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SUMMARY AND CONCLUSIONS

This work was carried out to discussed influence of cumin and thyme aqueous extracts on certain starter cultures: *Lactococcus lactis subsp cremoris, Lactococcus lactis subsp lactis, Lactococcus lactis subsp diacetylactis, Lactobacillius casei* and yoghurt starter *(Lactobacillus delbrueckii subsp bulgaricus & Streptococcus thermophillus*), also to evaluate antioxidant and anti -microbial effect of both extracts and to evaluate influence of extracts on chemical composition, microbiological and organoleptic properties of kariesh and Domiatti cheese during storage at 5±2°C for 60 days, experiment was design as follow :- five bacterial strains were investigated for acid production and growth rate at different concentrations (control, 0.5, 1, 2, 3, 4 and 5%) at zero time, 24 and 48 h. manufacture of kariesh and Domiatti cheese with addition of different concentrations of extracts (control, 0.5, 1.0, 2.0 and 3.0%) and storage for 60 days at 5±2°C. The most important results obtained from this study are summarized as follows:

1- Analysis of examined spices:

A. The chemical components of EO's (cumin and thyme) were fractionated and identified by GC-MS techniques.
   a. Analysis revealed that the major constituents of the EO from cumin were cuminaldehyde (29.83%), γ-terpinene (14.16%), 3-caren-lo-al (21.49%), 2-caren-lo-al (11.47%) and 2-α-pinene (9.79%).
   b. 29 essential compounds were identified in thyme EO. The major identified compounds were thymol (41.78%), ρ-Cymene (28.53), borneol (4.74%) and γ-terpinen (8.39%).

B. The antioxidant activity of extracts at different concentration by using DPPH radical scavenging was observed. It was noticed that thyme extract had the higher inhibition percentage of radical DPPH (73.23±0.25%) than cumin extract (69.8±0.2%) at 1000µg with high significant differences (F-test, $P<0.01$) between both extracts and among all concentrations.

C. The antimicrobial effect for cumin and thyme extracts was discussed. Data showed that, Gram-positive bacteria (e.g. *Staphylococcus aureus*) were more sensitive than Gram-negative bacteria (e.g. *E. coli*) in both extracts and also data showed that thyme extract has higher antibacterial activity than cumin extract. Inhibition zone for 3% thyme extract were 4 and 8mm for *E. coli* and *Staphylococcus aureus*, respectively, when at the same respect, values for 3% cumin extract were 3 and 5mm.

2- Influence of spices aqueous extracts on certain starter culture:-

A. Yoghurt starter culture:-

a- Cumin and thyme extracts has stimulatory effect which increase acid production. Acid percent for control at zero time was 0.31±0.01% and rose to 0.85±0.025 and 0.79±0.036% in 5% cumin and thyme, respectively. When after 48h of storage at 5±2°C, control sample raised to 0.56±0.02%. At the same respect, values reach to 1.07±0.025 and 1.03±0.02% for cumin and thyme extracts after 48h with high significant differences (F-test, $P<0.01$) among concentrations of both extracts and among storage periods of both extracts.

b- Growth rate increase by increasing of extract concentrations accordingly, total bacterial count in control

sample was 8±0.005 log cfu/ml and it reached to 8.02±0.006 and 8.06±0.005 log cfu/ml in 5% cumin and thyme extracts, respectively at zero time. Also, growth rate increase by increasing storage periods so that it reaches after 48h to 8.02±0.006, 8.06±0.005 and 8.09±0.01 log cfu/ml for control, 5% cumin and thyme, respectively. High significant differences (F-test, $P<0.01$) were observed among different concentrations of both extracts during all storage periods while among storage periods, high significant differences (F-test, $P<0.01$) were reported during storage in 3 and 5% of cumin extract, significant differences ($P<0.05$, F-test) were reported during storage in control and 2% cumin and thyme extracts and non-significant differences (F-test) in other concentrations of both extracts during storage periods.

