0	35.0	31.0
90	72.0	58.0	28.0	23.0	0.0	130.0	19.0	95.0	33.0
180	38.0	14.0	23.0	16.0	0.0	110.0	17.0	23.0	24.0
270	8.0	3.0	6.0	10.0	0.0	45.0	12.0	6.0	11.0

Table (17): Cellulose decomposing bacteria counts in olives brines treated with combination of natural and synthetic preservatives (counts/ml.).

Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter
0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
15	142.0	130.0	4.6	33.0	160.0	230.0	35.0	160.0	92.0
30	153.0	160.0	1.1	28.0	92.0	79.0	31.0	49.0	24.0
60	120.0	61.0	2.4	23.0	23.0	35.0	14.0	35.0	17.0
90	72.0	58.0	5.4	22.0	18.0	130.0	12.0	13.0	13.0
180	38.0	14.0	3.0	19.0	7.0	110.0	9.2	9.0	11.0
270	8.0	3.0	0.8	5.0	2.0	45.0	2.0	3.0	4.0

Table (18): Cellulose decomposing bacteria counts in brined whey treatments (counts/ml.).

Treat-ments /Days	Without NaOH			With NaOH	
	Pilot	Control	Whey	Control	Whey
0	5.0	5.0	92.0	5.9	33.0
15	142.0	130.0	240.0	230.0	130.0
30	153.0	160.0	92.0	79.0	49.0
60	120.0	61.0	46.0	35.0	33.0
90	72.0	58.0	79.0	130.0	35.0
180	38.0	14.0	33.0	110.0	33.0
270	8.0	3.0	25.0	45.0	17.0



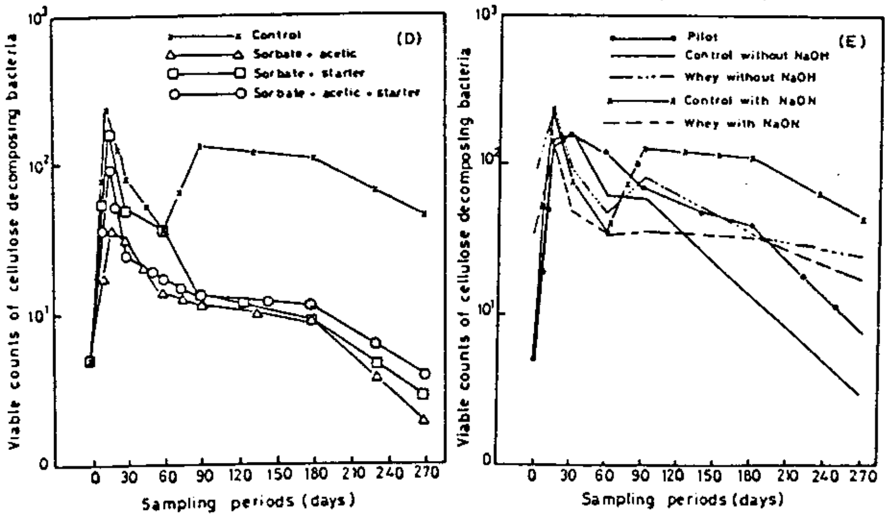


Fig.(6) Cellulose decomposing bacteria counts in brines treated with :

A : Individual preservatives of olives untreated with NaOH.

B : Individual preservatives of olives treated with NaOH.

C : Combination of preservatives of olives untreated with NaOH.

greater reduction in cellulytic population compared with sorbate treatment.

Brines of olives treated with NaOH showed higher cellulytic decomposers colony counts than untreated. Control indicated higher densities than all preservatives treated brines of olives treated with NaOH. This is in line with the results obtained by Sheneman and Costilow (1955) and Ingram *et al*. (1956). Starter treatment showed higher resistance on the 15th day samples than acetic treatment, while acetic exhibited higher resistance than starter treated brine on the 90th day samples. On the otherhand,sorbate treatment showed the least densities. This in agreement with the findings of Bell *et al*. (1959) who found that yeasts were inhibited in media containing 0.1% sorbic acid at pH 4.5, while lactic acid bacteria were inhibited at this concentration of the chemical at pH 3.5.

B. Combination of preservatives:

Data tobulated in Table (17) and illustrated by Fig. (6-C and D) indicate the inhibition of combination of preservatives than that of individual preservatives.

Brines of olives untreated with NaOH showed slightly lower cellulytic flora counts than that of NaOH treated olives. Sorbate + acetic + starter treated brine of olives untreated with NaOH reached the highest peak on the 15th day sample than other preservatives treated brines. Thereafter, this treatment showed moderate increase . However, sorbate + acetic + starter treatment exhibited the highest densities. This may be explained by the effect of the whey nutrients which overcame the effect of acetic on sorbate. Brine of sorbate + starter showed the lowest reduction from 15 days sample till the end of experimental periods than other preservatives treated brines. This may be deduced to the poor effect of sorbate in the absence of initial acidity of acetic on the proliferation of cellulytic microorganisms. Brine treated with sorbate + acetic showed the least densities. This may be explained by the effect of acetic acid directly upon the application on sorbate in the poor media free from whey components.

Sorbate + starter treated brine of olives treated with NaOH showed the greatest increase. . This may be due to the effect of the whey on the cellulytic counts against poor effect of sorbate in the absence of acetic acid. Brine treated with sorbate + acetic + starter showed lower colony counts than sorbate + starter treatment. However, sorbate + acetic + starter brine indicated more counts during storage periods than other treatments. Sorbate + acetic treated brine of olives treated with NaOH showed the same effect in the brine of untreated olives.

C. **Whey treatments:**

Data in Table (18) illustrated by Fig. (6-E) report that whey treatment of olives untreated with NaOH showed higher cellulytic colony counts than all treatments including pilot and corresponding control. This was quite expected due to the enriched media containing whey nutrients and due to the absence of preservatives in the brine. On the otherhand,whey treatment of olives treated with NaOH indicated lower densities than corresponding control. Also, whey treatment of olives treated with NaOH exhibited lower cellulytic colony counts than untreated. This is probably due to the difference of the counts at the commencement and due to the variation in amounts of the inhibitors from fermentation.

Brined whey treatments showed reduction after 15 days samples.

7. **Coliform counts:**

The hygienic conditions during fermentation and storage periods were studied using the countsof coliform groups. as indicator.

A. **Individual preservatives:**

Data given in Table (19) and illustrated by Fig. (7-A and B) show that pilot and control of olives untreated with NaOH exhibited the highest coliform colony counts on the

Table (19): Coliform group counts in olives brines treated with natural and synthetic individual preservatives (counts/ml.).

Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter
0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
15	1010.0	500.0	0.0	0.0	40.0	700.0	1.0	0.0	30.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
180	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table (20): Coliform group counts in olives brines treated with combination of natural and synthetic preservatives (counts/ml.).

Treat-ments /Days	Without NaOH					With NaOH			
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter
0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
15	1010.0	500.0	0.0	0.0	0.0	700.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
180	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table (21): Coliform group counts in brined whey treatments (counts /ml.).

Treat-ments /Days	Without NaOH			With NaOH	
	Pilot	Control	Whey	Control	Whey
0	3.0	3.0	50.0	3.0	45.0
15	1010.0	500.0	6000.0	700.0	2000.0
30	0.0	0.0	2140.0	0.0	5000.0
60	0.0	0.0	37.0	0.0	0.0
90	0.0	0.0	0.0	0.0	0.0
180	0.0	0.0	0.0	0.0	0.0
270	0.0	0.0	0.0	0.0	0.0

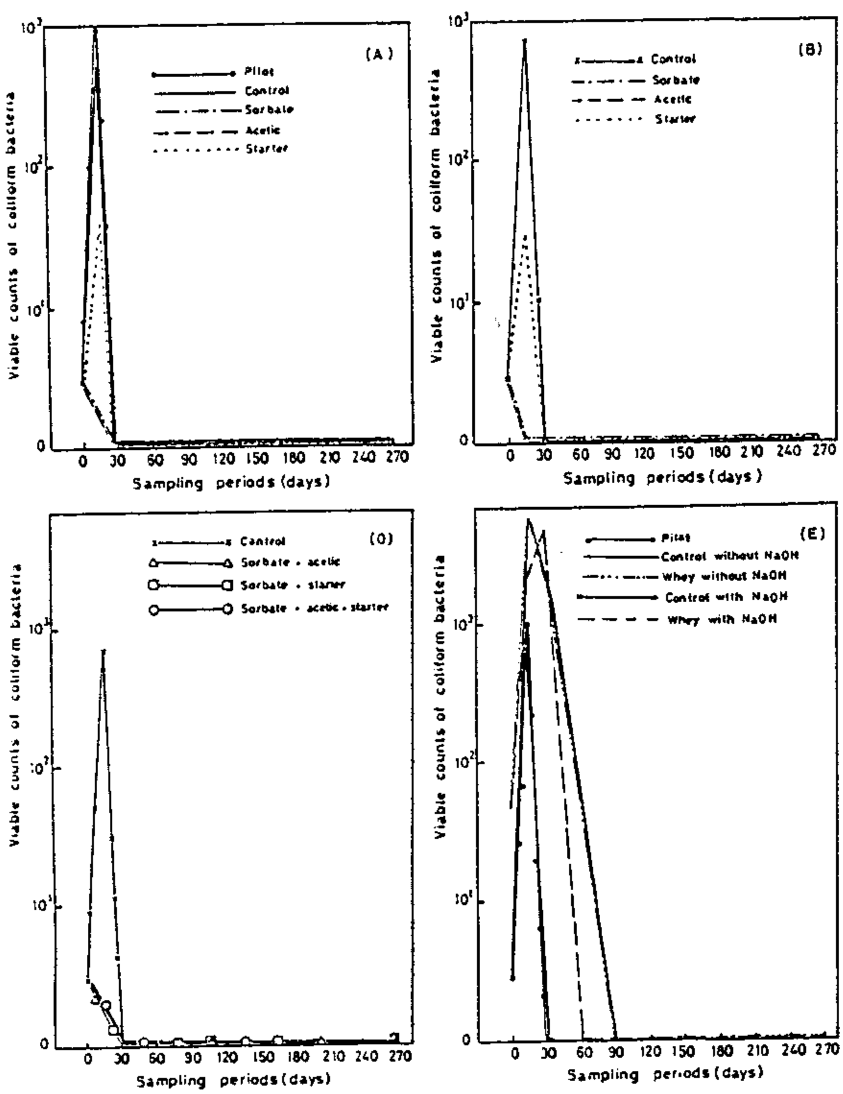


Fig.(7) Coliform group counts in brines treated with:

A : Individual preservatives of olives untreated with NaOH.

B : Individual preservatives of olives treated with NaOH.

C : Combination of preservatives of olives untreated with NaOH.

D : Combination of preservatives of olives treated with NaOH.

E : In brined whey treatment.

15th day samples than other treatments. However, pilot experiment reported higher colony counts than control brine on the 15th day. This may be deduced to the uncontrolled conditions in the plant. Starter treated brine showed lower counts on the 15th day sample than the pilot and control brines. Thereafter complete disappearance was observed where non a single colony was detected in all treatments, except for acetic treated brine which showed this degradation after the first sample.

The same trend was shown in brines of olives treated with NaOH. These results are in agreement with the findings of Taha et al. (1971) who reported that coliform groups were found up to the 4th day.

B. **Combination of preservatives:**

Data in Table (20) and illustrated by Fig. (7-C and D) showed complete disappearance after the first sample in brines treated with preservatives of olives untreated and treated with NaOH.

C. **Whey treatments:**

Data in Table (21) and illustrated by Fig. (7-E) indicate that the highest coliform colony counts were in whey treatments of olives untreated and treated with NaOH than all treatments including pilot and control. This may be deduced to the great spoilage of whey with coliform groups at the commencement. Also, this may be due to the enriched of the brine with fermentable carbohydrates and other nutrients. Coliform colony counts in whey treatments of olives untreated with NaOH reached the highest peak on the 15th day sample, thereafter it showed clear reduction . On the otherhand, whey treatment of olives treated with NaOH reached lower peak than that of untreated on the 30th day sample, thereafter exhibited reduction . Earlier reduction in whey treatment of olives untreated with NaOH than that of treated may be due to the lower pH levels it showed than that of whey treatment of NaOH treated olives (Table 30).

II. Identification of special microorganisms:

1. Yeasts:

A. Individual preservatives:

Data tabulated in Table (22) show that the appearance of resistant strains in preservatives treated brines was accompanied with the disappearnace of some strains found in control. Also, the presence of preservatives resulted in raise in the percentage of other resistant species found in control brines, but showed low percentage of sensitive ones.

Table (22): Screening of strains of yeasts in olivesbrines treated with Natural and synthetic individual preservatives (in percentage of examined strains).

Strain species	Without NaOH				With NaOH			
	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter
Saccharomyces cerevisiae	22.2	0.0	0.0	4.08	4.35	7.14	11.43	0.0
Saccharomyces fructum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Saccharomyces italicus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kluyveromyces fragilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kluyveromyces marxianus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lipomyces starkeyi	0.0	0.0	0.0	2.041	0.0	0.0	0.0	0.0
Hansenula anomala	5.56	16.22	9.52	20.41	13.04	7.14	8.57	4.0
Hansenula subpelliculosa	5.56	5.41	0.0	4.08	4.35	0.0	0.0	4.0
Pichia membranaefaciens	0.0	13.51	23.81	16.33	0.0	21.42	14.29	12.0
Pichia farinosa	0.0	0.0	0.0	0.0	0.0	7.14	0.0	0.0
Pichia melligeri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Debaryomyces hansenii	5.56	0.0	0.0	4.08	0.0	0.0	0.0	0.0
Candida krusei	11.1	21.62	4.76	8.163	4.35	0.0	2.86	12.0
Candida mycoderma	5.56	2.7	14.29	6.12	4.35	0.0	0.0	4.0
Candida tropicalis	0.0	5.41	4.76	6.12	4.35	0.0	5.71	0.0
Candida rugosa	0.0	2.7	4.76	0.0	0.0	0.0	0.0	0.0
Candida pseudotropicalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Torulopsis candida	11.1	8.11	9.52	14.29	17.39	14.29	5.71	24.0
Rhodotorula glutinis	16.67	2.7	4.76	2.04	30.44	14.29	2.86	12.0
Rhodotorula rubra	0.0	5.41	9.52	2.04	4.35	7.14	2.86	8.0
Rhodotorula minuta var. minuta	0.0	0.0	4.76	0.0	4.35	0.0	5.71	8.0
Rhodotorula mucilaginosa	0.0	0.0	4.76	0.0	0.0	14.29	2.86	4.0
Cryptococcus albidus	16.67	16.21	4.76	10.20	8.7	7.14	37.14	8.0

N.B. The total number of screened strains was 223 strain.

In brines of olives untreated with NaOH, species of family **Cryptococcaceae** were more predominated and most of them showed higher percentages than that of **Saccharomycetaceae.** The pectinolytic species **Rh. glutinis**, and also **Cr . albidus** represented the highest percentage among family **Cryptococcaceae** in control brine. Also, **Cr . albidus** showed the same percentage. These were followed by **C. krusei** and **T. candida,** but **C. mycoderma** represented the lowest percentage between **Cryptococcaceae**. **Sacc. cerevisiae** represented the highest percentage among **Saccharomycetaceae** and also recorded the highest percentage than all other species in control brine. **H. anomala, H. subpelliculose** and **Deb. hansenii** were weakly predominated, but **P. membranaefaciens** did'nt present in control brine. These results are in agreement with the findings of Atteya (1979) who found that **C. tropicalis** and **C. Krusei** were the most dominant species in the brines of all treatments, while **P. membranaefaciens** showed less densities. However, treated brines with preservatives showed **P. membranaefaciens** as a resistant species. . **C. krusei, H. anomala** and **Cr. albidus** exhibited the highest percentage in sorbate treated brine. **Deb. hansenii, C. mycoderma, C. rugosa** and **Rh. glutinis** showed the lowest resistance. **P. membranaefaciens** exhibited the highest resistance in acetic brine. This, can be explained by the ability of this strain to grow in the high acidity of this treatment (Table 31). Similar results obtained by Atteya (1979) who found that **P. membranaefaciens**

predominated in acidified brines and that its presence was greater in brines of olives untreated with NaOH than that treated. This was followed by the resistance of **C. mycoderma.**
On the otherhand,**H. subpelliculosa** and **Deb. hansenii** disappeared, while others appeared to be of low resistance. These results are in line with those obtained by Mark et al. (1956), Gonzalez (1966) and El-Shahat (1969). **Sacc. cerevisiae** was greatly affected by sorbate and acetic brines. Strarter treated brine exhibited the highest percentage of the pectinolytic species **H. anomala.** This was followed by **P. membranaefaciens, T. candida** and **Cr. albidus** respectively. **Sacc. cerevisiae** was found among the lowest resistance species. Also, **Lipomyces starkeyi** was present in starter brine flora. The appearance of **Saccharomyces sp. Lipomyces sp.** and **Deb. hansenii** may be deduced to the presence of fermentable nutrients of the whey. Pectinolytic species **Rh. glutinis** and **Rh. rubra** showed the lowest resistance. This is probably deduced to the great effect of lactics inhibitors on them besides the effect of the higher amounts of phenolic compounds in starter brine of olives untreated with NaOH than that of treated olives (Table 67). This in accordance with the results of Friend (1979) and Gibbs (1987).

In brines of olives treated with NaOH the greater diffusion of sugars than that of untreated (Table 43) resulted in the appearance of **Sacc. cerevisiae** in sorbate and acetic brines.

the presence of **P. membranaefaciens** in high density in sorbate brine of olives treated with NaOH indicates its high resistance to the preservative C.. the otherhand, **P. farinosa, Rh. rubra, H. anomala** and **Cr.albidus** exhibited the lower resistance while **H. subpelliculosa** disappeared. This may be due to the effect of higher acidity showed in brine of olives treated with NaOH than that of untreated while favours the effect of sorbate. Other species found in sorbate brine showed moderate resistance. **Cr.albidus** showed the highest resistnace in acetic acid brine. **P. membranaefaciens** showed also high resistance in acetic brine of olives treated with NaOH like that of untreated. **Sacc. cerevisiae and H. anomala** exhibited mild resistance. **C. krusei, Rh. glutinis, Rh. rubra** and **Rh. mucilaginosa** showed the least resistance. **T. candida** showed its highest density species in starter treatment, while the pectinolytic species **Rh. glutinis, P.membranaefaciens C.Krusei Rh. rubra Cr.albidus and Rh.minuta** showed moderate density .. **H. anomala, H. subpelliculosa, C. mycoderma** and **Rh. mucilaginosa** exhibited the least frequency. .

B. **Combination of preservatives:**

Data recorded in Table (23) report that the application of combined preservatives caused the disappearance of some species observed in brines treated by individual ones. This may be due to the great effect of combined preservatives than individual ones. Sorbate + acetic trated brine of olives untreated with NaOH showed a completely different spectrum of yeast species compared with either preservative alone or those of the control.

Table (23): Screening of strains of yeasts in olives brines treated with combination of natural and synthetic preservatives (in percentage of examined strains).