B. *Lactoccocus lactis subsp lactis* culture:-

a- There is a positive correlation between extract concentrations and acid production. Results for control, 5% cumin and thyme extracts in zero time were 0.33±0.015, 0.93±0.015 and 0.82±0.02%, respectively. On the other hand, at the same respect, after 48h values were 0.57±0.015, 1.32±0.006 and 1±0.02% for control, 5% cumin and thyme extracts. High significant differences (F-test, $P<0.01$) were found among concentrations during all storage periods of both extracts and among storage periods in all concentrations except 5% thyme extract which had significant differences ($P<0.05$, F-test).

b- Also, a positive correlation was present between extract concentrations and growth rate of cultures, values for control, 5% cumin and thyme extracts in zero day were 7.9±0.01, 7.96±0.006 and 7.98±0.01 log cfu/ml, respectively. While values at the same respect, after 48 h reached to 7.98±0.01, 8.26±0.005 and 8.03±0.005 log cfu/ml. High significant differences (F-test, $P<0.01$) were reported among different concentrations of both extracts at all storage periods and among all storage periods at different concentrations.

C. *Lactoccocus lactis subsp cremoris* culture:-

a- Acid percent for control, 5% cumin and thyme extracts –at zero time- were 0.32±0.015, 0.69±0.015 and 0.72±0.025, respectively, at the similar manner, values were –after 48h- 0.52±0.015, 1.01±0.015 and 1.02±0.025% with high significant differences (F-test, $P<0.01$) among concentrations during storage periods and among storage periods at all concentrations.

b- Growth rate of culture at zero time were 7.73±0.01, 7.9±0.01 and 7.85±0.009 log cfu/ml for control, 5% cumin and thyme extracts, respectively. These values reached after 48h to 7.88±0.004, 8.01±0.005 and 8.03±0.009 log cfu/ml at the same respect. High significant differences (F-test, $P<0.01$) were found among all concentrations and among all storage periods.

D. Lactobacillus casei culture:-

a- Acid production was increased by increasing extract concentrations and by increasing storage periods with high significant differences (F-test, $P<0.01$) in both cases. Data at

zero time for control, 5% cumin and thyme extracts were 0.29±0.015, 0.49±0.015 and 0.51±0.009 %, respectively, these values were increased after 48h to become 0.57±0.025, 1.08±0.026 and 1±0.02%, respectively.

b- High significant differences (F-test, $P<0.01$) were recorded among different concentrations of both extracts during storage periods and values for control, 5% cumin and thyme extract were –at zero time- 7.95±0.009, 8.02±0.01 and 8.07±0.005 log cfu/ml, respectively. At the same respect theses values after 48h reached to 7.97±0.021, 8.06±0.004 and 8.12±0.009 log cfu/ml. high significant differences (F-test, $P<0.01$) were recorded during storage periods at 1, 2, 3 and 4% concentrations of both extracts and at 0.5 and 5% in thyme extract, significant differences ($P<0.05$, F-test) were reported at 0.5 and 5% in cumin extract while responding to control sample, non-significant differences (F-test) were recorded.

E. *Lactoccocus lactis subsp diacetylactis* culture:-

a- Acidity values for control, 5% cumin and thyme extracts in zero time were 0.29±0.01, 0.52±0.025 and 0.47±0.015%, respectively and reached after 48h to 0.52±0.025, 1.07±0.025 and 0.97±0.025% at the same respect. High significant differences (F-test, $P<0.01$) were declared among different concentrations during all storage periods and also among during storage periods in all concentrations.

b- Acidity increase as a result of increasing growth rate of culture. Growth rate in zero days for control, 5% cumin and thyme extracts were 7.77±0.01, 7.93±0.01 and 8.03±0.009 log cfu/ml and it raised after 48h to become 7.9±0.01,

7.99±0.005 and 8.07±0.005 log cfu/ml, respectively. High significant differences (F-test, P<0.01) were found among different concentrations during storage periods, and among storage periods at all concentrations except at 4% cumin extract which had significant (P<0.05, F-test).

3- Manufacture of yoghurt supplemented with cumin and thyme extracts

A- Coagulation time:-

Aqueous extracts has stimulatory effect accordingly, coagulation time of yoghurt supplemented with different concentrations were lower than those reported for control. Values for 0.5, 1, 2 and 3% were (2:13, 2:08, 2:05 and 2:00h) and (2:12, 2:10, 2:08 and 2:05h) for cumin and thyme extracts, respectively. These values were lower than control sample which has 2:15h.