Strain species	Without NaCH				With NaCH			
	Control	Sorbate + acetic	Sorbate + starter	Sorbate +acetic +starter	**Control**	Sorbate + acetic	Sorbate + starter	Sorbate +acetic +starter
Saccharomyces cerevisiae	22.2	0.0	0.0	0.0	4.35	4.35	33.33	0.0
Saccharomyces fructum	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0
Saccharomyces italicus	0.0	0.0	0.0	0.0	0.0	4.25	0.0	0.0
Kluyveromyces fragilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kluyveromyces marxianus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lipomyces starkeyi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hansenula anomala	5.56	0.0	7.69	0.0	13.04	13.04	0.0	10.53
Hansenula subpelliculosa	5.56	0.0	7.69	0.0	4.35	0.0	0.0	0.0
Pichia membranaefaciens	0.0	25.0	7.62	0.0	0.0	4.35	8.33	31.58
Pichia farinosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pichia melligeri	0.0	0.0	0.0	0.0	0.0	0.0	8.33	0.0
Debaryomyces hansenii	5.56	0.0	0.0	0.0	0.0	4.35	0.0	0.0
Candida krusei	11.1	0.0	15.39	25.0	4.35	4.35	0.0	10.53
Candida mycoderma	5.56	0.0	15.39	0.0	4.35	4.35	0.0	21.05
Candida tropicalis	0.0	0.0	15.39	12.5	4.35	8.7	0.0	0.0
Candida rugosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Candida pseudotropicalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Torulopsis candida	11.1	0.0	0.0	0.0	17.39	13.04	8.33	5.26
Rhodotorula glutinis	16.67	0.0	15.39	12.5	30.44	13.04	8.33	5.26
Rhodotorula rubra	0.0	0.0	7.69	0.0	4.35	4.35	0.0	0.0
Rhodotorula minuta var. *minuta*	0.0	25.0	7.69	0.0	4.35	0.0	8.33	0.0
Rhodotorula mucilaginosa	0.0	25.0	0.0	0.0	0.0	8.7	8.33	5.26
Cryptococcus albidus	16.67	25.0	0.0	25.0	8.7	13.04	16.67	10.53

N.B. The total number of screened strains was 118 strain.

This may be deduced to the effect of acetic on sorbate in the absence of whey compon + ents. The predominant species found in this brine were **P. membranaefaciens, Rh. minuta, Rh. mucilaginosa,** and **Cr. albidus. C. krusei, C. mycoderma, C. tropicalis** and **Rh. glutinis** were the most predominant strains in sorbate + starter brine. On the otherhand, **H. anomala, H. subpelliculosa, P. membranaefaciens, Rh. rubra** and **Rh. minuta** showed the least appeareance in the same brine. However, sorbate + starter brine showed more species of yeasts. This may be deduced to the weak effect of delayed acids produced by starter in the presence of whey components. The relative decrease in the percentage of yeasts species in brine treated with sorbate+acetic + starter may be due to the effect of acetic right after application on sorbate in the presence of whey nutrients.

Brines of olives treated with NaOH showed more species than that of untreated. This is probably deduced to the greater diffuse of the fermentable components in brines of NaOH treated olives than that of untreated (Tables 44 and 53). These nutrients especially fermentable sugars were also resulted in the appearance of some species such as **Sacc. cerevisiae. H. anomala, T. candida, Rh. glutinis** and **Cr. albidus** which showed the highest frequency in sorbate + acetic brine, while in the other combinations showed low presence of these species. On the otherhand, **Sacc. cerevisiae** and **Cr. albidus** exhibited the highest predominance in sorbate + starter brine. **P. membranaefaciens** and **C. mycoderma** reported the highest appearance in sorbate + acetic + starter treated brine than other species. **H. anomala** , **C. krusei** and **Cr.albidus** exhibited moderate resistance, while **T.candida,** **Rh. glutinis** and **Rh. mucilaginosa** showed lower presence.

C. **Whey treatments:**

Data given in Table (24) report that whey treatments showed species which had not been found in other brines such as **Klu. marxianus, Klu. fragilis** and **C. pseudotropicalis.** This is in occordance with the findings of Badr-Eldin et al. (1984). Whey treatments showed wide range of species than corresponding controls This may be deduced to the enriched by the whey. Also, it could be observed that whey treatments exhibited higher percentage of pectinolytic species which was higher in whey treatment of olives treated with NaOH than untreated. This wereassured by the percentage of pectin in the fruits (Table 60) which was the lowest in whey treatments. Also, percentage of pectin in whey treatment of olives treated with NaOH was lower than that untreated.

2. **Lactic acid bacteria:**

It is well known that lactic acid bacteria are chiefly responsible for the desirable fermentation during pickling process of green olives (Cruess, 1958 and Frazier, 1967). Therefore, it was found of interest to study the occurrence

Table(24): Screening of strains of yeasts in brined whey treatments (in percentage of examined strains).

Strain species	Without NaOH		With NaOH	
	Control	**Whey**	**Control**	**Whey**
Saccharomyces cerevisiae	22.2	0.0	4.35	2.70
Saccharomyces fructum	0.0	0.0	0.0	0.0
Saccharomyces italicus	0.0	0.0	0.0	0.0
Kluyveromyces fragilis	0.0	0.0	0.0	2.70
Kluyveromyces marxianus	0.0	5.0	0.0	0.0
Lipomyces starkeyi	0.0	0.0	0.0	5.41
Hansenula anomala	5.56	5.0	13.04	18.92
Hansenula subpelliculosa	5.56	0.0	4.35	0.0
Pichia membranaefaciens	0.0	15.0	0.0	0.0
Pichia farinosa	0.0	0.0	0.0	0.0
Pichia melligeri	0.0	0.0	0.0	0.0
Debaryomyces hansenii	5.56	5.0	0.0	8.11
Candida krusei	11.1	10.0	4.35	5.41
Candida mycoderma	5.56	0.0	4.35	0.0
Candida tropicalis	0.0	5.0	4.35	2.70
Candida rugosa	0.0	0.0	0.0	0.0
Candida pseudotropicalis	0.0	5.0	0.0	0.0
Torulopsis candida	11.1	0.0	17.39	5.41
Rhodotorula glutinis	16.67	25.0	30.44	16.22
Rhodotorula rubra	0.0	5.0	4.35	5.41
Rhodotorula minuta var.	0.0	0.0	4.35	8.11
minuta	0.0	0.0	0.0	0.0
Rhodotorula mucilaginosa	0.0	5.0	0.0	2.703
Cryptococcus albidus	16.67	15.0	8.7	16.22

N.B. The total number of screened strains was 97 strain.

of different species of lactics during fermentation and storage of pickled green olives.

A. **Individual preservatives**

Data tabulated in Table (25) show that sorbate treatment of untreated olives with NaOHexhibited great inhibitory effect on **L. brevis, S. lactis** and **Leuc. mesenteroides**, while **L. casei, L. plantarum** and **Ped. cerevisiae** were not sensetive to this preservative. Acetic acid was effective against **L. casei,** while other strains were either encouraged or slightly affected. It was noticed that **Ped. cerevisiae** was the most resistant strain against preservatives brines of both untreated and treated olives with NaOH.

In brines of olives treated with NaOH the same trend showed in brines of olives untreated, except cocci lactics their percentages slightly increased for the aforementioned reasons.

Table (25): Screening of lactic acid bacteria in olives brines treated with natural and synthetic individual preservatives (in percentage of examined strains)

Straim species	Without NaOH				With NaOH			
	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter
L. brevis	35.14	20.00	32.43	19.92	26.83	22.50	35.14	19.57
L.casei	8.11	16.66	2.70	13.51	19.51	17.50	8.11	13.04
L.plantarum	18.92	20.00	16.22	37.84	21.95	17.50	13.51	30.44
L.lactis	00.00	00.00	00.00	00.00	00.00	5.00	00.00	00.00
S.lactis	10.81	3.33	16.22	8.11	9.76	5.00	13.51	13.04
Leuc.mesenteroides	16.22	3.33	16.22	8.11	12.20	5.00	10.82	13.04
Ped.cerevisiae	10.81	36.66	16.22	13.5	9.76	27.50	18.92	10.87

N.B. The total number of screened strains was 305 strain

Table (26):: screening of lactic acid bacteria in olives brines treated with combination of natural and synthetic combination of preservatives (in percentage of examined straim).

Strain species	Without NaOH				With NaOH			
	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter
L.brevis	35.14	29.41	27.78	28.57	26.83	38.89	14.29	38.89
L.casei	8.11	17.65	11.11	14.29	19.51	13.89	22.86	25.00
L.plantarum	18.92	20.59	19.44	47.62	21.95	22.22	28.57	27.78
L.lactis	00.00	5.88	0.0	00.00	00.00	00.00	00.00	00.00
S.lactis	10.81	8.82	13.89	2.38	9.76	8.33	11.43	2.78
Leuc.mesenteroides	16.22	8.82	13.89	2.38	12.20	8.33	11.43	2.78
Ped.cerevisiae	10.81	8.82	13.89	4.48	9.76	8.33	11.43	2.78

N.B. The total number of screened strains was 297 strain.

Table (27): Screening of lactic acid bacteria in whey treatments (in percentage of examined strains).

Strain species	Without NaOH		With NaOH	
	Control	Whey	Control	Whey
L.brevis	35.14	15.79	26.83	17.95
L.casei	8.11	18.42	19.51	20.51
L.plantarum	18.92	15.79	21.95	15.39
L.lactis	00.00	18.42	00.00	17.95
S.lactis	10.81	7.89	9.76	10.26
Leuc.mesenteroides	16.22	13.16	12.20	10.26
Ped. cerevisiae	10.81	10.53	9.76	7.69

N.B. The total number of screened strains was 155 strain.

B. **Combination of preservatives**

Batal given in Table (26) report that sorbate + acetic treatment of olives untreated with NaOH exhibited inhibitory effect on cocci lactics especially **Leuc. mesenteroides.** Also, **L. brevis** showed relatively great inhibition in this brine, while **L. casei** and **L. plantarum** were not affected. In sorbate + starter treated brine **L. plantarum, S. lactis, Ped. cerevisiae** and **L. casei** slightly resisted the inhibitory effect of sorbate, while **Leuc. mesenteroides** was slightly inhibited. Sorbate + acetic + starter treated brine exhibited great inhibitory effect on cocci lactics. This may be deduced to the relatively low pH showed in this brine Table (29). This is in accordance with the findings of Antonio (1953), Gonzalez (1963, 1967) and Frazier (1967).

On the other hand this treatment in creased the percentage of **L. plantarum.** This may be due to the inocula-ted cells of the starter.

the brines. The pickled fruits were investigated for the soluble acids, total sugars, reducing surgars, total nitrogen, protein nitrogen, ether extract and total moisture. Moreover, NaCl concentration, vitamin C, tannins content and pectic substances in both the brines and the fruits were determined.

1. **Changes in pH values**

pH levels play an important role in controlling the microorganisms predominated through the fermentation course.

A. **Individual preservatives**

The data presented in Table (28) show that there was highly significant decrease in the pH levels till 60 days samples to reach the minimum mean of pH level. This is in agreement with the findings of Yassa (1979), who stated that the pH value of olive brine showed a gradual decrease during pickling. Thereafter, there was highly significant higher values in pH values in 90 days samples. This is possibly due to the increase in yeasts counts which destroyed acids throughout their metabolism. Similar results were obtained by Underkofler and Hickey (1954), who reported that the presence of yeasts was considered to be deterimental, since they may decrease the acidity through their metabolism. However, during storage periods there were highly significant decreases in pH values. This may be due to the high lactics densities at the commencement of this period in most brines. Also, this is probably due to the loss exhibited in soluble acids from pickled fruits to the brines in some treatments on 270 days samples.

Brines of olives untreated with NaOH showed significantly lower values of pH when treated with acetic acid or starter preservatives. Acetic acid treatment rendered highly significant decrease of pH value in its brine than other treatments of olives untreated with NaOH including pilot and control. This may be due to the initial acidity of applied acetic acid. Also, this is probably due to the relatively inhibition of acetic acid to yeasts densities (Table 7) and high lactics counts (Table 4). Acetic acid treated brine was followed by brine treated with starter. The mean value of pH levels in this treatment showed highly significant decrease than brines of pilot, control and sorbate treatments. this may be due to the highest lactics activity among brines of olives untrated with NaOH (Table 4). These results are in line with those of vaughn <u>et</u> <u>al</u>. (1943). High pH values exhibited in brines of control and pilot may be deduced to the absence of starter population and intial acidity of applied acetic acid. The average of pH values in brines of pilot, control and sorbate, which showed non-significant difference between them, recorded the highest

Table (28): pH values in olives brines treated with natural and synthetic individual preservatives.

Treatments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	7.7	7.7	7.7	4.0	7.7	7.7	7.7	4.0	7.7	6.878
15	5.3	5.2	3.5	4.0	3.9	3.9	4.1	3.53	3.9	4.148
30	3.4	3.5	5.0	3.0	3.5	3.3	3.9	3.2	3.3	3.567
60	3.1	2.9	3.5	3.6	2.7	3.2	3.7	3.9	3.2	3.311
90	3.7	3.8	4.0	4.1	3.11	3.7	4.1	3.6	3.7	3.756
180	3.65	3.73	4.1	3.8	4.0	3.63	3.0	3.5	3.63	3.676
270	3.6	3.7	3.3	3.4	3.5	3.6	3.4	3.2	3.6	3.478
Means	4.357	4.361	4.443	3.7	4.059	4.147	4.271	3.561	4.147	4.116

	5%	1%		5%	1%
L.S.D. Interval:	0.0422	0.0561	L.S.D. Treatment:	0.048	0.0636

Table (29): PH, values in olives brines treated with combination of natural and synthetic preservatives.

Treatments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	7.7	7.7	4.0	7.7	4.0	7.7	4.0	7.7	4.0	6.056
15	5.3	5.2	4.0	4.0	3.8	3.9	4.0	3.8	3.5	4.167
30	3.4	3.5	3.0	3.7	3.7	3.3	3.81	3.0	3.3	4.412
60	3.1	2.9	3.5	2.9	3.6	3.2	3.93	2.9	3.3	3.259
90	3.7	3.8	3.8	3.5	3.4	3.7	3.98	3.7	3.2	3.642
180	3.65	3.73	3.9	3.5	3.3	3.63	5.0	3.4	3.1	3.696
270	3.6	3.7	3.2	3.3	3.0	3.6	3.4	3.3	3.0	3.344
Means	4.357	4.361	3.7	4.086	3.543	4.147	4.016	3.971	3.343	3.939

	5%	1%		5%	1%
L.S.D. Interval:	0.0745	0.0991	L.S.D. Treatment:	0.085	0.1124

Table (30): PH values in brined whey treatments of olives.

Treatments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	7.7	7.7	6.5	7.7	6.5	7.22
15	5.3	5.2	4.6	3.9	4.6	4.72
30	3.4	3.5	3.0	3.3	3.0	3.24
60	3.1	2.9	2.8	3.2	3.0	3.00
90	3.7	3.8	3.6	3.7	4.4	3.84
180	3.65	3.73	3.0	3.63	3.0	3.41
270	3.6	3.7	3.3	3.6	3.8	3.54
Means	4.357	4.361	3.829	4.147	4.043	4.139

	5%	1%		5%	1%
L.S.D. Interval:	0.135	0.182	L.S.D. Treatment:	0.114	0.154

averages of pH values during the experimental period. The increase in pH values of sorbate treated brine is probably due to the effect of sorbate on lactics activity (Table 4) according to Restaino _et al_. (1982). Although sorbate treated brine showed the lowest lactics activity, it maintained relatively low pH level due to the inhibition of yeasts.

Brines of olives treated with NaOH usually rendered highly significant decrease in the average of pH values than corresponding treatments untreated with NaOH during experimental time. This is possibly deduced to the greater diffuse of fermentable carbohydrate and true proteins (Tables 43 and 52) in brines of NaOH treated olives than untreated, which enhanced lactic acid fermentation. Highly significant and significant negative correlation (r) between percentages of total titratable acidity and total sugars or true proteins assure these results (Table 30-A)These results are in accordance with that obtained by Juven et al. (1968 and Yassa (1979). The differences in the averages of pH values in brines of olives treated with NaOH showed the same trend in brines of untreated olives.

B. **Combination of preservatives:**

Results tabulated in Table (29) report low pH values in brines treated with the combinations of preservatives including acetic acid.

There were highly significant decreases between averages of pH values in periods samples till 60 days samples. There was insignificant difference between averages of 90 and 180 days samples, but they showed highly significant higher level than samples of 60 days. This is probably deduced to the relative decrease in the densities of lactic acid bacteria and/or to the high counts of yeasts in most treatments. Also, this may be due to the highly significant increase of soluble acids in the fruite which was absorbed from the brines during these periods. There was highly significant decrease in samples of 270 days than those of 180 days.

Brines of olives treated with NaOH showed highly significant decreases in the mean values of pH than the corresponding

Table 30-A): Correlation Coefficient (r)

Treatment	Without NaOH									With NaOH							
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Sorbate +Acetic	Sorbate +starter	Sorbate +acetic +starter	Whey	Control	Sorbate 0.1%	Acetic to pH4	Starter	Sorbate +acetic	Sorbate +starter	Sorbate +acetic +starter	Whey
(r) Between total acidity in the brine and total sugars in the fruits.	-0.77*	-0.718	-0.773*	-0.712	-0.93**	-0.637	-0.907**	-0.856*	-0.89**	-0.974**	-0.831*	-0.564	-0.939**	0.399	-0.96**	-0.688	-0.900**
(r) Between total acidity in the brine and true-protein in the fruits.	-0.98**	-0.906**	-0.609	-0.654	-0.988**	-0.561	-0.952**	-0.854*	-0.966**	-0.843*	-0.902**	-0.672	-0.87*	-0.538	-0.953**	-0.938**	-0.736
(r) Between total acidity in the brine and soluble acids in the fruits	-0.85*	0.0524	0.677**	0.982**	0.943**	0.916**	0.928**	0.995**	0.932**	0.832*	0.938**	0.982**	0.887**	0.875**	0.944**	0.973**	0.869*
(r) Between pectin and total sugars in the fruits.	0.3011	0.944**	0.961**	0.944**	0.937**	0.9863**	0.851*	0.978**	0.969**	0.9278**	0.921**	0.9167**	0.8764**	0.919**	0.882**	0.8359*	0.8801*
(r) Between pectin and reducing sugars in the fruits	0.8156*	0.834*	0.871*	0.961**	0.965**	0.942**	0.8184*	0.88**	0.959**	0.886**	0.934**	0.939**	0.91**	0.863*	0.869*	0.9183**	0.947**

5% 0.7545   1% 0.8745

treatments of untreated olives in most cases. This may be deduced to the greater leaching of the nutrients essential for lactics activity from the fruits in brines of olives treated with NaOH than untreated.

In brines of olives untreated with NaOH, sorbate + acetic + starter treated brine exhibited the lowest average of pH values among other treatments including pilot and control. This is probably due to the relatively high lactics counts and great inhibition of yeasts. This was followed by sorbate + acetic treatment which exhibited highly significant decrease in the average of pH levels than pilot, control and sorbate + starter treatments. This may be deduced to the greatest inhibition of yeasts exhibited in sorbate + acetic treated brine according to Eklund (1983). The highest average of pH values was in sorbate + starter treated brine, since it showed highly signifcant increase than other combination of preservatives treated brines. This may be due to the delayed production of acids. Pilot and control experiments exhibited the highest levels of pH than preservatives treated brines. This is probably deduced to the greatest counts of yeasts than other treatments.

In brines of olives treated with NaOH; sorbate + acetic + starter treated brine showed the same trend in corresponding brine of untreated olives. This was followed by sorbate +

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In brines of olives untreated with NaOH, sorbate + acetic + starter treated brine exhibited the lowest average of pH values among other treatments including pilot and control. This is probably due to the relatively high lactics counts and great inhibition of yeasts. This was followed by sorbate + acetic treatment which exhibited highly significant decrease in the average of pH levels than pilot, control and sorbate + starter treatments. This may be deduced to the greatest inhibition of yeasts exhibited in sorbate + acetic treated brine according to Eklund (1983). The highest average of pH values was in sorbate + starter treated brine, since it showed highly signifcant increase than other combination of preservatives treated brines. This may be due to the delayed production of acids. Pilot and control experiments exhibited the highest levels of pH than preservatives treated brines. This is probably deduced to the greatest counts of yeasts than other treatments.

In brines of olives treated with NaOH; sorbate + acetic + starter treated brine showed the same trend in corresponding brine of untreated olives. This was followed by sorbate +

starter and sorbate + acetic treatments which showed non-significant difference between them, but they exhibited highly significant decrease than control experiment. This highly significant decrease than control may be due to the great inhibition of yeasts by this combination of preservatives (according to Sheneman and Costilow, 1955).

C. **whey treatments:**

The data presented in Table (30) report highly significant decreases between periods in the averages of pH levels till the 60 days samples to reach the lowest pH values among different preservatives treatments. Thus, the pH levels in whey treatments decreased very quickly. Therefore,whey treatments were the most favourable process to obtain quick pickles. On the otherhand,there was highly significant increase on 90 days samples than 30, 60, 180 and 270 days samples. This is may be deduced to the high yeast densities and/or great percentage of acids absorbed by the fruits. However, during storage period there was highly significant decrease in 180 days samples than 90 days samples, while there in significant increase between 180 and 270 days samples.

pH levels in brined whey of olives treated with NaOH showed highly significant increase in the average of pH values than that of untreated. The average of pH levels in brined whey of olives untreated reported highly significant decrease than brines of pilot and control. On the other hand, there was significant decrease in brined whey of olives treated with NaOH than corresponding control. These decreases in pH values may be due to the enriched media of the whey for lactics activity.

2. Changes in total titratable acidity:

Data given in Tables (28, 29, 30, 31, 32 and 33) show reverse relationship between pH levels and percentages of total titratable acidities. Therefore,the pH levels were tightly related to the total titratable acidities. This relationship was greatly affected by buffer systems formed in the brines as a result of the presence of ions from NaCl salt, NaOH and whey, This observation is in accordance with these obtained by Jose et al.,1952 and Prescott and Dunn (1959), who found that alakli salts may neutralize the acids formed in the pickle.

A. Individual preservatives:

It was found from results given in Table (31)that the titratable acidity (mean) increased significantlly(at 1% level) with time till the end of the experiment.

In brines of olives untreated with NaOH, starter and acetic treated brines exhibited an insignificant difference in the averages of total titratable acidities. These two

Table (31): Percentage of total titratable acidity (as lactic acid) in olives brines treated with natural and synthetic individual preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	0.0	0.0	0.0	0.350	0.0	0.0	0.0	0.350	0.0	0.078
15	0.140	0.180	0.315	0.300	0.162	0.180	0.117	0.353	0.298	0.227
30	0.261	0.234	0.063	0.352	0.423	0.270	0.314	0.368	0.594	0.320
60	0.301	0.252	0.162	0.370	0.513	0.270	0.648	0.300	0.756	0.397
90	0.322	0.279	0.180	0.341	0.549	0.306	0.862	0.351	0.819	0.445
180	0.327	0.296	0.292	0.350	0.547	0.459	1.143	0.567	0.792	0.530
270	0.334	0.342	0.567	0.702	0.711	0.405	0.855	0.666	0.702	0.587
Means	0.241	0.226	0.226	0.395	0.415	0.270	0.563	0.422	0.566	0.369

	5%	1%		5%	1%
L.S.D. Interval:	0.0327	0.0434	L.S.D. Treatment:	0.037	0.0493

Table (32): Percentage of total titratable acidity (as lactic acid) in olives brines treated with combination of natural and synthetic preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	0.0	0.0	0.350	0.0	0.350	0.0	0.350	0.0	0.350	0.156
15	0.140	0.180	0.315	0.180	0.348	0.180	0.300	0.405	0.356	0.267
30	0.261	0.234	0.387	0.315	0.477	0.270	0.314	0.531	0.540	0.370
60	0.301	0.252	0.342	0.378	0.513	0.270	0.370	0.683	0.558	0.407
90	0.322	0.279	0.333	0.549	0.592	0.306	0.342	0.792	0.630	0.461
180	0.327	0.296	0.316	0.648	0.881	0.459	0.236	0.999	0.855	0.558
270	0.334	0.342	0.540	0.900	1.170	0.405	0.702	1.071	1.224	0.743
Means	0.241	0.226	0.369	0.424	0.619	0.270	0.373	0.640	0.645	0.423

	5%	1%		5%	1%
L.S.D. Interval:	0.0447	0.0595	L.S.D. Treatment:	0.051	0.0674

Table (33): Percentage of total titratable acidity in brined whey treatments of olives.

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	0.0	0.0	0.13	0.0	0.130	0.052
15	0.140	0.18	0.341	0.180	0.342	0.237
30	0.261	0.234	0.891	0.270	0.918	0.515
60	0.301	0.252	1.530	0.270	1.278	0.726
90	0.322	0.279	1.476	0.306	1.422	0.761
180	0.327	0.296	1.359	0.459	1.386	0.765
270	0.334	0.342	1.584	0.405	1.350	0.803
Means	0.241	0.226	1.044	0.270	0.975	0.551

	5%	1%		5%	1%
L.S.D. Interval:	0.076	0.103	L.S.D. Treatment:	0.0646	0.087

treatments showed the highest averages of total acidity, since they exhibited highly significant increase than other treatments including pilot experiment and control. This may be due to the lactics activity in starter treated brine, and relative inhibition of yeasts in acetic acid treated brine. On the otherhand, sorbate, control and pilot brines showed the lowest yield of acids respectively which did'nt exhibited any significant difference between them.

Control brine showed the lowest percentage of total acidity than preservatives treated brines. In brines of olives treated with NaOH, starter and sorbate treated brines which did'nt show any significant difference between them, yield the highest percentage of total acidities than other brines including control. These two treatments exhibited highly significant increase than acetic and control brines. Thus brines treated with individual preservatives improved the production of acids especially of NaOH treated olives.

B. Combination of preservatives:

The data represented in Table (32) indicate that total acidities in combination of preservatives treated brines were lower than that of individual preservatives regardless the percentage of acids applied at the moment of pickling. This is probably due to the relative inhibition of lactics by these combinations. This in accordance with Restaino *et al*. (1982).

There was highly significant increase between averages of 15, 30, 180 and 270 days samples and each previous period. 60 days samples showed insignificant increase than previous period, but significant higher leel in 90 days samples than previous period at 5% level.

Brines treated with combination of preservatives of olives untreated with NaOH reported highly significant increase in total acidity than pilot and control brines. This indicated the relative improve in acid production caused by synergistic action of these combinations. Sorbate + acetic + starter treated brine exhibited the highest acids production than all treatments including pilot and control, since it showed highly significant increase than these treatments. This may be due to the intilal acidity of acetic and relatively high lactics in the presence of low densities of yeasts. This was followed by sorbate + starter treated brine which showed highly signififcant icrease than control and pilot brines, while it was significantly increased than sorbate + acetic brine. Sorbate + acetic treatment showed the lowest percentage of total acidity among combination of preservatives treated brines.

In brines of olives treated with NaOH, sorbate + acetic + starter and sorbate + starter treated brines which exhibited insignificant difference between them, showed highly significant increase than sorbate + acetic treated brine.

However, all preservatives treated brines exhibited significant increase than contorl, indicating their improving effect on yielding acids.

C. **Whey treatments:**

Data given in Table (33) show that there were highly significant increases in acidities averages between 15, 30 and 60 days samples. Moreover their values were higher than corresponding mean values of preservative brines. This indicated the suitablity of brined whey treatments for quick pickling, but these brines were not favourable for the storage of pickles.. However there were non-significant increase between each average of 90, 180 and 270 acidity samples and average of previous period samples. This may be deduced to the activity of yeasts. Acidities of brined whey treatments were higher than pilot experiment and controls, since they showed highly significant increases than these experiments. This is probably due to the enriched by the whey which enhanced lactics fermentation (Table 6). Also, whey treatments exhibited the highest percentage of acids yield than all preservatives treated brines, which were double the amounts obtained from brines treated with preservatives. Brined whey of olives untreated with NaOH showed significant increase than that of treated olives. This may be due to the higher yeasts densities in whey of olives treated with NaOH than untreated.

3. Changes in the percentage of lactic acid:

Lactic acid gives the desirable taste of pickles. Therefore, it is preferred to be the produced acid in pickling.

A. Individual preservatives:

Data recorded in Table (34) report that the average of percentages of lactic acid significantly increased as the pickling proceeds except in the 60 days samples. Mean values on 60 days samples showed insignificant decrease than that on 30 days samples. However the amount of acids yielding during storage period was nearly three times the amount yielded during fermentation period. This is probably due to the predominance of homofermentative lactics (**L. plantarum**) during storage period (Table 25). This is in agreement with the findings of Frazier (1967).

In brines of olives untreated with NaOH, starter treated brine exhibited the highest mean value of lactic acid percentage, since it showed highly significant increase than all treatments of olives untreated with alkali including pilot experiment and control. This may be deduced to the high densities of lactics and due to the high percentage of homofermentative (**L. plantarum**) in the starter (Table 25). This in line with the results obtained by Etchells et al. (1966). On the otherhand. acetic acid treated brine exhibited the lowest lactic percentage among preservatives treated brines of olives untreated with alkali.

Table (34): Percentage of lactic acid in olives brines treated with natural and synthetic individual preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.068	0.0912	0.261	0.010	0.055	0.097	0.044	0.043	0.179	0.0942
30	0.131	0.180	0.0315	0.135	0.090	0.162	0.098	0.063	0.333	0.136
60	0.120	0.144	0.081	0.054	0.198	0.090	0.216	0.081	0.234	0.135
90	0.1073	0.117	0.090	0.090	0.288	0.225	0.162	0.090	0.207	0.153
180	0.109	0.108	0.126	0.135	0.504	0.324	0.279	0.270	0.675	0.281
270	0.253	0.279	0.459	0.441	0.378	0.400	0.477	0.602	0.549	0.426
Means	0.113	0.131	0.150	0.124	0.216	0.185	0.182	0.164	0.311	0.175

	5%	1%		5%	1%
L.S.D. Interval:	0.0067	0.0089	L.S.D. Treatment:	0.00775	0.010

Table (35): Percentage of lactic acid in olives brines treated with combinition of natural and synthetic preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.068	0.0912	0.015	0.060	0.067	0.097	0.010	0.311	0.060	0.087
30	0.131	0.180	0.045	0.180	0.108	0.162	0.045	0.405	0.117	0.153
60	0.120	0.144	0.099	0.144	0.126	0.090	0.234	0.207	0.072	0.137
90	0.1073	0.117	0.162	0.180	0.108	0.225	0.144	0.135	0.189	0.152
180	0.109	0.108	0.207	0.189	0.315	0.324	0.099	0.405	0.504	0.251
270	0.253	0.279	0.500	0.369	0.3375	0.400	0.441	0.556	0.558	0.411
Means	0.113	0.131	0.147	0.160	0.152	0.185	0.139	0.289	0.214	0.170

	5%	1%		5%	1%
L.S.D. Interval:	0.00667	0.0089	L.S.D. Treatment:	0.00754	0.010

Table (36): Percentage of lactic acid in brined whey treatments of olives.

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	0.0	0.0	0.130	0.0	0.130	0.052
15	0.068	0.0912	0.183	0.097	0.301	0.148
30	0.131	0.18	0.254	0.162	0.603	0.266
60	0.120	0.144	0.369	0.090	0.495	0.244
90	0.1073	0.117	0.252	0.225	0.207	0.182
180	0.109	0.108	0.324	0.324	1.386	0.450
270	0.253	0.279	1.278	0.400	0.666	0.575
Means	0.113	0.131	0.399	0.185	0.541	0.274

	5%	1%		5%	1%
L.S.D. Interval:	0.0091	0.0123	L.S.D. Treatment:	0.0077	0.0104

This treatment showed highly significant decrease than other preservatives treated brines. This may be due to the mild densities of lactics it showed and relatively high counts of yeasts. Also, this treatment exhibited low percentage of **L. plantarum.** Sorbate treated brine showed moderate concentration of lactic acid. This may be due to the low lactics counts it contained. Pilot experiment exhibited highly significant decrease than all brines of olives untreated with NaOH. Also, control experiment showed highly significant decrease than other brines except it exhibited insignificant decrease than acetic treatment. This is probably due to the high yeasts densities in this brine (Table 7).

In brines of olives treated with NaOH the same trend showed in brines of untreated except control exhibited highly signficant increase than acetic treated brine and non-significant than sorbate treatment. However, brines of olives treated with NaOH exhibited higher lactic acid concentration than that of untreated. This may be due to the greater diffusion of the nutrients from olives treated with NaOH than that untreated which encourage the growth of lactics (Tables 43 and 52).

B. Combination of preservatives:

Data given in table (35) report highly significant higher values in 15 and 30 days samples in the concentration of lactic acid than the previous period of each, while 60 days samples showed highly significant decrease than 30 days samples. Thereafter, there were highly significant increases between the periods till the end of experimental time to reach nearly the same concentration of individual preservatives.

In brines treated with combination of preservatives of olives untreated with NaOH, there were highly significant increases in lactic acid than that of pilot experiment and control. This may be due to the high counts of yeasts found in pilot and control brines. The highest percentage of lactic was in sorbate + starter treated brine, since it exhibited highly significant increase than sorbate + acetic and sorbate + acetic + starter treated brines. This may be deduced to the high lactics densities in sorbate + starter treated brine. The last two preservatives treated brines exhibited insignificant difference between them. However, the production of lactic in brines treated with combinated preservatives of olives untreated with NaOH was lower than that treated with individual preservatives of the same olives. This is probably due to the great inhibition of lactics in brines treated with combination of preservatives than that of individual ones. These results had been assured by Bell <u>et al</u>. (1959) who reported that lactic acid bacteria were inhibited at 0.1% sorbate and pH 3.5.

Brines of olives treated with NaOH exhibited higher production of lactic acid than that of olives untreated. This may be due to the great diffusion of fermentable sugars and true-proteins (Tables 44 and 53), which enhanced lactic acid fermentation. Sorbate + starter treated brine showed the highest laçtic percentage than other preservatives treated brines, since it exhibited highly significant increase than other treatments including control. This is possibly due to the high lactics densities and the low yeasts counts in sorbate + starter teated brine (Tables 5 and 8). This was followed by sorbate + acetic + starter treated brine, which showed highly significant increase in lactic than control brine and sorbate + acetic treated brine. Although this treatment showed the highest lactics densities, it exhibited also the highest yeasts counts (Tables 5 and 8). Therefore, sorbate + acetic + starter rendered moderate concentration of lactic. Sorbate + acetic treated brine showed the lowest concentration of lactic than other treatments including control. This is probably due to the great degradation of lactics.

C. **Whey treatments:**

Data given in Table (36) show highly significant higher levels in lactic acid concentration in 15 and 30 days samples. 60 and 90 days samples exhibited highly significant decreases. This may be due to the high yeasts counts and low lactics densities. Thereafter, 180 and 270 days samples exhibited highly significant increases. However, whey treatments reached higher concentrations of lactic than other treatments including pilot and controls. This is probably due to the enriched media which enhanced lactics activity.

4. Changes in total volatile acids:

Among acids produced during pickling are the volatile acids which represented lower concentration than lactic acid. These acids like acetic acid play a mainor role in the taste of pickles.

A. Individual preservatives:

The data presented in Table (37) show that there were highly significant increases in volatile acids between mean values of 0, 15, 30 and 60 days samples. Average of 90 days samples exhibited insignificant increase than average of 60 days samples. Thereafter there was insignificant decrease in the average of 180 days samples than the average of 90 days samples, but 270 days average showed highly significant decrease than 180 days samples. The increase in volatile acids may be due to the activity of heterofermentative lactics, while the decrease is probably due to the absorbtion of acetic by olive fruits.

In brines of olives untreated with NaOH, acetic acid treated brine exhibited the highest volatile acids percentage, Table(37): Percentage of total volatile acids (as acetic acid) in olives brines treated with natural and synthetic individual preservatives.

Treat-ments /Days	Without NaOH					With NaOH				
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	Means
0	0.0	0.0	0.0	0.233	0.0	0.0	0.0	0.233	0.0	0.052
15	0.048	0.059	0.036	0.193	0.071	0.055	0.0487	0.206	0.080	0.089
30	0.087	0.036	0.021	0.145	0.222	0.072	0.144	0.203	0.174	0.123
60	0.121	0.072	0.054	0.212	0.210	0.120	0.293	0.146	0.348	0.175
90	0.143	0.108	0.060	0.169	0.174	0.030	0.468	0.175	0.348	0.186
180	0.145	0.126	0.114	0.143	0.030	0.090	0.577	0.297	0.090	0.179
270	0.054	0.042	0.072	0.174	0.220	0.108	0.253	0.144	0.102	0.130
Means	0.085	0.063	0.051	0.181	0.132	0.068	0.255	0.201	0.163	0.133

L.S.D. Interval: 5% 0.0149, 1% 0.0198 — L.S.D. Treatment: 5% 0.0169, 1% 0.022

Table (38): Percentage of total volatile acids (as acetic acid) in olives brines treated with combination of natural and synthetic preservatives.

Treat-ments /Days	Without NaOH					With NaOH				
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Means
0	0.0	0.0	0.233	0.0	0.233	0.0	0.233	0.0	0.233	0.104
15	0.048	0.059	0.200	0.080	0.187	0.055	0.193	0.063	0.197	0.120
30	0.087	0.036	0.228	0.090	0.246	0.072	0.180	0.084	0.283	0.145
60	0.121	0.072	0.162	0.156	0.258	0.120	0.091	0.318	0.324	0.180
90	0.143	0.108	0.114	0.246	0.324	0.030	0.132	0.438	0.294	0.203
180	0.145	0.126	0.074	0.306	0.324	0.090	0.090	0.528	0.234	0.213
270	0.054	0.042	0.120	0.354	0.600	0.108	0.174	0.342	0.444	0.249
Means	0.085	0.063	0.162	0.176	0.310	0.068	0.156	0.253	0.287	0.173

L.S.D. Interval: 5% 0.0048, 1% 0.0064 — L.S.D. Treatment: 5% 0.0053, 1% 0.0072

Table (39): Percentage of total volatile acids (as acetic acid) in brined whey treatments of olives.

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.048	0.059	0.106	0.055	0.027	0.059
30	0.087	0.036	0.426	0.072	0.210	0.166
60	0.121	0.072	0.775	0.120	0.522	0.322
90	0.143	0.108	0.816	0.030	0.810	0.381
180	0.145	0.126	0.690	0.090	0.001	0.210
270	0.054	0.042	0.204	0.108	0.456	0.173
Means	0.085	0.063	0.431	0.068	0.289	0.187

L.S.D. Interval: 5% 0.021, 1% 0.028 — L.S.D. Treatment: 5% 0.0173, 1% 0.0232 since it showed highly significant higher value than other treatments including pilot and control experiments. This was expected due to the acetic acid applied and due to the high number of heteröfermentative **L. brevis** isolates (Table 25). This was followed by starter treated brine which exhibited highly significant increase than sorbate, pilot and control brines. The lowest concentration of volatile acids were in control and sorbate treatments, which showed insignificant difference between them. Sorbate treated brine and control showed highly significant decrease than other treatments.

Brines treated with preservatives of olives treated with NaOH showed highly significant higher values than control. This may be deduced to the great inhibition of yeasts exhibited by these preservatives (Table 7). Sorbate treated brine showed the highest percentage of volatile acids, which rendered highly significant increase than other treatments including control. This may be due to the great inhibition of yeasts (Table 7). This was followed by brine treated with acetic acid, which showed highly significant higher value than starter and control brines. Starter showed the lowest percentage of volatile acids among preservatives treated brines.

B. **Combination of preservatives:**

Data given in Table (38) show highly significant higher values between each period and previous one till the end of experimental time.

In brines of olives untreated with NaOH, sorbate + acetic + starter treated brine showed the highest percentage of volatile acids. This may be due to the acetic acid applied and to the high lactics densities (Table 5). Sorbate + starter treated brine showed moderate concentration of volatile acids. The lowest percentage was shown in sorbate + acetic treated brine among preservatives brines. This is probably due to the lowest densities of lactics it showed. Control and pilot experiments exhibited lower concentrations of volatile acids than preservatives treated brines. However, there were highly significant differences between all treatments. Also, the same trend was shown in brines of olives treated with NaOH.