B- Organoleptic properties:-

The best all over score in 1st day of storage was for thyme 0.5% while in 2nd day were cumin 1.0%. High significant differences (F-test, P<0.01) were observed in flavour, acidity and all over score properties in 1st day of storage while non-significant differences (F-test) were found in body and texture and appearance, while responding to 2nd day of storage, high significant differences (F-test, P<0.01) were reported in body & texture and all over score, significant differences (P<0.5, F-test) were found in flavour and acidity properties while non-significant differences (F-test) were found in appearance property.

4- Influence of spices aqueous extracts on some cheeses

A- Kariesh cheese

a. Coagulation time:-

There is an inverse correlation between extract concentration and coagulation time. By increasing the concentration of the extract, the coagulation time decreases, values were 1:30, 1:27, 1:20 and 1:18h for 0.5, 1.0, 2.0 and 3.0%, respectively for cumin extract. At the same respect, these values were 1:20, 1:17, 1:15 and 1:15h for thyme extract, while for control it was 1:35h.

b. Microbiological properties:-

Total bacterial counts were decreased by increasing concentrations with high significant differences (F-test, $P<0.01$) among different concentrations of both extracts during storage periods values ranged between 6.83±0.01, 6.23±0.06 and 6.08±0.08 log cfu/g for control, 3.0% cumin and thyme extracts, respectively. These values were increased during storage period to become 7±0.01, 6.57±0.03 and 6.68±0.03 log cfu/g, respectively after 60 days with high significant differences (F-test, $P<0.01$) during storage periods. Regarding to coliform bacteria no detections were found neither in control nor in supplemented cheese.

c. Chemical composition

Acidity content was increased by increasing concentrations and during storage periods with high significant differences (F-test, $P<0.01$) in two cases. Acidity% for control at zero day was 0.36±0.009% and it increase to reach at 3.0% cumin extract 0.513±0.03% these results were increased after 60 days to reach 0.546±0.05 and 0.78±0.03%, respectively, regarding to ash content it ranged between 1.94±0.09% for control and

3.63±0.4% at 3.0% cumin extract with high significant differences (F-test, P<0.01) among concentrations at all storage periods. These results raised to become after 60 days 2.5±0.15 and 4±0.09% without significant differences during storage period at all concentrations except in control which had high significant differences (F-test, P<0.01). non-significant differences (F-test) were found among different concentrations of cumin extract at all storage periods in TS%, values for control and 3.0% cumin extract at zero day were 25.54±1.27 and 24.5±1.36%, respectively, and become after 60 days 27.13±0.7 and 20.06±0.4% at the same respect, after 60 days. High significant differences (F-test, P<0.01) were found in SN% during all storage periods at all concentrations and among different concentrations at all storage period except 15 and 30 days which had significant differences (P<0.05, F-test).

TN% in kariesh cheese supplemented with cumin extract were increase by increasing extract concentrations and it ranged in zero day between 2.99±0.28 and 3.21±0.2% for control and 3.0%, respectively. These results increased after 60 days to reach 2.5±0.05 and 2.5±0.05 at the same respect. Non-significant differences (F-test) were found among storage periods at all concentrations except 1.0% which had significant differences (P<0.05, F-test), also non-significant differences (F-test) were found among different concentrations during storage period except in 45 days which had significant differences (P<0.05, F-test) and 60 days which had high significant differences (F-test, P<0.01). No AN% were found at fresh samples during all concentrations, but after 60 days it were 0.63±0.02 and 0.11±0.09 % for control and 3%, respectively. High significant differences (F-test, P<0.01) were found among all storage periods at all concentrations, also, high significant differences (F-test, P<0.01) were found among different concentrations at all storage periods except zero day which had no-significant differences (F-test).

TP% in kariesh cheese varied between 18.5±1.8 and 19.92±1.3% for control and 3% samples, respectively, these samples become 16.38±0.34 and 18.6±0.37% after 60 days at the same respect. Non-significant differences (F-test) were found among storage periods at all concentrations, also, non-significant differences (F-test) were observed among all concentrations during storage periods except at 45 days which had significant differences ($P<0.05$, F-test) and 60 days which had high significant differences (F-test, $P<0.01$). Regarding to TP/DM%, non-significant differences (F-test) were found among concentrations at zero day which its value ranged between 70.52±7.08 and 81.31±5.31% at control and 3%, respectively, while significant differences ($p<0.05$, F-test) were recorded among concentrations at 15 and 30 days and high significant differences (F-test, $P<0.01$) were recorded at 45 and 60 days. Non-significant differences were found among storage periods at control and 3% while significant differences ($P<0.05$, F-test) were found at other concentrations.