C. **Whey treatments:**

Data tabulated in Table (39) show that highly significant increases in volatile acids between 15, 30, 60 and 90 days means, each than the above mean. On the otherhand, 180 and 270 days means exhibited highly significant decrease. Mean values of volatile acids in whey treatments of olives untreated with NaOH showed highly significant higher level than that of olives treated with NaOH. Whey treatments were highly significant higher than pilot and control experiments. Also, they were higher than all treatments. This is probably due to the high counts of heterofermentative lactics they contained (Table 27).

5. Changes in soluble acids in the fruits:

Sugars diffused from the olive fruits are fermented to acids which are again absorbed by these fruits. These acids give the fruits the desirable taste. Therefore,the percentage of total acidity in the brine and soluble acids in the fruits showed positive correlation (r) (Table 30-A).

A. Individual preservatives:

Data recorded in Table (40) show that there was highly signifcant decrease in soluble acids of the fruits on 15 days samples than zero time samples. There were highly significant higher values in the mean values of 30, 60, 90, 180 and 270 days samples each than the previous samples. This may be due to the increase in the brines total acidities which are absorbed by the olives (Table 31).

Olives untreated with NaOH of starter treated brine showed the highest soluble acids percentage than other treatments including pilot and control fruits. This was followed by olives of acetic acid treated brine which showed highly significant increase than fruits of sorbate, pilot and control brines. Fruits of brine treated with sorbate exhibited the lowest mean of soluble acids, which showed highly significant decrease than other treatments including pilot and control. Pilot furits showed highly significant higher level than that of control. These results were closely similar to total acidities in the brines (Table 31), since there were highly

Table (40): Percentage of soluble acids (as lactic acid) in olives of brines treated with natural and synthetic individual preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	0.276	0.276	0.276	0.276	0.276	0.233	0.233	0.233	0.233	0.257
15	0.205	0.200	0.211	0.207	0.296	0.223	0.206	0.234	0.297	0.231
30	0.271	0.209	0.112	0.287	0.387	0.241	0.226	0.261	0.340	0.259
60	0.297	0.214	0.147	0.246	0.457	0.270	0.437	0.243	0.671	0.331
90	0.306	0.251	0.176	0.260	0.529	0.290	0.762	0.297	0.790	0.407
180	0.304	0.291	0.241	0.307	0.532	0.430	1.001	0.490	0.783	0.487
270	0.317	0.279	0.398	0.601	0.670	0.361	0.931	0.580	0.608	0.527
Means	0.282	0.246	0.223	0.312	0.450	0.2926	0.542	0.334	0.532	0.357

	5%	1%		5%	1%
L.S.D. Interval:	0.0115	0.0154	**L.S.D. Treatment:**	0.0131	0.0174

Table(41): Percentage of soluble acids (as lactic acid) in olives of brines treated with combination of natural and synthetic preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	0.276	0.276	0.276	0.276	0.276	0.233	0.233	0.233	0.233	0.257
15	0.205	0.200	0.273	0.216	0.290	0.223	0.246	0.302	0.300	0.251
30	0.271	0.209	0.298	0.247	0.325	0.241	0.261	0.410	0.340	0.289
60	0.297	0.214	0.302	0.332	0.410	0.270	0.270	0.596	0.416	0.345
90	0.306	0.251	0.312	0.502	0.510	0.290	0.296	0.611	0.589	0.4074
180	0.304	0.291	0.304	0.608	0.730	0.430	0.266	0.869	0.617	0.491
270	0.317	0.279	0.416	0.811	1.000	0.361	0.375	1.000	1.114	0.6303
Means	0.282	0.246	0.312	0.427	0.506	0.2926	0. 278	0.574	0.516	0.382

	5%	1%		5%	1%
L.S.D. Interval:	0.0327	0.0434	**L.S.D. Treatment:**	0.03703	0.0492

Table (42): Percentage of soluble acids (as lactic acid) in olives of brined whey treatments (on the fresh base).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	0.276	0.276	0.276	0.233	0.233	0.259
15	0.205	0.200	0.311	0.223	0.284	0.245
30	0.271	0.209	0.689	0.241	0.311	0.344
60	0.297	0.214	1.326	0.270	0.801	0.582
90	0.306	0.251	1.412	0.290	1.121	0.676
180	0.304	0.291	1.337	0.430	1.398	0.752
270	0.317	0.279	1.004	0.361	1.300	0.652
Means	0.282	0.246	0.908	0.2926	0.778	0..5014

	5%	1%		5%	1%
L.S.D. Interval:	0.079	0.106	**L.S.D. Treatment:**	0.066	0.089

significant positive correlations (r) (Table 30-A) in most cases between percentages of total acidities and soluble acids in the fruits.

Olives treated with NaOH of sorbate and starter treatments, which showed insignificant difference between them, exhibited highly significant increase than that of acetic and control brines. Individual preservatives showed highly significant increase than that of control. These results were corresponding to the percentages of total acidities in the brines (Table 31).

B. Combination of preservatives:

Data given in Table (41) report that fruits of combination of preservatives treated brines showed higher average of soluble acids on all periods except 90 days samples than that found in individual preservatives treated brines. This may be deduced to the high concentration of total acidities in brines treated with combination of preservatives than that of individual preservatives during these periods.

There was insignificant decrease in 15 days samples than zero time samples, while 60, 90, 180 and 270 days samples showed highly significant increase each than the previous period. On the otherhand 30 days samples exhibited significant increase.

In brines of olives untreated with NaOH, fruits of sorbate + acetic + starter treated brine exhibited highly significant increase than other treatments including pilot and control fruits, This was followed by the olives of sorbate + starter treated brine which showed highly significant increase than that of sorbate + acetic treated brine, pilot and control experiments. Fruits of sorbate + acetic treated brine showed the lowest soluble acids percentage in olive fruits than other fruits of combination of preservatives treated brines, which showed highly significant decrease than them. Control fruits showed highly significant decrease than fruits of combined preservatives treatments, but exhibited insignificant decrease than fruits of the pilot. experiment. These results were postulated by highly significant positive correlation (r) between total aciditiy in the brine and soluble acids in the fruits (Table 30-A)This is due to the formed acids in the brine which were absorbed by the olives. Therefore, the increase in total acidity of the brine increased the soluble acids in the fruits.

Olives treated with NaOH of sorbate + starter treated brine showed highly significant increase than fruits of other treatments including control fruits. This treatment was followed by olives of sorbate + acetic + starter treated brine which exhibited highly significant increase than control and sorbate + acetic treated brine. Olives of brine treated with sorbate + acetic showed the lowest average of soluble acids which showed highly significant decrease than combined preservatives treated brines. However control exhibited insignificant increase than fruits of sorbate + acetic treated brine, but showed highly significant decrease than other combined preservatives treated brines. These results may be deduced to the aforementioned reasons showed in the brines of untreated olives.

C. Whey treatments:

The data presented in Table (42) showed insignificant decrease in 15 days samples in soluble acids than that of zero time, while there was highly significant increases on 60 days samples, and significant increase in 30 and 90 days samples. On 180 days samples there was insignificant increase than 90 days samples. Finally, there was significant decrease in 270 days samples than 180 days samples. However, this increase in soluble acids in fruits of whey treatments may be due to the great increase in total acidity in the brine in whey treatments. Whey treatments showed highly significant increase than pilot and corresponding controls fruits. This may be deduced to the high total acidity of the whey treatments than pilot and control experiments. Olives untreated with NaOH exhibited highly significant increase than that of treated olives. This is probably due to the higher acidity in whey of olives untreated with NaOH than that of treated olives. However, whey treatments rendered higher soluble acids than all treatments. This may be due to the higher total acidity in whey treatments than all treatments.

6. <u>Changes in total sugars in the fruits:</u>

Sugars in the fruits diffused to the brine to be fermented by lactic acid bacteria to lactic acid required in pickling.

A. <u>Individual preservatives:</u>

Data tabulated in Table (43) show that there was highly significant diffusion in total sugars between the periods samples till the end of experimental time. These highly significant diffusion in total sugars is probably due to the high osmotic pressure exerted from the high concentration of the salt in the brine. This in accordance with the findings of Fabian <u>et</u> <u>al</u>. (1932) and Jones (1940). On the other hand, the great release lately may be due to the softening of the fruits and to the increase in the total acidity of the brine during the last periods. The increase in total acidity resulted in killing the fruits tissues and degradation of pectin, hence the constituents easily flow to the brine. This is in line with the results observed by Abd-El-Wahed (1980).

Olives untreated with NaOH of pilot experiment showed greater diffusion of total sugars than fruits of control and preservatives treated brines, since it exhibited the lowest percentage of total sugars in the fruits. Olives of pilot experiment showed significant decrease than fruits of acetic acid treated brine. Also, fruits of pilot experiment showed highly significant decrease than that of sorbate

Table (43): Percentage of total sugars in olives of brines treated with natural and synthetic individual preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	Means
0	2.230	2.230	2.230	2.230	2.230	2.145	2.145	2.145	2.145	2.192
15	1.175	2.224	1.748	1.427	1.367	1.110	1.102	0.923	1.082	1.351
30	1.137	2.110	1.288	1.285	1.278	1.010	1.068	0.877	0.687	1.193
60	1.039	1.871	1.210	1.179	1.034	0.917	0.972	0.571	0.492	1.032
90	0.941	1.559	1.169	1.087	0.896	0.675	0.713	0.387	0.368	0.866
180	0.652	1.155	0.886	0.873	0.462	0.191	0.402	0.251	0.352	0.580
270	0.047	0.208	0.220	0.201	0.037	0.0	0.0	0.0	0.0	0.079
Means	1.032	1.622	1.250	1.183	1.043	0.864	0.915	0.736	0.732	1.042

	5%	1%		5%	1%
L.S.D. Interval:	0.117	0.156	**L.S.D. Treatment:**	0.133	0.176

Table (44): Percentage of total sugars in olives of brines treated with combination of natural and synthetic preservatives (on the feesh base).

Treat-ments /Days	Without NaOH					With NaOH				
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Means
0	2.23	2.23	2.23	2.23	2.23	2.145	2.145	2.145	2.145	2.192
15	1.175	2.224	1.927	1.208	1.650	1.110	1.146	1.082	0.774	1.366
30	1.137	2.110	1.623	1.182	1.381	1.010	1.045	0.687	0.699	1.208
60	1.039	1.871	1.255	1.063	0.826	0.917	0.946	0.492	0.678	1.010
90	0.941	1. 559	1.140	0.997	0.674	0.675	0.866	0.368	0.561	0.865
180	0.652	1.155	0.726	0.872	0.638	0.191	0.486	0.350	0.333	0.600
270	0.047	0.208	0.019	0.411	0.116	0.0	0.218	0.0	0.189	0.134
Means	1.032	1.622	1.274	1.138	1.074	0.864	0.979	0.732	0.768	1.0536

	5%	1%		5%	1%
L.S.D. Interval:	0.106	0.141	**L.S.D. Treatment:**	0.12	0.16

Table (45): Percentage of total sugars in olives of brined whey treatments (on the fresh base).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	2.230	2.230	2.230	2.145	2.145	2.196
15	1.175	2.224	1.933	1.110	1.096	1.508
30	1.137	2.110	1.566	1.010	0.902	1.345
60	1.039	1.871	1.305	0.917	0.701	1.167
90	0.941	1.559	1.243	0.675	0.619	1.007
180	0.652	1.155	1.236	0.191	0.460	0.739
270	0.047	0.208	0.440	0.0	0.402	0.219
Means	1.032	1.622	1.422	0.864	0.904	1.687

	5%	1%		5%	1%
L.S.D. Interval:	0.22	0.3	**L.S.D. Treatment:**	0.186	0.251

treated brine. This great diffusion showed by olives of the pilot experiment may be due to the great softening it showed (Table 58). High release of total sugars in fruits of starter treated brine may be due to the highest percentage of total acidity in the brine and relatively low percentage of pectin (Tables 31 and 58).This phenomenon was assured by the highly significant negative correlation (r) between total acidity and total sugars (Table30-A)and highly significant positive correlation (r) between pectin and total sugars percentages in fruits of starter treated brine (Table 30-A)These were followed by fruits of acetic acid treated brine which showed insignificant decrease than that of sorbate, but significant decrease than fruits of control brine. This low percentage of total sugars in fruits of acetic acid treated brine is mainly due to the low percentage of pectin, since this treatment showed insignificant negative correlation (r) between total sugars and total acidity (Table 30-A)but exhibited highly significant positive correlation (r) between total sugars and pectin in the fruits. The low percentage of total sugars in the fruits of sorbate treated brine may be due to the high total acidity, since there was significant negative correlation (r) between total sugars and total acidity (Table 30-A) The highest percentage of total sugars was in fruits of control experiment. This may be due to the insignificant negative correlation (r) between total sugars and total acidity and highly significant positive correlation between total sugars and pectin (Table 30-A).

Among olives treated with NaOH the lowest percentage of total sugars was in the fruits of brines treated with starter and that treated with acetic acid which showed insignificant difference between them. This may be due to the low percentage of pectin in the fruits of both and due to the highest acidity in starter treated brine. This was followed by fruits of control experiment which exhibited insignificant increase than olives of starter and acetic treated brines. The highest percentage of total surgars remained in fruits of sorbate treatment. This may be deduced to the highest percentage of pectin found in the fruits of this treatment. These results were assured by highly significant positive correlation (r) between total sugars and pectin in the fruits (Table 30-A) Also, these results were postulated by negative correlation (r) between total sugars in the fruits and total acidity in the brine, which was highly significant in fruits of control and starter treatment, and significant in fruits of sorbate treatment and insignificant in fruits of acetic acid treatment (Table 30-A).

B. Combination of preservatives:

Data given in Table (44) report that there was highly significant decrease in total sugars between each period samples and the previous samples. This may be due to the reasons mentioned with individual preservatives. However, the total sugars diffused from the fruits of combined preservatives treated brines were almost the same amount diffused from fruits of individual ones.

About olives untreated with NaOH, the lowest percentage of total sugars was in the fruits of pilot and sorlate + acetic + starter treatments which showed insignificant difference between them. Fruits of pilot and sorbate + acetic + starter treatments exhibited highly significant decrease than fruits of control and sorbate + acetic treatment. Fruits of pilot experiment showed significant decrease than fruits of sorbate + starter treatment. Fruits of sorbate + acetic + starter treatment showed insignificant difference than that of sorbate + starter.This may be deduced to the highest percentage of total acidity in sorbate + acetic + starter treated brine which was assured by significant negative correlation (r) between total sugars and total acidity (Table30-A). Total sugars in fruits of pilot and sorbate + acetic + starter treated brines was followed by fruits of sorbate + starter treatment which showed highly significant decrease than olives of control and significant decrease than sorbate + acetic treated brines. Fruits of sorbate + acetic treatment exhibited highly significant decrease than control olives. Fruits of control brine showed the highest percentage of total sugars than that of other treatments including pilot olives. This may be due to the lowest percentage of total acidity it showed. This was postulated by insignificant negtive correlation (r) between total sugars and total acidities (Table 30-A).

Olives treated with NaOH of sorbate + starter and sorbate + acetic + starter treated brines showed insignificant difference in total sugars. These two treatments exhibited the lowest percentage of total sugars. This may be deduced to the highest total acidity they showed. There was highly significant decrease in total sugars in the fruits of sorbate + acetic + starter treated brine than that of sorbate + acetic treated brine and insignificant decrease than fruits of control. Olives of sorbate + starter treatment showed highly significant decrease than fruits of sorbate + acetic treated brine. The highest percentage of total sugars was in fruits of sorbate + acetic treated brine. This is probably due to the high percentage of pectin showed in their fruits and low percentage of total acidity in its brine (Tables 59 and 32).

C. **Whey treatments:**

The data presented in Table (45) report that the total sugars remained in the fruits of brine with whey treatment were higher than that found in fruits of preservatives treated brines in most cases. This may be deduced to the sugars of the whey absorbed by the fruits. Therefore, there was non-significant decrease in 30, 60 and 90 days samples each than the previous period samples and significant decrease in 180 days samples than 90 days samples. On the other hand, there was highly significant decrease in 15 days samples than zero time samples. This may be due to the high osmotic pressure of the brined whey at the commencenent which resulted in great diffusion. 270 days samples showed highly significant decrease than the previous period samples. This is probably deduced to the pronounced decrease in pectin content of the fruits and high percentage of total acidity showed during this period (Tables 60 and 33).

Fruits treated with NaOH showed highly significant decrease in total sugars than that untreated. This may be due to the lower pectin in the fruits treated with NaOH than that untreated (Table 60).

Fruits untreated with NaOH of whey treatment reported highly significant increase than pilot fruits and significant decrease than control fruits. These results are probably deduced to the absorbtion of whey sugars by the fruits. Also, fruits treated with NaOH showed insignificant increase than control fruits for the aforementioned reason.

7. Changes in reducing sugars in the fruits:

A. Individual preservatives:

Data recorded in Table (46) show highly significant decrease in reducing sugars in the fruits between each period

Table (46): Percentage of reducing sugars in olives of brines treated with natural and synthetic individual preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	1.692	1.692	1.692	1.692	1.692	1.607	1.607	1.607	1.607	1.654
15	0.568	0.693	0.772	1.094	1.240	0.690	0.950	0.822	0.827	0.851
30	0.501	0.543	0.716	0.846	0.892	0.651	0.880	0.691	0.694	0.713
60	0.480	0.497	0.522	0.506	0.603	0.597	0.847	0.385	0.431	0.541
90	0.287	0.315	0.385	0.496	0.538	0.230	0.689	0.266	0.414	0.402
180	0.099	0.133	0.264	0.485	0.461	0.128	0.134	0.218	0.218	0.238
270	0.0	0.018	0.0	0.0	0.037	0.0	0.0	0.0	0.0	0.006
Means	0.518	0.556	0.622	0.731	0.780	0.557	0.730	0.570	0.600	0.629

	5%	1%		5%	1%
L.S.D. Interval:	0.0211	0.028	L.S.D. Treatment:	0.024	0.0318

Table (47): Percentage of reducing sugars in olives of brines treated with combination of natural and synthetic preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	1.692	1.692	1.692	1.692	1.692	1.607	1.607	1.607	1.607	1.654
15	0.568	0.693	0.933	0.623	0.881	0.690	0.692	0.654	0.746	0.720
30	0.501	0.543	0.781	0.539	0.856	0.651	0.675	0.619	0.651	0.646
60	0.480	0.497	0.357	0.456	0.826	0.597	0.662	0.483	0.528	0.542
90	0.287	0.315	0.328	0.374	0.674	0.230	0.609	0.335	0.507	0.407
180	0.099	0.133	0.238	0.273	0.638	0.128	0.486	0.254	0.328	0.286
270	0.0	0.018	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Means	0.518	0.556	0.618	0.565	0.795	0.557	0.676	0.565	0.624	0.608

	5%	1%		5%	1%
L.S.D. Interval:	0.013	0.018	L.S.D. Treatment:	0.1144	0.152

Table (48): Percentage of reducing sugars in olives of brined whey treatments (on the fresh base).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	1.692	1.692	1.692	1.607	1.607	1.658
15	0.568	0.693	0.867	0.690	0.854	0.734
30	0.501	0.543	0.748	0.651	0.852	0.659
60	0.480	0.497	0.594	0.597	0.549	0.543
90	0.287	0.315	0.497	0.230	0.543	0.374
180	0.099	0.133	0.421	0.128	0.366	0.229
270	0.0	0.018	0.0	0.0	0.0	0.004
Means	0.518	0.556	0.688	0.557	0.682	0.600

	5%	1%		5%	1%
L.S.D. Interval:	0.037	0.05	L.S.D. Treatment:	0.03	0.04

samples and previous period till the end of the experimental time. This is probably deduced to the effect of the osmotic pressure during first periods, thereafter the decrease in fruit pectin and the increase in total acidity affected the diffusion of reducing sugars. This is in accordance with the findings of Enrico (1936).

Pilot olives showed the lowest precentage of reducing sugars indicating the highest diffusion of reducing sugars among olives untreated with NaOH. This pilot fruits exhibited highly significant decrease than other olives untreated with NaOH. This is probably due to the lowest pectin percentage in pilot fruits rendered softening which facilitated the release of these sugars. This was followed by control fruits which showed highly significant decrease in reducing sugars than fruits of preservatives treatments for the abovementioned reason. Therefore,these results were postulated by the significant positive correlation (r) between reducing sugars and pectin percentages in pilot and control fruits (Table 30-A). The highest percentage of reducing sugars were in the fruits of starter treatment which showed highly significant increase than fruits of other treatments including control and pilot fruits. Fruits of starter treatment showed high percentage of pectin. In olives of starter treated brine there was highly significant positive correaltion (r) between percentage of reducing sugars and pectin (Table30-A) Also, this may be due to the absorbtion of whey sugars. This was followed by fruits of acetic treatment which showed highly significant increase than fruits of sorbate treated brine.Fruits of sorbate treated brine showed the lowest percentage of reducing sugars.

Among fruits treated with NaOH the lowest percentage of reducing sugars was the fruits of control and acetic acid treated brine which showed insignificant difference between them. Olives of control showed highly significant decrease than fruits of sorbate and starter treated brines. This may be due to the lowest percentage of pectin in the olives of control brine, which showed highly significant positive correlation (r) between reducing sugars and pectin (Table 30-A). On the other hand fruits of acetic acid treatment showed high percentage of total acidity from the first moment of pickling and low percentage of pectin. The highest percentage of reducing sugars was in olives of sorbate treatment which showed highly significant increase than fruits of other treatments including control olives. This may be deduced to the highest percentage of pectin it showed than olives of other treatments. This was followed by fruits of starter treatment. This high percentage of reducing sugars in olives of starter treatment may be as a result of whey application, which contained sugars.

C. **Whey treatments:**

Data given in Table (48) report highly significant decrease between each period and the previous period till the end of experimental period.

Fruits of whey brines showed highly significant increase in reducing sugars than fruits of pilot and corresponding controls. This may be deduced to the presence of sugars in the whey, which either consumed through the fermentation instead of olive sugars or absorbed by the fruits instead of olive sugars diffused.

8. **Changes in total crude-protein:**

Total protein is diffused from the fruits to the brine. Most of this protein is used as nitrogen source by micro-organisms especially lactic acid bacteria (according to Costilow and Fabian, 1953). Therefore, lactics fermentation greatly affected by nitrogen content.

A. **Individual preservatives:**

Data recorded in Table (49) show highly significant decrease between each period samples and the previous period till the end of experimental period. This decrease occurred under the effect of osmotic pressure in the brine at the commencement and with the aid of the softening of the fruits lately.Also, total acidity of the brine may affect this diffusion.

Table (49): Percentage of total crude-protein in olives of brines treated with natural and synthetic individual preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	Means
0	1.800	1.800	1.800	1.800	1.800	1.720	1.720	1.720	1.,720	1.764
15	1.301	1.567	1.775	1.720	1.710	1.601	1.689	1.650	1.660	1.630
30	0.994	1.496	1.560	1.435	1.421	1.574	1.419	1.400	1.420	1.413
60	0.862	1.307	1.364	1.312	1.296	1.321	1.311	1.287	1.310	1.263
90	0.697	1.201	1.290	1.260	1.245	1.110	1.235	1.200	1.230	1.163
180	0.600	1.110	1.203	1.204	1.190	1.087	1.184	1.168	1.181	1.103
270	0.480	0.806	1.111	1.006	0.997	0.798	0.997	0.983	1.000	0.909
Means	0.962	1.327	1.443	1.391	1.380	1.316	1.365	1.344	1.360	1.321

L.S.D. Interval: 5% 0.024, 1% 0.032 L.S.D. Treatment: 5% 0.0273, 1% 0.0363

Table (50): Percentage of total crude-protein in olives of brines treated with combination of natural and synthetic preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Means
0	1.800	1.800	1.800	1.800	1.800	1.720	1.720	1.720	1.720	1.764
15	1.301	1.567	1.751	1.718	1.700	1.601	1.628	1.660	1.609	1.615
30	0.994	1.496	1.679	1.496	1.409	1.574	1.601	1.420	1.389	1.450
60	0.862	1.307	1.508	1.335	1.302	1.321	1.397	1.310	1.313	1.295
90	0.697	1.201	1.378	1.290	1.235	1.110	1.260	1.230	1.200	1.178
180	0.600	1.110	1.250	1.230	1.180	1.087	1.170	1.181	1.104	1.101
270	0.480	0.806	1.044	1.100	1.000	0.798	1.000	1.000	0.910	0.904
Means	0.962	1.327	1.487	1.424	1.375	1.316	1.400	1.360	1.321	1.330

L.S.D. Interval: 5% 0.032, 1% 0.043 L.S.D. Treatment: 5% 0.036, 1% 0.048

Table (51): Percentage of total crude-protein in olives of brined whey treatments (on the fresh base).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	1.800	1.800	1.800	1.720	1.720	1.768
15	1.301	1.567	1.703	1.601	1.600	1.5544
30	0.994	1.496	1.408	1.574	1.330	1.3604
60	0.862	1.307	1.346	1.321	1.251	1.2174
90	0.697	1.201	1.330	1.110	1.190	1.106
180	0.600	1.110	1.321	1.087	1.180	1.060
270	0.480	0.806	1.200	0.798	1.100	0.877
Means	0.962	1.327	1.444	1.316	1.339	1.278

L.S.D. Interval: 5% 0.050, 1% 0.065 L.S.D. Treatment: 5% 0.041, 1% 0.055

Pilot olives showed the lowest percentage of total crude-protein than other fruits untreated with NaOH. Total protein of pilot olives exhibited highly significant decrease than other treatments including control fruits. This is probably due to the lowest percentage of pectin it showed. This was followed by control proteins which exhibited highly significant decrease than that of fruits in preservatives treated brines. This may be due to the low percentage of pectin in control fruits. However, the lowest percentage of total crude-protein among olives untreated with NaOH of preservatives brines was in fruits of starter and acetic treated brines, which showed insignificant difference between them. This is probably deduced to the lower percentage of pectin and higher percentage of total acidity than olives of sorbate treated brine. Fruits of sorbate treated brine showed the highest percentage of crude-protein. It could be concluded that the preservatives treatments encouraged the release of the suitable amounts of the nutrients, which covered requirement for the growth of low counts. Hence, they kept the nutrative value of the fruits.

Olives treated with NaOH of control experiment showed highly significant decrease than fruits of sorbate and starter treated brines, but showed significant decrease than olives of acetic acid treated brine. This may be due to the lowest percentage of pectin in control fruits than that of individual preservatives. Among olives of brines treated with individual preservatives, fruits of acetic treated brine showed the lowest percentage of crude-protein. This treatment exhibited insignificant difference than olives of the other two treatments. These results are in agreement with the findings of Abd-El-Wahed (1980).

B. Combination of preservatives:

Data given in Table (50) show that the concentration of crude-protein in fruits of combination of preservatives was quite similar to those of individual ones. There were highly significant decreases between the periods samples till the end of experimental time.

Olives untreated with NaOH of combination of preservatives treated brines showed highly significant increase than that of pilot and control experiments. This mainly may be due to the higher percentage of pectin in fruits of treated brines with preservatives than pilot and control. Olives of sorbate + acetic treated brine showed the highest percentage of crude-protein than fruits of other preservatives treated brines. This is probably deduced to the high percentage of pectin in the fruits and may be due to the lower percentage of total acidity it showed in the brine. The lowest percentage of crude-protein among fruits of preservatives brines was in olives of sorbate + acetic + starter treated brine. This may be deduced to the highest total acidity it showed than other treatments.

Olives treated with NaOH of control experiment showed lower percentage of crude-protein than that of brines treated with combination of preservatives. Fruits of control exhibited insignificant difference from that of sorbate + acetic + starter treated brine, while showed highly significant decrease than that of sorbate + acetic treated brine and significant decrease than fruits of sorbate + starter treated brine. This may be due to the low percentage of pectin in control fruits than other fruits. Olives of sorbate + acetic showed highly significant increase than that of sorbate + acetic + starter treated brine and significant increase than that of sorbate + starter treated brine. This may be due to the lowest mean value of total acidity showed in this treatment. On the other hand ,the lowest percentage of crude-protein was in the fruits of sorbate + acetic + starter treated brine. This is probably due to the highest percentage of total acidity it exhibited.

C. **Whey treatments**:

Data recorded in Table (51) show that there were highly significant decreases between periods samples till the end of the experimental period,except 180 days samples which exhibited insignificant decrease.

Fruits untreated with NaOH of brined whey showed highly significant increase than that of pilot and control. This is probably deduced to the absorbtion of whey proteins by more softening olives which showed low pectin.

Fruits treated with NaOH showed insignificant increase than control olives.

9. **Changes in true-protein:**

True-protein is the protein which is consumed in the growth of lactic acid bacteria. This protein is regarded as the sole nitrogen source for these microorganisms. Hence, it plays an important role in their activation.

A. **Individual preservatives:**

The data presented in Table (52) show highly significant decreases between the mean values of periods samples of true-protein till the end of experimental time. This is possibly due to the effect of osmotic pressure of the salt on the diffusion of true-protein during early periods which showed high percentage of NaCl in the brine. These results are similar to those obtained by Jones (1940). Thereafter the decrease of pectin in the fruits (softening) and the increase in brines acidity caused the increase of the diffusion of true-protein as well as other constitutents.

Table (52): Percentage of true-protein in olives of brines treated with natural and synthetic individual preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	1.384	1.384	1.384	1.384	1.384	1.322	1.322	1.322	1.322	1.356
15	1.001	1.204	1.364	1.324	1.314	1.229	1.295	1.266	1.276	1.253
30	0.765	1.151	1.198	1.105	1.0912	1.209	1.090	1.076	1.090	1.086
60	0.662	1.005	1.051	1.008	0.998	1.013	1.007	0.987	1.008	0.971
90	0.536	0.925	0.991	0.968	0.958	0.854	0.947	0.920	0.943	0.894
180	0.462	0.851	0.926	0.924	0.915	0.834	0.910	0.897	0.907	0.847
270	0.3693	0.619	0.852	0.772	0.765	0.611	0.764	0.754	0.769	0.698
Means	0.740	1.020	1.110	1.069	1.061	1.010	1.048	1.032	1.045	1.015

	5%	1%		5%	1%
L.S.D. Interval:	0.0267	0.036	**L.S.D. Treatment:**	0.030	0.040

Table (53): Percentage of true-protein in olives of brines treated with combination of natural and synthetic preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	1.384	1.384	1.384	1.384	1.384	1.322	1.322	1.322	1.322	1.356
15	1.001	1.204	1.347	1.321	1.308	1.229	1.249	1.276	1.236	1.241
30	0.765	1.151	1.291	1.111	1.085	1.209	1.229	1.090	1.066	1.111
60	0.662	1.005	1.161	1.021	1.001	1.013	1.073	1.007	1.010	0.995
90	0.536	0.925	1.017	0.991	0.948	0.854	0.967	0.943	0.920	0.900
180	0.462	0.851	0.973	0.945	0.908	0.834	0.897	0.907	0.847	0.847
270	0.3693	0.619	0.801	0.845	0.802	0.611	0.765	0.769	0.698	0.698
Means	0.740	1.020	1.139	1.088	1.062	1.010	1.072	1.045	1.014	1.021

	5%	1%		5%	1%
L.S.D. Interval:	0.025	0.0332	**L.S.D. Treatment:**	0.0283	0.0380

Table (54): Percentage of true-protein in olives of brined whey treatments (on the fresh base).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	1.384	1.384	1.384	1.322	1.322	1.360
15	1.001	1.204	1.311	1.229	1.221	1.193
30	0.765	1.151	1.081	1.209	1.020	1.045
60	0.662	1.005	1.035	1.013	0.960	0.935
90	0.536	0.925	1.021	0.854	0.913	0.850
180	0.462	0.851	1.015	0.834	0.907	0.814
270	0.3693	0.619	0.922	0.611	0.844	0.673
Means	0.740	1.020	1.110	1.010	1.027	0.981

	5%	1%		5%	1%
L.S.D. Interval:	0.075	0.101	**L.S.D. Treatment:**	0.064	0.086

Olives untreated with NaOH of individual preservatives treated brines exhibited highly significant increase in true-protein than that of pilot and control. This may be deduced to the higher pectin content in fruits of preservatives treated brines than that of pilot and control. Olives of starter and acetic treated brines which showed non-significant difference between them, exhibited the lowest percentage of true-protein. These fruits showed highly significant decrease than olives of sorbate treated brine. This is possibly due to the low percentage of pectin in the fruits and to the brines acidity.

Olives treated with NaOH of preservatives treated brines showed also higher percentages of true-protein than that of control. Control fruits showed significant decrease than olives of sorbate and starter treated brines, but non-significant difference than that of acetic treatment. This may be due to the high pectin content in fruits of individual preservatives treated brines. However, olives of individual preservatives treated brines showed insignificant differences between them. These results are in agreement with the findings of Abd-El-Wahed (1980).

B. **Combination of preservatives:**

Data given in Table (53) show highly significant decreases between periods samples in true-protein of the fruits till the end of experimental period.

Olives untreated with NaOH of brines treated with combination of preservatives exhibited higher percentages of true-protein than that of pilot experiment and control. This is probably due to the higher percentage of pectin in fruits of preservatives treated brines than that of pilot and control. The lowest percentage of true-protein among olives of preservatives brines was in fruits of sorbate + acetic + starter treated brine. This treatment showed highly significant decrease than fruits of sorbate + acetic treated brine and non-significant decrease than that of sorbate + starter treated brine. This may be deduced to the highest percentage of total acidity than the other two treatments.

Olives treated with NaOH of combined preservatives treated brines showed higher percentage of true-protein than that of control. This is probably due to the higher percentage of pectin in fruits of preservatives treated brines than that of control. The lowest percentage of true-protein was in olives of sorbate + acetic + starter treated brine, which showed highly significant decrease than fruits in sorbate + acetic treated brine and significant decrease than that of sorbate + starter treated brine. This may be due to the high percentage of total acidity it showed. Also, this may be explained by the presence of proteolytic enzymes of some lactics. These enzymes may destroy fruit proteins aiding in their diffusion to the brine of this treatment. This is in accordance with the results of Ziyada (1981).

C. **Whey treatments:**

Data tabulated in Table (54) show highly significant decreases between 15, 30 and 270 days samples than the previous periods samples. This great diffusion of true-protein may be due to the high osmotic pressure during early periods, while it may be due to the low pectin (Table 60) during 270 days samples. 90 days samples showed significant decrease than previous period samples but, 180 days period samples exhibited non-significant difference than 90 days samples.

Olives untreated with NaOH of brined whey showed highly significant increase than that of pilot experiment and significant increase than fruits of control. This may be due to the absorbtion of the amino acids of the whey be softened fruits. Treated olives with NaOH of brined whey showed also non-significant increase in true-protein of the fruits than control fruits.

10. **Changes in ether extract in the fruits:**

The most of nutrative value of the pickled olives is due to the fat content. This constituent is liable to spoliage by lipolytic microorganisms.

A. **Individual preservatives:**

Data given in Table (55) report insignificant decrease between 0 and 15 days samples. There was significant decrease

Table (55): Percentage of ether extract in olives of brines treated with natural and synthetic individual preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	4.9	4.9	4.9	4.9	4.9	4.721	4.721	4.721	4.721	4.820
15	4.604	4.812	4.9	4.811	4.846	4.704	4.713	4.700	4.694	4.754
30	4.234	4.660	4.816	4.753	4.753	4.631	4.684	4.610	4.602	4.638
60	4.062	4.567	4.773	4.692	4.606	4.209	4.508	4.584	4.410	4.4901
90	3.881	4.312	4.625	4.600	4.483	3.577	4.467	4.550	4.224	4.3021
180	3.840	4.018	4.512	4.032	4.307	3.283	4.322	3.964	4.116	4.044
270	3.185	3.234	4.240	4.003	4.092	3.107	4.194	3.506	3.415	3.664
Means	4.101	4.358	4.681	4.542	4.570	4.033	4.516	4.376	4.312	4.388

	5%	1%		5%	1%
L.S.D. Interval:	0.100	0.134	**L.S.D. Treatment:**	0.114	0.152

Table (56): Percentage of ether extract in olives of brines treated with combination of natural and synthetic preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	4.9	4.9	4.9	4.9	4.9	4.721	4.721	4.721	4.721	4.820
15	4.604	4.812	4.851	4.846	4.890	4.704	4.710	4.720	4.701	4.760
30	4.234	4.660	4.827	4.802	4.880	4.631	4.690	4.552	4.677	4.661
60	4.062	4.567	4.782	4.680	4.874	4.209	4.655	4.273	4.616	4.524
90	3.881	4.312	4.704	4.557	4.596	3.577	4.582	4.180	4.577	4.330
180	3.840	4.018	4.214	4.508	4.553	3.283	4.219	3.941	4.169	4.083
270	3.185	3.234	4.067	4.273	4.439	3.107	3.861	3.528	3.724	3.713
Means	4.101	4.358	4.621	4.652	4.733	4.033	4.491	4.274	4.455	4.413

	5%	1%		5%	1%
L.S.D. Interval:	0.057	0.076	**L.S.D. Treatment:**	0.065	0.086

Table (57) : Percentage of ether extract in olives of brined whey treatments (on the fresh base).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	4.9	4.9	4.9	4.721	4.721	4.828
15	4.606	4.812	4.640	4.704	4.110	4.574
30	4.234	4.660	4.498	4.631	4.087	4.422
60	4.062	4.567	4.361	4.209	3.968	4.233
90	3.881	4.312	4.008	3.577	3.634	3.882
180	3.840	4.018	3.948	3.283	3.376	3.693
270	3.185	3.234	3.421	3.107	2.289	3.047
Means	4.101	4.358	4.254	4.033	3.741	4.097

	5%	1%		5%	1%
L.S.D. Interval:	0.075	0.101	**L.S.D. Treatment:**	0.063	0.085

between 15 and 30 days samples. Thereafter, there were highly significant decreases between periods samples of ether extract till the end of experimental period. This may be due to the release of fat affected by high osmotic pressure of the brine which was enhanced by softening of the fruits and activity of lipolytic microorganisms.

Olives untreated with NaOH of individual preservatives treated brines showed highly significant increases in ether extract than that of pilot and control. This may be deduced to the higher percentage of pectin in olives of brines treated with preservatives (Table 58) than pilot and control fruits. Also, these preservatives treated brines exhibited high percentage of NaCl (Table 76) which exert higher osmotic pressure than pilot and control brines. In addition lipolytic microorganisms densities were higher in pilot and control experiments than fruits of preservatives treated brines. However, olives of individual preservatives treated brines showed non-significant difference between them, except significant difference between fruits of sorbate and acetic treated brine.

Ether extract in olives treated with NaOH was lower than that of untreated. This is probably deduced to saponification occurred during NaOH treatment. Concerning the difference between the treatments the same trend showed in the olives treated with NaOH was observed in untreated olives.

It could be concluded that the use of preservatives enhanced the nutrative value of pickled olives, since the use of these preservatives reflected high fat content in the fruits. These results are in accordance with the findings of Abd-El-Wahed (1980) and Hassan (1981).

B. Combination of preservatives:

Data tabulated in Table (56) show non-significant decrease on 15 days samples, while there were highly significant decreases between other periods samples till the end of the experimental time for the reasons showed in individual preservatives.

Olives untreated with NaOH in brines treated with combination of preservatives exhibited highly significant higher values than that of pilot and control. This may be deduced to the same reason showed with individual preservatives in this respect. Percentages of fat in the fruits of brines treated with combination of preservatives were higher than that of individual ones. Olives untreated with NaOH of sorbate + acetic + starter treated brine exhibited the highest percentage of ether extract, since it showed significant increase than sorbate + starter and highly significantincrease than sorbate + acetic fruits. This may be due to the high percentage of pectin it showed. Olives of sorbate + acetic treated brine exhibited the lowest ether extract content, since they showed non-significant difference than that of sorbate + starter treated brine and showed highly sinificant decreasing than that of sorbate + acetic + starter treated brine. Sorbate + starter exhibited moderate ether extract content.

Olives treated with NaOH in combination of preservatives treated brines showed highly significant increase in ether extract than control. Olives of sorbate + acetic treated brine exhibited the highest percentage of ether extract than that of other combination of preservatives, since they showed highly significant increase than that of sorbate + starter treated brine and non-significant increase than that of sorbate + acetic + starter. The lowest percentage of ether extract was in fruits of sorbate + starter treated brine, since it showed highly significant decrease than that of sorbate + acetic treatment and sorbate + acetic + starter treated brine.

C. **Whey treatments:**

Data in Table (57) show highly significant decreases between the periods till the end of experimental time; which can be expected for the aforementioned reasons.

Olives untreated with NaOH showed highly significant decrease than that of control. This may be due to the lower percentage of pectin and higher lipolytic microorganisms densities exhibited than control fruits (Table 12). The same trend was observed in fruits treated with NaOH.

11. **Changes in pectin in the fruits:**

The firmness of the fruits is highly correlated with the presence of pectic substances. These substances are greatly affected by the acidity in the brine, soluble acids in the olives and pectinolytic microorganisms. Conversion of protopectin to soluble pectin occurrs by acids, hence causes degradation of pectin according to Lampi et al., (1958) and Abd-El-Wahed, (1980).

A. **Individual preservatives:**

Data given in Table (58) report highly significant decreases between the average of periods samples till the end of experimental period. This may be due to the highly significant increase in total acidity till the end of experimental time, which led to conversion of protopectin to soluble pectin which diffused from the fruits. This is in agreement with the results obtained by Abd-El-Wahed (1980). Also, this may be due to the effect pectinolytic enzymes, which came from the fruits (Fernandez Diez et al., 1974), pectinolytic microorganisms (Vaughn and Barend 1953) and lactics which secreted pectinolytic enzymes (Sakellaris et al., 1988).

The average of pectin percentage in fruits untreated with NaOH in the brines treated with individual preservatives showed highly significant increases than that of pilot and control experiments. Therefore, the brines treated with

Table(58): Percentage of pectin in olives of brines treated with natural and synthetic individual preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	0.880	0.880	0.880	0.880	0.880	0.870	0.870	0.870	0.870	0.876
15	0.860	0.870	0.876	0.850	0.861	0.840	0.856	0.835	0.849	0.855
30	0.791	0.805	0.823	0.806	0.827	0.796	0.807	0.793	0.812	0.807
60	0.750	0.765	0.800	0.784	0.777	0.744	0.791	0.768	0.768	0.772
90	0.711	0.725	0.784	0.751	0.740	0.705	0.765	0.743	0.730	0.739
180	0.640	0.667	0.749	0.736	0.731	0.648	0.738	0.729	0.706	0.705
270	0.590	0.610	0.713	0.693	0.689	0.598	0.693	0.672	0.659	0.657
Means	0.746	0.760	0.804	0.786	0.786	0.743	0.789	0.773	0.771	0.773

	5%	1%		5%	1%
L.S.D. Interval:	0.0042	0.0056	**L.S.D. Treatment:**	0.0047	0.0063

Table (59): Percentage of pectin in olives of brines treated with combination of natural and synthetic preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	0.880	0.880	0.880	0.880	0.880	0.870	0.870	0.870	0.870	0.876
15	0.860	0.870	0.846	0.869	0.862	0.840	0.846	0.853	0.837	0.854
30	0.791	0.805	0.809	0.825	0.819	0.796	0.800	0.812	0.814	0.808
60	0.750	0.765	0.792	0.789	0.786	0.744	0.783	0.800	0.796	0.778
90	0.711	0.725	0.768	0.762	0.758	0.705	0.754	0.776	0.777	0.748
180	0.640	0.667	0.742	0.740	0.739	0.648	0.724	0.750	0.748	0.711
270	0.590	0.610	0.703	0.701	0.698	0.598	0.683	0.706	0.704	0.666
Means	0.746	0.760	0.791	0.800	0.790	0.743	0.780	0.795	0.792	0.777

	5%	1%		5%	1%
L.S.D. Interval:	0.0044	0.0058	**L.S.D. Treatment:**	0.00494	0.0066

Table (60): Percentage of pectin in olives of brined whey treatments (on the fresh base).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	0.880	0.880	0.880	0.870	0.870	0.876
15	0.860	0.870	0.805	0.840	0.790	0.833
30	0.791	0.805	0.720	0.796	0.701	0.763
60	0.750	0.765	0.702	0.744	0.673	0.727
90	0.711	0.725	0.678	0.705	0.600	0.684
180	0.640	0.667	0.630	0.648	0.563	0.630
270	0.590	0.610	0.564	0.598	0.444	0.561
Means	0.746	0.760	0.711	0.743	0.663	0.725

	5%	1%		5%	1%
L.S.D. Interval:	0.009	0.0123	**L.S.D. Treatment:**	0.008	0.010

individual preservatives improved the firmness of the fruits. This may be due to the great inhibition of pectinolytic micro-organisms caused by individual preservatives (Table 13). Olives of sorbate treated brine showed the highest percentage of pectin. This is in agreement with the findings of Abd-El-Wahed (1980). This was followed by the percentage of pectin in the fruits in the brines treated with acetic acid and starter. Olives in control brine showed highly significant increase than that of pilot pickling. this may be due to the higher pectinolytic bacterial activity in pilot experiment than that of control.

Olives treated with NaOH in preservatives brines showed also highly significant increase than that of control. Olives of sorbate treated brine exhibited the highest percentage of pectin. This was followed by starter and acetic treated brines respectively.

B. **Combination of preservatives:**

Data recorded in Table (59) report that olives in brines treated with combination of preservatives exhibited highly significant higher level in the percentage of pectin than that of individual ones in most treatment. This is probably deduced to the great effect of these combinations on pectinolytic microorganisms (Table 14).

There were highly significant decreases between each period samples and the previous period.

Percentage of pectin in olives untreated with NaOH of sorbate + starter brine was the highest.This may be due to the low soluble acids found in the fruits of this treatment. This was followed by olives in sorbate + acetic + starter brine and sorbate + acetic brine .

The same trend was shown in fruits treated with NaOH. The NaOH treatment exhibited rapid degradation in pectin therefore there less percentage of pectin was detected after this treatment. All treatments showed highly significant increases than pilot and corresponding controls experiments. This may be deduced to the lower activity of pectinolytic microorganisms in preservatives treatments than pilot and controls.

C. **Whey treatments:**

Data given in Table (60) show highly significant decreases between the periods samples till the end of experimental period.

Olives in brine treated with whey exhibited the highest rate of degradation than other treatments including pilot and controls experiments. This is probably deduced to the high pectinolytic bacterial counts (Table 15) and the highest percentage of soluble acids (Table 42). Highly significant decreases in pectin percentages in olives of whey treatments than that of pilot and controls indicated this great degradation. Therefore whey pickles exhibited the greatest softening as indicated in the organoleptic evaluation (Table 87). Percentage of pectin in the olives untreated with NaOH was higher than that treated. This may be due to the effect of NaOH onfacililating the degradation of pectin.

12. Changes in pectin in the brines:

Pectin which diffuses from the fruits is considered the most suitable media for pectinolytic microorganisms in the brine.

A. Individual preservatives:

Data given in Table (61) show non-significant increase in the average of 15 days samples. This may be deduced to the low effect of soluble acids and pectinolytic microorganisms on releasing pectin components. On the otherhand, 30 days samples exhibited highly significant increase. This is probably due to the great release of pectin components (Table 58) and due to the low pectinolytic enzymes activity. The 60 and 90 days samples exhibited non-significant difference between them and 30 days samples. 180 days samples showed significant increase than the previous period, but 270 days samples exhibited non-significant increase in pectin of the

Table (61): Percentage of pectin in olives brines treated with natural and synthetic individual preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.014	0.010	0.003	0.024	0.010	0.025	0.010	0.030	0.020	0.0162
30	0.071	0.0233	0.0344	0.071	0.0521	0.070	0.060	0.045	0.040	0.052
60	0.080	0.0438	0.040	0.061	0.063	0.076	0.070	0.057	0.036	0.059
90	0.060	0.0267	0.050	0.092	0.043	0.040	0.105	0.0312	0.042	0.054
180	0.103	0.055	0.044	0.047	0.0733	0.072	0.1034	0.0781	0.101	0.075
270	0.110	0.080	0.054	0.063	0.085	0.097	0.109	0.080	0.099	0.086
Means	0.063	0.034	0.032	0.051	0.047	0.054	0.065	0.046	0.048	0.049

	5%	1%		5%	1%
L.S.D. Interval:	0.02	0.0266	L.S.D. Treatment:	0.023	0.0302

Table (62): Percentage of pectin in olives brines treated with combination of natural and synthetic preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.014	0.010	0.035	0.009	0.017	0.025	0.020	0.010	0.021	0.018
30	0.071	0.0233	0.0397	0.041	0.055	0.070	0.060	0.042	0.042	0.049
60	0.080	0.0438	0.041	0.0884	0.060	0.076	0.050	0.060	0.060	0.062
90	0.060	0.0267	0.042	0.042	0.042	0.040	0.045	0.088	0.023	0.045
180	0.103	0.055	0.045	0.044	0.090	0.072	0.046	0.010	0.045	0.057
270	0.110	0.080	0.055	0.060	0.101	0.097	0.060	0.102	0.090	0.084
Means	0.063	0.034	0.037	0.041	0.052	0.054	0.040	0.045	0.040	0.045

	5%	1%		5%	1%
L.S.D. Interval:	0.0094	0.013	L.S.D. Treatment:	0.011	0.0142

Table (63): Percentage of pectin in the brined whey treatments of olives.

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.014	0.010	0.046	0.025	0.0367	0.026
30	0.071	0.0233	0.045	0.070	0.1034	0.063
60	0.080	0.0438	0.046	0.076	0.108	0.071
90	0.060	0.0267	0.076	0.040	0.108	0.062
180	0.103	0.055	0.071	0.072	0.106	0.081
270	0.110	0.080	0.081	0.097	0.101	0.094
Means	0.063	0.034	0.052	0.054	0.080	0.057

	5%	1%		5%	1%
L.S.D. Interval:	0.0303	0.041	L.S.D. Treatment:	0.026	0.035

brine. This is probably deduced to the low secretion of pectinolytic enzymes by microorganisms which were in the decline phase. Also, this increase in pectin components may be due to the great release of pectin during these periods.

Pilot brine of olives untreated with NaOH showed significant increase than control and highly significant increase than sorbate brine, but non-significant increase than acetic and starter brines. This may be deduced to the great release of pectin components (Table 58). This was followed by acetic acid treated brine, which exhibited non-significant increase than other treatments including control. Sorbate treated brine showed the lowest percentage of pectin. This mainly may be due to the low release of pectin from the fruits (Table 58).

Brines of olives treated with NaOH exhibited non-significant difference between them.

B. Combination of preservatives:

Data given in Table (62) report a gradual increase in pectin components till the end of experimental period except 90 days samples, which exhibited highly significant decrease. This increase was highly significant during 15, 30, 60 and 270 days samples, and significant during 180 days samples.

Olives untreated with NaOH of sorbate + acetic + starter treated brine exhibited highly significant increase than sorbate + acetic treated brine and significant increase than sorbate + starter treated brine. This may be deduced to the low pectinolytic bacterial counts. However, preservatives brines showed highly significant and significant decrease than pilot pickles. This is probably deduced to the low release of pectin components (Table 59).

Preservatives treated brines of NaOH treated olives showed significant and non-significant decrease than control. This also, may be due to the low pectin components released from the fruits (Table 59).

C. **Whey treatments:**

Data recorded in Table (63) report that pectin in the brined whey treatments of olives untreated and treated with NaOH exhibited significant and non-significant increase than corresponding controls. This is probably deduced to the great release of pectin from the fruits, although vigorous pectinolytics activity occurred.

13. Changes in tannins in the fruits:

Tannins exhibited inhibitory effect on microorganisms especially lactic acid bacteria which are the most important in pickles.. The suitable percentage of tannins in the pickled olives give the desirable taste.

Data tabulated in Tables (64, 65 and 66) reported highly significant decrease in the average of tannins in the fruits between each period samples and the previous ones till the end of the experimental period. This is probably deduced to the effect of high osmotic pressure of brine NaCl at the commencement and due to the combined effect of softening (low fruit pectin contents) and low osmotic pressure during last periods of the experiment.

A. <u>Individual preservatives:</u>

Data recorded in Table (64) report that olives untreated with NaOH of starter treated brine exhibited the lowest percentage of tannins in the fruits. This treatment showed highly significant decrease than other treatments including pilot and control experiments. This is probably deduced to the high percentage of NaCl in the brine it showed till the end of experimental period which resulted in high osmotic pressure (Table 76). On the otherhand, fruits of sorbate treated brine showed the highest percentage of tannins. This treatment exhibited highly significant increase than other treatments including pilot and control. This may be due to the great firmness of fruits of sorbate brine (high percentage of pectin) which hindered the diffuse of tannins from the fruits (Table 58). Olives of acetic brine showed moderate percentage of tannins. This treatment exhibited non-significant difference than control and highly significant increase than pilot pickles.

Table (64): Percentage of tannins in olives of brines treated with natural and synthetic individual preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	0.998	0.998	0.998	0.998	0.998	0.921	0.921	0.921	0.921	0.964
15	0.877	0.930	0.954	0.915	0.836	0.811	0.825	0.764	0.726	0.849
30	0.762	0.875	0.946	0.883	0.570	0.765	0.507	0.370	0.316	0.666
60	0.648	0.814	0.893	0.765	0.386	0.330	0.478	0.237	0.188	0.527
90	0.546	0.631	0.854	0.650	0.316	0.258	0.408	0.210	0.154	0.447
180	0.192	0.183	0.782	0.201	0.202	0.139	0.336	0.058	0.082	0.242
270	0.049	0.062	0.461	0.078	0.062	0.036	0.008	0.006	0.006	0.085
Means	0.582	0.642	0.841	0.641	0.481	0.466	0.498	0.367	0.342	0.54

		5%	1%			5%	1%
L.S.D. Interval:		0.0094	0.013		**L.S.D. Treatment:**	0.011	0.0142

Table (65): Percentage of tannins in olives of brines treated with combination of natural and synthetic preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	0.998	0.998	0.998	0.998	0.998	0.921	0.921	0.921	0.921	0.958
15	0.877	0.930	0.975	0.953	0.958	0.811	0.645	0.725	0.805	0.853
30	0.762	0.875	0.956	0.794	0.756	0.765	0.427	0.316	0.379	0.670
60	0.648	0.814	0.873	0.700	0.572	0.330	0.263	0.188	0.253	0.516
90	0.546	0.631	0.812	0.499	0.416	0.258	0.231	0.154	0.224	0.419
180	0.192	0.183	0.752	0.321	0.290	0.139	0.116	0.082	0.107	0.242
270	0.049	0.062	0.316	0.124	0.102	0.036	0.013	0.006	0.010	0.080
Means	0.582	0.642	0.812	0.627	0.583	0.466	0.374	0.342	0.386	0.534

		5%	1%			5%	1%
L.S.D. Interval:		0.019	0.0251		**L.S.D. Treatment:**	0.0214	0.0284

Table (66): Percentage of tannins in olives of brined whey treatments (on the fresh base).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	0.998	0.998	0.998	0.921	0.921	0.967
15	0.877	0.930	0.877	0.811	0.768	0.853
30	0.762	0.875	0.827	0.765	0.708	0.7874
60	0.648	0.814	0.691	0.330	0.327	0.562
90	0.546	0.631	0.601	0.258	0.190	0.445
180	0.192	0.183	0.253	0.139	0.070	0.1674
270	0.049	0.062	0.067	0.036	0.005	0.044
Means	0.582	0.642	0.616	0.466	0.427	0.547

		5%	1%			5%	1%
L.S.D. Interval:		0.0242	0.033		**L.S.D. Treatment:**	0.0204	0.0275

experiment. Pilot fruits showed low percentage of tannins due to the softening it showed.

Olives treated with NaOH exhibited lower percentages of tannins than that untreated. This may be deduced to the effect of NaOH on the diffusion of tannins. This is in accordance with the find'ngs of Cruess (1958) and Gomez (1986). However, olives treated with NaOH showed the same trend as untreated olives.

B. Combination of preservatives:

Data given in Table(65) generally report that fruits of combination of preservatives treated brines did'nt show apparent difference than that of individual ones.

Olives untreated with NaOH of sorbate + acetic treated brine exhibited the highest percentage of tannins. These fruits showed highly significant increase than other treatments including pilot and control fruits. This is probably due to the lowest total solids the brine treated with sorbate + acetic contains than other treatments which include the soluble solids of the whey. Olives of sorbate + acetic + starter treated brine which showed non-significant difference than pilot, exhibited the lowest percentage of tannins. This may be deduced to the high osmotic pressure resulted from soluble solids of the starter whey. Olives of sorbate +

Starter and control brines showed mild percentage of tannins.

Olives treated with NaOH in brines treated with combined preservatives showed highly significant decreases than control olives. This is probably deduced to the great effect of high acidity besides the previous NaOH treatment on the diffusion of tannins. Fruits of sorbate + starter brine exhibited highly significant decrease than other two treatments which showed non-significant difference between them. This may be due to the effect of high osmotic pressure resulted from soluble solids of the starter whey in the presence of low percentage of pectin (Table 59).

C. Whey treatments;

Data tabulated in Table (66) report that fruits untreated with NaOH of whey treatment exhibited significant decrease than control and highly significant increase than pilot fruits. Fruits treated with NaOH of whey treatment exhibited highly significant decrease than control. These lower percentages of tannins in olives of the whey than corresponding controls may be due to the softening of the fruits in the whey treatments.

14. Changes in tannins in the brines:

The development of microorganisms is controlled by the

Table (67): Percentage of tannins in olives brines treated with natural and synthetic individual preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.110	0.050	0.036	0.067	0.134	0.085	0.064	0.131	0.176	0.095
30	0.209	0.107	0.050	0.089	0.392	0.138	0.397	0.499	0.587	0.274
60	0.311	0.169	0.096	0.209	0.586	0.528	0.403	0.649	0.702	0.406
90	0.428	0.310	0.132	0.304	0.620	0.706	0.493	0,669	0.742	0.489
180	0.710	0.701	0.183	0.662	0.733	0.796	0.506	0.721	0.750	0.640
270	0.801	0.783	0.488	0.869	0.790	0.790	0.587	0.801	0.772	0.742
Means	0.367	0.303	0.141	0.314	0.465	0.435	0.350	0.496	0.533	0.378

	5%	1%		5%	1%
L.S.D. Interval:	0.007	0.009	L.S.D. Treatment:	0.008	0.010

Table (68): Percentage of tannins in olives brines treated with combination of natural and synthetic preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.110	0.050	0.018	0.027	0.030	0.085	0.256	0.085	0.093	0.084
30	0.209	0.107	0.030	0.179	0.213	0.138	0.511	0.352	0.512	0.250
60	0.311	0.169	0.110	0.258	0.396	0.528	0.609	0.633	0.629	0.405
90	0.428	0.310	0.132	0.452	0.563	0.706	0.697	0.690	0.658	0.515
180	0.710	0.701	0.198	0.613	0.683	0.796	0.780	0.720	0.776	0.664
270	0.801	0.783	0.594	0.800	0.811	0.790	0.800	0.740	0.851	0.774
Means	0.367	0.303	0.155	0.333	0.385	0.435	0.522	0.460	0.503	0.385

	5%	1%		5%	1%
L.S.D. Interval:	0.023	0.031	L.S.D. Treatment:	0.03	0.04

Table (69): Percentage of tannins in the brined whey treatments of olives.

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.110	0.050	0.109	0.085	0.133	0.097
30	0.209	0.107	0.133	0.138	0.182	0.154
60	0.311	0.169	0.278	0.528	0.561	0.369
90	0.428	0.310	0.347	0.706	0.683	0.495
180	0.710	0.701	0.675	0.796	0.740	0.724
270	0.801	0.783	0.872	0.790	0.840	0.817
Means	0.367	0.303	0.345	0.435	0.448	0.380

	5%	1%		5%	1%
L.S.D. Interval:	0.0204	0.028	L.S.D. Treatment:	0.0173	0.023

Table (70): Determination of vitamin C in olives of brines treated with natural and synthetic individual preservatives (mg/100gm.) (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	23.00	23.00	23.00	23.00	23.00	19.00	19.00	19.00	19.00	21.222
15	11.00	12.00	13.89	15.23	13.57	8.09	9.12	10.53	8.20	11.292
30	4.00	5.56	7.01	8.89	6.78	5.24	5.32	6.99	5.30	6.121
60	3.00	4.50	4.74	6.70	4.40	3.51	3.50	4.80	3.72	4.319
90	2.00	2.10	2.60	2.60	1.70	2.10	2.83	1.30	2.54	2.197
180	0.0	1.30	1.95	1.20	1.20	1.00	1.10	1.30	2.20	1.250
270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Means	6.143	6.923	7.599	8.231	7.236	5.563	5.839	6.274	5.851	6.629

	5%	1%		5%	1%
L.S.D. Interval:	0.255	0.34	L.S.D. Treatment:	0.29	0.384

Table (71) : Determination of vitamin C in olives of brines treated with combination of natural and synthetic preservatives (mg/100gm) (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	23.00	23.00	23.00	23.00	23.00	19.00	19.00	19.00	19.00	21.222
15	11.00	12.00	13.22	13.76	14.07	8.09	9.03	9.00	9.98	11.128
30	4.00	5.56	7.69	6.89	8.17	5.24	5.57	6.00	5.62	6.082
60	3.00	4.50	4.06	4.60	5.10	3.51	3.43	4.34	3.33	3.986
90	2.00	2.10	2.69	1.95	2.70	2.10	2.31	1.90	1.64	2.154
180	0.0	1.30	1.40	1.53	1.80	1.00	1.53	1.49	0.95	1.222
270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Means	6.143	6.923	7.437	7.393	7.834	5.563	5.839	5.961	5.789	6.542

	5%	1%		5%	1%
L.S.D. Interval:	0.17	0.22	L.S.D. Treatment:	0.17	0.25

Table (72): Determination of vitamin C in olives of brined whey treatments (mg/100gm) (on the fresh base).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	23.00	23.00	23.00	19.00	19.00	21.40
15	11.00	12.00	8.25	8.09	5.30	8.928
30	4.00	5.56	6.50	5.24	3.41	4.942
60	3.00	4.50	2.93	3.51	2.21	3.230
90	2.0	2.10	2.65	2.10	0.0	1.770
180	0.0	1.30	1.94	1.00	0.0	0.848
270	0.0	0.0	0.0	0.0	0.0	0.0
Means	6.143	6.923	6.467	5.563	4.274	5.874

	5%	1%		5%	1%
L.S.D. Interval:	0.25	0.33	L.S.D. Treatment:	0.21	0.28

of control showed highly significant decrease than fruits of sorbate and acetic treated brines and significant decrease than fruits of starter treated brine. This may be due to the softening of pilot and control olives which potentiated the diffusion of the vitamin. Fruits of acetic treated brine exhibited highly significant increase than the other two treatments. On the otherhand, fruits of starter brine showed the lowest percentage of vitamin C than other treatments.

Olives treated with NaOH showed also the same trend except olives of sorbate treated brine which exhibited the lowest percentage. These results are in line with the findings of Abd-El-Wahed (1980).

B. Combination of preservatives:

Data given in Table (71) show relatively lower percentage of vitamin C than that of individual ones. Olives untreated and treated with NaOH showed highly significant increase than pilot and corresponding controls except fruits treated with NaOH of sorbate + acetic + starter brine which showed significant increase. This may be deduced to the firmness of the fruits of the preservatives brines.

Olives untreated with NaOH of sorbate + acetic + starter treated brine contained the highest percentage of vitamin C. This treatment exhibited highly significant higher values than the other two treatments which did'nt show any significant difference between them.

On the otherhand,olives treated with NaOH of sorbate + starter brine which did'nt show any significant difference than that of sorbate + acetic treated brine, exhibited the highest percentage. Fruits of sorbate + acetic + starter exhibited the lowest percentage of vitamin C.

C. **Whey treatments:**

Data recorded in Table (72) show that fruits untreated and treated with NaOH of the whey treatments exhibited highly significant decrease than corresponding controls. This apparent decrease was probably deduced to the softening of the fruits. Pilot fruits exhibited highly significant decrease than fruits untreated with NaOH of whey treatments. This may be due to the softening of the fruits.

16. **Changes in vitamin C in the brine:**

The amount of vitamin C in the brine was attributed to the diffusion of the vitamin from the fruits. Also, the concentration of the vitamin was affected by its oxidation. The presence of vitamin C in the brine was regarded as microbial inhibitor (according to Svorcova and Libuse, 1979).

Data recorded in Tables (73, 74 and 75) report that there was highly significant increase on 15 days samples. This may be deduced to the effect of high osmotic pressure at the commencement. Thereafter, there was highly significant decrease till 90 days samples, and the vitamin completely disappeared at 180 and 270 days samples. This is probably due to the oxidation of the vitamin.

A. Individual preservatives:

Data given in Table (73) report that sorbate treated brine of olives untreated with NaOH exhibited the highest concentration of vitamin C. This treatment showed highly significant increase than other brines of olives untreated with NaOH except non-significant increase than pilot brine. Control brine exhibited the lowest concentration. Acetic and starter treated brines exhibited moderate concentrations.

Control brine of olives treated with NaOH which showed significant increase than starter and acetic treated brines exhibited highly significant increase than sorbate treated brine. These results are in agreement with the findings of Abd-El-Wahed (1980).

B. Combination of preservatives:

Data tabulated in Table (74) report that preservatives treated brines of olives untreated with NaOH showed highly

Table (73): Determination of vitamine C in olives brines treated with natural and synthetic individual preservatives (mg/100gm).

Treat-ments /Days	Without NaOH					With NaOH				
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	Means
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	4.0	3.6	4.6	3.7	4.1	4.1	3.6	3.9	3.6	3.911
30	3.0	2.4	3.0	3.2	2.7	3.2	2.9	3.2	3.4	3.000
60	3.0	2.1	2.6	2.7	1.9	2.9	2.4	2.9	2.9	2.600
90	2.5	1.9	2.6	2.4	1.6	2.9	1.8	2.6	2.7	2.333
180	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Means	1.786	1.429	1.829	1.714	1.471	1.871	1.529	1.800	1.800	1.692

		5%	1%		5%	1%
L.S.D. Interval:		0.06	0.074	L.S.D. Treatment:	0.06	0.08

Table (74): Determination of vitamin C in olives brines treated with combination of natural and synthetic preservatives (mg/100gm).

Treat-ments /Days	Without NaOH					With NaOH				
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Means
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	4.0	3.6	4.1	5.7	4.4	4.1	4.9	3.1	3.4	4.144
30	3.0	2.4	3.7	3.2	3.4	3.2	3.4	2.9	2.9	3.122
60	3.0	2.1	2.9	2.4	3.2	2.9	2.4	2.1	2.4	2.600
90	2.5	1.9	2.4	1.8	2.9	2.9	2.2	1.9	2.2	2.300
180	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Means	1.786	1.429	1.871	1.871	1.986	1.871	1.843	1.429	1.557	1.738

		5%	1%		5%	1%
L.S.D. Interval:		0.06	0.07	L.S.D. Treatment:	0.063	0.08

Table (75): Determination of vitamin C in brined whey treatments of olives (mg/100gm).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	0.0	0.0	0.0	0.0	0.0	0.0
15	4.0	3.6	5.4	4.1	3.2	4.060
30	3.0	2.4	2.4	3.2	3.2	2.840
60	3.0	2.1	2.2	2.9	2.9	2.620
90	2.5	1.9	2.1	2.9	1.4	2.160
180	0.0	0.0	0.0	0.0	0.0	0.0
270	0.0	0.0	0.0	0.0	0.0	0.0
Means	1.786	1.429	1.73	1.871	1.53	1.669

		5%	1%		5%	1%
L.S.D. Interval:		0.083	0.11	L.S.D. Treatment:	0.07	0.09

significant increase than pilot and control brines. Sorbate + acetic + starter treated brine exhibited the highest concetration of vitamin C. Sorbate + acetic and sorbate + starter treated brines showed the same concentration.

Control brine of olives treated with NaOH contained the highest concentration of vitamin C. Sorbate + acetic brine exhibited non-significant difference than control brine. Sorbate + acetic + starter treated brine showed moderate concentration. Sorbate + starter treated brine exhibited the lowest concentration of the vitamin.

C. **Whey treatments:**

Data recorded in Table (75) report that brined whey of fruits untreated with NaOH exhibited highly significant increase than that of control, but showed non-significant decrease than pilot brine. Brines of fruits treated with NaOH exhibited highly significant decrease than control.

17. Changes in NaCl in the brine:

Concentration of NaCl in the brine controlled the microbial activity. Also, it gives the fruits the desirable taste.

Data tabulated in Tables (76, 77 and 78) show highly significant decrease between samples of the periods till the end of experimental period. This may be deduced mainly to the

Table (76): Percentage of NaCl in olives brines treated with natural and synthetic individual preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
15	9.9	10.0	10.1	10.6	10.2	10.0	11.63	11.70	10.30	10.492
30	9.5	9.4	9.2	10.0	9.4	9.75	9.70	10.0	9.82	9.641
60	8.2	8.1	9.0	9.4	9.4	8.35	9.01	9.21	9.5	8.908
90	7.8	7.8	8.5	8.7	8.72	7.92	9.0	9.0	8.9	8.482
180	7.6	7.4	8.0	8.0	8.3	7.71	7.97	8.74	8.542	8.029
270	7.6	7.3	7.4	7.6	8.19	7.53	7.83	8.36	7.9	7.746
Means	9.086	9.000	9.314	9.614	9.601	9.180	9.734	10.001	9.709	9.471

	5%	1%		5%	1%
L.S.D. Interval:	0.13	0.17	**L.S.D. Treatment:**	0.14	0.19

Table (77): Percentage of NaCl in olives brines treated with combination of natural and synthetic preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
15	9.9	10.0	9.8	10.41	9.98	10.0	9.508	10.0	9.120	9.858
30	9.5	9.4	8.92	9.82	9.421	9.75	8.798	9.56	8.729	9.322
60	8.200	8.100	8.72	9.600	8.911	8.35	8.46	9.42	8.701	8.718
90	7.800	7.800	8.257	8.940	8.426	7.920	8.018	8.620	8.200	8.220
180	7.600	7.400	8.000	8.510	8.107	7.710	7.662	8.310	7.947	7.916
270	7.600	7.300	7.371	8.000	7.581	7.530	7.400	8.100	7.837	7.635
Means	9.086	9.000	9.153	9.754	9.347	9.180	8.978	9.573	9.080	9.239

	5%	1%		5%	1%
L.S.D. Interval:	0.1	0.13	**L.S.D. Treatment:**	0.11	0.14

Table (78): Percentage of NaCl in the brined whey treatments of olives.

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	13.0	13.0	13.0	13.0	13.0	13.0
15	9.9	10.0	10.019	10.0	10.087	10.001
30	9.5	9.4	9.89	9.75	9.791	9.666
60	8.2	8.1	9.411	8.35	9.413	8.694
90	7.8	7.8	8.800	7.92	8.690	8.202
180	7.6	7.4	8.463	7.71	8.586	7.952
270	7.6	7.3	7.941	7.53	7.900	7.654
Means	9.086	9.000	9.646	9.180	9.638	9.310

	5%	1%		5%	1%
L.S.D. Interval:	0.1	0.14	**L.S.D. Treatment:**	0.09	0.12

the release of water from the fruits during the process. This is in line with the findings of Fabian *et al.* (1932).

A. Individual preservatives:

Data recorded in Table (76) show that individual preservatives treated brines of olives untreated with NaOH exhibited highly significant higher concentration than that of pilot and control which did'nt show any significant difference between them. It is postulated that the cells of fruits in preservatives treated brines had not been destroyed by pectinolytic and cellulytic microorganisms, hence they did 'nt lost their internal cell cap easily. Starter and acetic treated brines which did'nt exhibit non-significant difference between them, showed highly significant higher level than sorbate treated brine.

Preservatives treated brines of olives treated with NaOH exhibited highly significant higher level than control. Acetic brine showed highly significant higher level than sorbate and starter treated brines. These results are in line with the findings of Abd-El-Wahed (1980).

B. Combination of preservatives:

Data given in Table (77) showed pronounced decrease in NaCl concentration in the combined preservatives treated brines than that of individual ones. This is probably deduced to the acidified brines with acetic acid which faciliated the release moisture from fruit tissues.

Sorbate + acetic treated brine of olives untreated with NaOH exhibited the lowest NaCl concentration. This was followed by sorbate + acetic + starter treated brine. This may be due to the effect of acetic on plant tissues . Sorbate + starter treated brine exhibited the highest percentage. Although the three treated brines showed highly significant difference between them, they exhibited also highly significant increase than pilot and control but non-significant difference between pilot and sorbate + acetic. This may be deduced to the high osmotic pressure of the fruits of preserved brines.

The same trend was exhibited in brines of olives treated with NaOH.

C. **Whey treatments:**

Data given in Table (78) show that brined whey treatments exhibited highly significant increase in NaCl content than pilot and corresponding controls.This is probably deduced to the great softening of the fruits in whey treatments which led to the lost of NaCl of the fruits.

18. **Changes in NaCl in the fruits:**

Olives absorb the NaCl from the brine to give the desirable taste for the pickles. Therefore, data tabulated in Tables (79, 80 and 81) exhibited highly significant increase in the NaCl in the fruits till the end of the experimental period. The results of the treatments represent reverse relationship with that of NaCl in the brine, since the decrease in salt concentration in the brine resulted in increase in NaCl of the olives. Therefore, the results observed in the fruits may be explained by the same reasons found in the brine.

19. Changes in the moisture of the fruits:

Data tabulated in Tables (82 and 83) show that there were non-significant difference of the moisture content of the fruits between periods of individual preservatives till the end of the experiment, except 270 days samples which showed significant increase. Also, combined preservatives exhibited non-significant increase till 60 days samples, then highly significant increase on 90 and 180 days samples. Finally there was significant increase on 270 days samples. On the other hand data recorded in Table (84) exhibited highly significant higher value in moisture content in the fruits of the whey treatments. This increase in olives of the whey treatments may be deduced to the softening of the fruits. These results are in line with the results obtained by Abd-El-Wahed (1980).

Table (79): Percentage of NaCl in olives of brines treated with natural and synthetic individual preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	3.100	3.000	2.900	2.400	2.800	3.000	1.230	1.324	2.700	2.495
30	3.300	3.400	3.700	3.000	3.410	3.200	3.150	2.860	3.200	3.277
60	4.650	4.700	3.900	3.440	3.600	4.500	3.391	3.210	3.500	3.877
90	5.005	5.000	4.410	4.210	4.200	4.950	3.920	3.780	4.100	4.397
180	5.256	5.300	4.902	4.830	4.610	5.142	4.650	4.110	4.500	4.811
270	5.261	5.300	5.433	5.211	5.000	5.256	4.806	4.574	4.900	5.082
Means	3.796	3.814	3.606	3.299	3.374	3.721	3.021	2.837	3.271	3.416

	5%	1%		5%	1%
L.S.D. Interval:	0.14	0.19	**L.S.D. Treatment:**	0.16	0.21

Table (80): Percentage of NaCl in olives of brines treated with combination of natural and synthetic preservatives (on the fresh base).

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	3.100	3.000	3.000	2.600	2.811	3.000	3.204	2.900	3.620	3.026
30	3.300	3.400	3.927	3.200	3.400	3.200	4.100	3.300	4.100	3.547
60	4.650	4.700	4.213	3.400	4.000	4.500	4.354	3.700	4.200	4.191
90	5.005	5.000	4.622	4.000	4.418	4.950	4.800	4.300	4.674	4.641
180	5.256	5.300	5.000	4.400	4.800	5.142	5.200	4.600	4.820	4.946
270	5.261	5.300	5.508	4.900	5.237	5.256	5.400	4.800	5.000	5.185
Means	3.796	3.814	3.753	3.214	3.524	3.721	3.865	3.371	3.773	3.648

	5%	1%		5%	1%
L.S.D. Interval:	0.06	0.15	**L.S.D. Treatment:**	0.06	0.09

Table (81): Percentage of NaCl in olives of brined whey treatments (on the fresh base).

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	0.0	0.0	0.0	0.0	0.0	0.0
15	3.100	3.000	2.721	3.000	2.709	2.906
30	3.300	3.400	2.917	3.200	3.077	3.189
60	4.650	4.700	3.461	4.500	3.411	4.144
90	5.005	5.000	4.086	4.950	4.182	4.645
180	5.256	5.300	4.321	5.142	4.251	4.854
270	5.261	5.300	4.854	5.256	4.826	5.099
Means	3.796	3.814	3.1943	3.721	3.208	3.550

	5%	1%		5%	1%
L.S.D. Interval:	0.11	0.14	**L.S.D. Treatment:**	0.09	0.12

Table (82): Percentage of moisture in olives of brines treated with natural and synthetic individual preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter	
0	81.097	81.097	81.097	81.097	81.097	80.097	80.097	80.097	80.097	80.653
15	81.299	81.184	81.201	81.990	81.315	80.483	80.169	81.388	80.521	81.061
30	81.532	81.306	81.369	83.000	81.723	80.821	80.634	81.721	80.967	81.453
60	82.376	81.733	81.527	83.111	82.001	81.333	81.247	83.265	81.379	81.997
90	84.111	83.958	83.866	83.204	82.511	81.987	81.453	83.478	82.254	82.980
180	84.661	84.248	84.000	84.632	84.278	82.846	81.772	84.988	83.677	83.900
270	84.848	84.507	84.046	87.281	86.315	84.321	83.011	85.632	85.986	85.105
Means	82.846	82.576	82.444	83.474	82.749	81.700	81.198	82.938	82.126	82.450

	5%	1%		5%	1%
L.S.D. Interval:	1.2	1.6	L.S.D. Treatment:	1.361	1.8

Table (83): Percentage of moisture in olives of brines treated with combination of natural and synthetic preservatives.

Treat-ments /Days	Without NaOH					With NaOH				Means
	Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate + acetic + starter	
0	81.097	81.097	81.097	81.097	81.097	80.097	80.097	80.097	80.097	80.653
15	81.299	81.184	82.010	81.483	82.270	80.483	80.228	80.499	80.316	81.086
30	81.532	81.306	82.710	81.859	83.000	80.821	81.137	81.000	81.482	81.650
60	82.376	81.733	82.931	82.124	83.128	81.333	82.563	81.407	82.886	82.276
90	84.111	83.958	83.690	82.833	84.000	81.987	83.452	82.366	83.927	83.369
180	84.661	84.248	84.640	84.421	84.967	82.846	84.631	83.954	85.009	84.375
270	84.848	84.507	84.988	86.601	85.218	84.321	85.026	86.200	85.178	85.210
Means	82.846	82.576	83.152	82.917	83.379	81.700	82.448	82.218	82.699	82.66

	5%	1%		5%	1%
L.S.D. Interval:	0.75	0.97	L.S.D. Treatment:	0.83	1.1

Table (84): Percentage of moisture in olives of brined whey treatments.

Treat-ments /Days	Without NaOH			With NaOH		Means
	Pilot	Control	Whey	Control	Whey	
0	81.097	81.097	81.097	80.097	80.097	80.697
15	81.299	81.184	81.299	80.483	80.891	81.031
30	81.532	81.306	81.613	80.821	81.231	81.301
60	82.376	81.733	82.940	81.333	82.072	82.091
90	84.111	83.958	84.261	81.987	82.641	83.392
180	84.661	84.248	84.928	82.846	83.526	84.042
270	84.848	84.507	85.218	84.321	84.732	84.725
Means	82.846	82.576	83.051	81.700	82.170	82.468

	5%	1%		5%	1%
L.S.D. Interval:	0.08	0.11	L.S.D. Treatment:	0.07	0.09

A. Individual preservatives:

Data given in Table (82) report that fruits untreated with NaOH exhibited non-significant difference between them in moisture content. The lowest precentage among these fruits was in fruits of sorbate treated brine. This may be due to the great firmness exhibited in these fruits. Fruits of acetic treated brine showed the highest percentage of moisture. This may be deduced to the relatively low firmness it showed. Fruits of control and starter treated brine showed moderate moisture content. On the otherhand, pilot exhibited higher percentage than fruits of starter treated brine.

Fruits treated with NaOH showed lower percentages than that untreated. This may be due to the effect of NaOH at the commencement. Concerning the difference between treatments, the same trend as that of olives untreated with NaOH was shown.

B. Combination of preservatives:

Data given in Table (83) show non-pronounced difference between percentages of moisture in fruits of combined preservatives and individual ones.

Olives untreated with NaOH exhibited non-significant difference between different treatments. Fruits of sorbate + acetic + starter exhibited higher moisture content than other olives including pilot and control. This was followed by fruits of sorbate + acetic treated brine. These increases in these two treatments may be due to the relatively low pectin content it showed.

The same trend was shown in fruits treated with NaOH. All treatments showed higher percentages of moisture than corresponding control.

C. Whey treatments:

Data tabulated in Table (84) report that fruits of whey treatments exhibited highly significant increase than pilot and corresponding controls. This is probably deduced to the softening of the whey olives.

Organoleptic evaluation of olive fruits after pickling and storage:

1. After pickling:

A. Individual preservatives:

Table (85) show that olives untreated with NaOH reported higher quality than the treated fruits. On the otherhand, olives treated with NaOH of control brine exhibited higher quality than olives untreated of pilot and control brines, which showed low quality. Olives of pilot brine exhibited bad texture and appearance. This is probably deduced to high pectinolytic bacterial

Table (85): Organoleptic evaluation in olives of brines treated with natural and synthetic individual preservatives.

Days	Tests	Without NaOH					With NaOH			
		Pilot	Control	Sorbate 0.1%	Acetic to pH4	Starter	Control	Sorbate 0.1%	Acetic to pH4	Starter
60	Taste	35	27	45	49	49	35	43	35	49
	Colour	4	12	5	15	14	12	7	13	14
	Texture	2	3	15	15	14	15	13	15	14
	Appearance	2	5	10	10	10	8	9	9	10
	Odor	6	7	10	10	10	4	10	10	10
	Sum	49	54	85	99	97	74	82	82	97
90	Taste	40	31	46	50	50	37	44	38	49
	Colour	6	14	7	15	15	13	8.5	14	14
	Texture	2	3	15	15	14	14	13	14	13
	Appearance	7	6	10	10	10	8.5	8	9.5	10
	Odor	7	8	10	10	10	7	10	10	10
	Sum	62	62	88	100	99	77.5	83.5	85.5	96
180	Taste	40	33	46	50	49	39	45	40	50
	Colour	7	14	7	15	15	14	9	15	15
	Texture	2	3	15	14	13	13	12.5	13	12
	Appearance	7	6	10	10	9.5	8	8	10	9
	Odor	6	8	10	10	9	5	10	10	9
	Sum	62	64	88	99	95.5	79	84.5	83	95
270	Taste	42	35	47	50	50	42	47	47	50
	Colour	8	14	9	15	15	15	9	15	15
	Texture	1	2	14	12	11	11	13	12	10
	Appearance	6	5	9	10	8	8	8	10	10
	Odor	5	7	10	9	7	5	10	10	10
	Sum	62	63	88	96	91	81	87	94	95

Table (86): Organoleptic evaluation in olives of brines treated with combination of natural and synthetic preservatives.

Days	Tests	Without NaOH					With NaOH			
		Pilot	Control	Sorbate + acetic	Sorbate + starter	Sorbate +acetic +starter	Control	Sorbate + acetic	Sorbate + starter	Sorbate +acetic +starter
60	Taste	35	27	35	47	50	35	40	47	49
	Colour	4	12	5	15	7.5	12	13	15	13
	Texture	2	3	15	15	15	15	15	15	15
	Appearance	2	5	10	10	9	8	7	10	9.5
	Odor	6	7	10	9	10	4	10	9	10
	Sum	49	54	75	96	91.5	74	85	96	96.5
90	Taste	40	31	39	47	50	37	42	46	49
	Colour	6	14	6	10	8	13	12	13	13
	Texture	2	3	14	15	14	14	15	15	15
	Appearance	7	6	9	10	9	8.5	7	9	9.5
	Odor	7	8	9	9	10	5	10	9	10
	Sum	62	62	77	91	91	77.5	86	92	96.5
180	Taste	40	33	41	47	50	39	43	48	50
	Colour	7	14	7	10	9	14	13.5	13	13
	Texture	2	3	13.5	14	14	13	14	14	14
	Appearance	7	6	9.5	9.5	9.5	8	8	9	9
	Odor	6	8	9.5	9	10	5	10	9	10
	Sum	62	64	80.5	89.5	92.5	79	88.5	93	96
270	Taste	42	35	44	48	50	42	45	50	50
	Colour	8	14	8	10	9	15	12	13	13
	Texture	1	2	12	12	12	11	13	12	12
	Appearance	6	5	8	8	8	8	8	9	9
	Odor	5	7	8	8	9	5	9	10	8
	Sum	62	63	80	86	88	81	87	94	92

Table (87): Organoleptic evaluation in olives of brined whey treatments.

Days	Tests	Without NaOH			With NaOH	
		Pilot	Control	Whey	Control	Whey
60	Taste	35	27	25	35	25
	Colour	4	12	14	12	14
	Texture	2	3	10	15	9
	Appearance	2	5	9.5	8	9.5
	Odor	6	7	6	4	6
	Sum	49	54	64.5	74	63.5
90	Taste	40	31	25	37	25
	Colour	6	14	14	13	14
	Texture	2	3	9	14	8
	Appearance	7	6	7	8.5	7
	Odor	7	8	6	5	5
	Sum	62	62	61	77.5	59
180	Taste	40	33	24	39	24
	Colour	7	14	14	14	14
	Texture	2	3	5	13	9
	Appearance	7	6	7	8	7
	Odor	6	8	6	5	4
	Sum	62	64	56	79	58
270	Taste	42	35	24	42	24
	Colour	8	14	15	15	14
	Texture	1	2	4	11	6
	Appearance	6	5	7	8	6
	Odor	5	7	7	5	3
	Sum	62	63	57	81	51

densities (Table 13). Also, this may be due to the growing of yeasts which gave bad appearance. The same trend was observed with olives untreated with NaOH of control brine for the same reasons. On the other hand, olives treated with NaOH of control brine rendered good texture and colour.

Among olives untreated with NaOH of brines treated with individual preservatives, fruits of acetic acid treated brine showed the best quality after pickling. Therefore, this treatment was regarded to be the best one, since the taste, colour, texture, appearance and odor were the most acceptable. Olives of acetic acid treated brine relatively prevented the growth of yeasts and other spoilage microorganisms and fixed the diserable yellow colour. This is in line with the findings of Annheimer and Fabian (1940) and Schmill (1950). This was followed by fruits of starter brine, since they rendered good taste, colour, texture, odor and appearance. This good colour may be deduced to the increased yield of acids (according to Schmill, 1950). Olives of sorbate treated brine exhibited the lowest quality among olives untreated with NaOH of preservatives brines. This is mainly possible due to the darkening by sorbate. This result is similar to those observed by De La Borbolla Y and Alcala <u>et al</u>. (1961).

The same trend was shown in NaOH treated fruits for the same reasons.

B. Combination of preservatives:

Data tabulated in Table (86) report relatively lower quality in olives of combination of preservatives treated brines than that of individual ones. This may be deduced to the controlled lactic acid fermentation by the combined preservatives than that of individual preservatives.

Olives treated with NaOH exhibited relatively higher quality than that of untreated.

Among fruits untreated with NaOH, fruits of sorbate + starter and sorbate + acetic + starter treated brines showed higher quality than olives of sorbate + acetic treated brine. This is due to the good taste, texture, colour, odor and appearance they rendered. It seems that acetic and sorbate in sorbate + acetic + starter treated brine played an important role in preventing yeasts and pectinolytic microorganisms, hence accepted the fruits good appearance and texture. Acids especially lactic acid relatively prevented darkening occurring by sorbate. Fruits of sorbate + acetic treated brine exhibited the lowest quality among olives untreated and treated with NaOH of preservatives brines, since the darkening of the fruits appeared and acetic acid did'nt overcome that darkening.

The olives treated with NaOH and preserved using sorbate + acetic + starter showed the best quality among combination of preservatives, since the acids added and produced overcome the darkening happening by added sorbate. Also, this combination prevented the degradation of pectin by pectinolytic microorganisms. This treatment was followed by fruits of sorbate + starter treatment, since it rendered good colour, taste, appearance and odor. The lowest quality was belonged to olives of sorbate + acetic treated brine, since it exhibited dark colour and the taste was relatively not acceptable. This darkening due to the act of sorbate. This is in accordance with the findings of Abd-El-Wahed (1980).

C. **Whey treatments:**

It is clearly observed from the data given in Table (87) that whey treatments produced bad quality olives. Olives untreated with NaOH of brined whey treatment showed better quality than that treated. Also,both whey treatments were less quality than corresponding controls, since whey treatments showed great and quickly softening. The undiserable change observed with these treatments was cheesy flavour which overcome the pickle flavour. However, whey treatment was characterized by golden yellow colour, but the growth of pink and yellow yeasts gave the product bad appearance. It could be concluded that whey treatment is more suitable for obtaining quick pickle, since the fermentation was quick and the desirable acidity was accomplished throughout a short time. Otherwise, this treatment was unsuitable for the storage of pickle.

2. At the end of the storage period:

A. Individual preservatives:

Data given in Table (85) show that the same trend during pickling was almost observed during storage, since olives in brines treated with acetic acid exhibited the best organoleptic quality among olives untreated with NaOH, while olives of starter treated brine were the best among NaOH treated olives. Sorbate treatment produced the lowest colour and appearance qualities, but it showed the best texture due to the great inhibition of pectinolytic microorganisms.

However, the texture of olives untreated with NaOH was relatively better than that treated. This may be deduced to the relative more degradation of pectin by NaOH treatment (according to Abd-El-Wahed, 1980).

Olives untreated with NaOH of acetic acid treated brine recorded the best evaluation than all other treatments.

B. Combination of preservatives:

The data tabulated in Table (86) show that the quality of olives treated with NaOH was better than those untreated, since the colour was better with NaOH treatment. This may be due to the great production of acids which improved the colour. However, the best treatment among olives untreated with NaOH was sorbate + acetic + starter brine, while the best treatment with olives treated with NaOH was sorbate + starter treatment.

C. **Whey treatments:**

Data given in Table (87) show that whey treatments exhibited the lowest quality than all treatments. This can be attributed to the high counts of pectinolytic microorganisms and high acidity showed with these treatments. However, olives treated with NaOH of brined whey produced lower quality than that of untreated. This may be due to the relatively degradation of pectin by NaOH.

fermentation and storage. Azizi-Axe the most widely produced olives in Egypt was selected to this study. The pilot experiment which was similar to the line production in the factory, which used the olives untreated with NaOH. Control experiments were done corresponding to each variety of the olives (untreated and treated with NaOH).

This study included microbiological and chemical estimations in the brines which were taken under aseptic conditions at the following intervals : zero time, 15, 30, 60, 90 days (during fermentation) 180 and 270 days (during storage). Organoleptic evaluations were done in olives at intervals: 60, 90, 180 and 270 days.

The microbiological determinations were: Total bacterial counts, lactic acid bacteria counts, yeasts counts, lipolytic bacterial counts, pectinolytic bacterial counts, cellulytic bacterial counts and coliform group counts. The isolates which were taken throughout yeasts counts and lactic acid bacteria counts were identified.

The chemical estimations included The determination of pH values, total titratable acidity, lactic acid, total volatile acids, tannins, vitamin C, NaCl concentration and pectic substances in the brine. On the other hand, soluble acids, total sugars, reducing sugars, total crude-protein, true-protein, , ether extract, tannins, vitamin C, NaCl concentration,pectic substances and moisture were determined in the fruits. The taste, colour, texture, appearance and odor were determined through organoleptic evaluation of the pickled olives.

Results can be summarized in the following :

I. **Microbiological studies:**

1. The total microbical counts in the brines of olives treated with NaOH were higher than the corresponding brines of olives untreated. The total microbial densities in the brines treated with combination of preservatives were lower than that treated with individual preservatives. On the other hand, the highest counts were in the brined whey treatments, pilot and control experiments.

2. Brines untreated with preservatives including whey treatments and starter treated brines contained the highest counts of lactic acid bacteria. On the other-hand, the brines treated with chemical preservatives contained lower counts especially that treated with combination of preservatives. Therefore,the later exhibited lower quality. The highest counts recorded in whey treatments than all treatments, which resulted in obtaining quick pickling.

3. Yeasts counts were competitive with lactic acid bacterial densities, hence they were the first ones exhibited competition with lactic acid fermentation. Yeasts counts were higher in brines of olives treated with NaOH than that of untreated. The inoculation of the brine with starter only did'nt show any effect on the yeasts densities, but the counts increased due to the presence of the nutrients in the whey used in the preparation of the starter. Pilot experiment counts were lower than whey treatments. Sorbate treated brines exhibited potential effect on yeasts densities. The brines treated with combination of preservatives were more affected than that treated with individual preservatives. Yeasts densities in whey treatments were higher than other preservatives treatments.

4. Starter treated brines among individual preservatives did'nt also exhibited any effect on lipolytic bacterial counts but the densities increased in the brines of olives untreated with NaOH. The counts of pilot experiment were higher than that of control. These microorganisms were relatively resistant to the effect of acetic acid. There was a decrease in the counts from the 30 days samples to the end of the experimental period. The great decrease was in sorbate and starter treated brines and the same effect showed in the brines of olives

treated with NaOH. The counts of whey treatments were higher than that of control, pilot experiments and all other treatments except starter treatment.

5. Pectinolytic bacterial counts were higher in pilot experiment than control experiment and the two experiments were higher than individual preservatives treatments. Sorbate was more effective against these microorganisms. The counts in the brines of the olives treated with NaOH were higher than that of the corresponding brines of olives untreated. The brines treated with combination of preservatives were more effective than that of individual ones. The counts were lower in the brines of untreated olives with NaOH than that of the treated. Sorbate + acetic + starter treated brine were more effective on the pectinolytic bacterial counts. The whey treatments counts were lower than pilot, control experiments and most individual preservatives treatments. Whey treatments counts were higher than combination of preservatives treatments.

6. Pilot and control experiments of olives untreated showed higher cellulytic bacterial densities than preservatives treatments. The counts of pilot experiment were higher than control. Sorbate and acetic treated brines exhibited the lowest densities. The counts of combined preservatives treated brines were lower than the counts of individual preservatives ones. The counts of whey treatments were higher than other treatments.

7. Starter treated brine and whey treatments showed high effect on the densities of different microorganisms investigated at the last periods of pickling and during storage period due to the accumulation effect of the inhibitors on the counts.

8. After zero time the coliform group disappeared in preservatives brines but the counts increased in pilot control, starter and whey treatments for 15-30 days then disappeared there after.

9. Presence of preservatives accomponied with the disappearance of some sensitive strains of yeasts and/or raise in the percentage of resistance ones.

10. Species of family **Cryptococcaceae** were more predominated than that of **Saccharomycetaceae** in individual preservatives treated brines.

11. Brines treated with individual preservatives showed **P. membranaefaciens** as a resistant strain.

12. The application of combined preservatives caused the disappearance of some species observed in the brines treated with individual ones and control. Brines treated with combined preservatives of olives treated with NaOH showed more species than that of untreated.

13. Whey treatment exhibited species had not been found in other brines such as **Klu marxians, klu. fragilis and C. pseudotropicalis.** Also, whey treatments rendered higher percentage of pectinolytic species which was higher in whey treatment of olives treated with NaOH than untreated.

14. Sorbate treatment of untreated olives with NaOH exhibited great inhibitory effect on **L. brevis, S. lactis** and **leuc. mesenteroides.** Acetic acid treatment of the same olives was effective against **L. casei.**

15. **Ped. cerevisiae** was the most resistant strain against individual preservatives brines.

16. Sorbate + acetic treatment of olives untreated with NaOH exhibited inhibitory effect on cocci lactics, especially **Leuc. mesenteroides,** while sorbate + starter treatment did'nt inhibit **L. plantarum, S. lactis, Ped. cerevisiae** and **L. casei.** Sorbate + acetic + starter treatmentexhibited great inhibitory effect on cocci lactics, but increased **L. plantarum.** The same trend was shown in brine of olives treated with NaOH.

olives untreated with NaOH than that treated. The highest percentage remained in control experiments, followed by olives untreated with NaOH in the whey, then that found in sorbate + acetic acid treated brine than other treatments.

7. The percentage of reducing sugars remained in the olives untreated with NaOH of sorbate + acetic + starter brine was higher than all other treatments including pilot, control and whey treatments.

8. Percentage of total crude-protein remained in olives untreated with NaOH was higher than that in olives treated. The highest percentage remained in olives untreated in sorbate + acetic treated brine. This was followed by that remained in olives untreated in the whey. True-protein showed the same trend.

9. Ether extract in olives untreated with NaOH was higher than that treated. The highest percentage was in untreated olives in sorbate + acetic + starter treated pickles. The percentages of ether extract in the fruits of preservatives treated brines were higher than corresponding controls and pilot experiment, while whey treatments showed lower percentage than corresponding controls.

10. The fruits in the brines of individual and combined

preservatives exhibited the highest percentage of pectin than pilot and control fruits. The fruits treated with NaOH showed lower percentage than untreated. The olives untreated in sorbate and sorbate + starter treated brines exhibited the highest percentage of pectin, while fruits of whey treatments showed the lowest percentage of pectin.

11. The percentage of tannins in the olives untreated with NaOH was higher than treated olives. . The highest percentage showed in olives untreated with NaOH of sorbate and sorbate + acetic treated brines.

12. Vitamin C was lost from the fruits during pickling. The fruits in the acidified brines with acetic acid exhibited the highest percentage of the vitamin. The vitamin C in the brine was lost in all treatments during storage.

13. The fruits of preservatives brines showed lower percentage of NaCl than that of pilot and control in most treatments including whey treatments. Fruits in acetic treated brines exhibited the lowest percentage of NaCl. The percentage of NaCl in the brine exhibited reverse relationship with that of the fruits.

14. The percentage of the moisture increased with time till the end of the experimental period. The highest increase

was in the fruits of the preservatives brines than pilot and control experiments.

III. Organoleptic tests:

1. Olives untreated with NaOH of acetic treated brine recorded the best evaluation than olives of other individual preservatives.

2. Olives of combined preservatives exhibited lower quality than that of individual preservatives.

3. The best treatment among olives untreated with NaOH in the combined preservatives treated brines was in the fruits in sorbate + acetic + starter, while the best treatment with treated olives was sorbate + starter treatment.

4. Whey treatments exhibited the lowest quality than all treatments after storage period. Olives treated with NaOH in brined whey produced lower quality than that of untreated.

5. Whey treatments may be suitable for quick pickling but not for the storage of pickles.

6. Olives in individual preservatives treated brines were valid for the storage for the herein experimented period (270 days), while olives in combined preservatives treated brines were valid for storage for longer period.