Fat% increased during storage and values for control and 3% in zero day were 0.8±0.099 and 0.92±0.025 % and reached to 0.96±0.04 and 1.2±0.09% after 60 days, at the same respect. Non-significant differences (F-test) were found among storage periods at all concentrations also non-significant differences (F-test) were recorded among concentrations in zero, 30 and 45 days and significant differences ($P<0.05$, F-test) were found in 15 and 60 days. Non-significant differences (F-test) were found among storage periods at all concentrations in fat/DM also, non-significant differences (F-test) were found among concentrations in zero, 30 and 45 days and significant differences ($P<0.05$, F-test) were found in 60 days and high significant differences (F-test, $P<0.01$) were found in 15 days, results for control and 3% were 3.13±0.38 and 3.76±0.1% at zero day while after 60 days it were 3.56±0.15 and 4.62±0.34%, respectively.

Salt content in kariesh cheese in zero day ranged between 1.68±0.16 and 2.53±0.18 for control and 3% and become after 60 days 2.27±0.21 and 3.78±0.01%, respectively. High significant differences (F-test, P<0.01) were found among all concentrations at all storage periods and also among storage periods at all concentrations except for control which had significant differences (P<0.05, F-test). Regarding to salt in serum, values varied between 2.25±0.21 and 3.35±0.24% in zero day at control and 3.0% at the same respect, these values reach after 60 days to 3.12±0.21 and 5.34±0.39%. High significant differences (F-test, P<0.01) were found among all concentrations at all storage periods and also among storage periods at all concentrations except for control which had significant differences (P<0.05, F-test).

Responding to kariesh cheese supplemented with thyme extract, acidity content ranged between 0.36±0.009 and 0.48±0.02% for control and 3.0%, at the same respect, values after 60 days were0.456±0.05 and 0.72±0.02%. High significant differences (F-test, P<0.01) were found among all storage periods at all concentrations, also among all concentrations at all storage periods except for 30 days which had significant differences (P<0.05, F-test). Ash content have high significant differences (F-test, P<0.01) were among all storage periods at all concentrations and among concentrations in 60 days while non-significant differences were found among concentrations at zero, 15, 30 and 45 days and values in zero day for control and 3.0% were 1.94±0.09 and 2.07±0.2% at the same respect these values become after 60 days 2.5±0.15% and 3.01±0.1%.

TS content increase by increasing storage periods and its value at zero day were 25.54±1.27 and 24.66±2.01%, for control and 3.0%, respectively and reach after 60 days at the same respect, to 27.13±0.7 and 25.66±0.55% without any significant differences (F-test) neither among

storage periods nor concentrations. SN content were ranged between 0.185±0.005 and 0.166±0.007% for control and 3.0% in zero day while after 60 days values at the same respect, were 0.59±0.001and 0.49±0.009%. High significant differences (F-test, P<0.01) were among storage periods at all concentrations and also among concentrations for 15, 30 and 60 days, significant differences (P<0.05, F-test) were found in concentrations of zero day and non-significant differences (F-test) were found in 45 days.

TN% ranged between 2.9±0.28 and 2.99±0.09% in zero day for control and 3.0%, respectively, and it reach after 60 days to 2.45±0.05 and 2.7±0.04% without significant differences (F-test) neither among concentrations nor among storage periods. High significant differences (F-test, P<0.01) were found in AN% among storage periods at all concentrations and among different concentrations at all storage periods except in zero day which had non-significant differences (F-test), no AN% were found in zero day while it raised after 60 days to 0.63±0.02 and 1.04±0.01% for control and 3.0%, respectively.

Non-significant differences (F-test) were found among all concentrations during storage periods in TP% values for zero day were 18.51±1.8 and 19.42±0.57% for control and 3.0%, respectively these values decreased during storage and become 16.38±0.34 and 17.22±0.31%, respectively. Non-significant differences (F-test) were found among storage periods for control, 1.0 and 2.0% while significant differences (P<0.05, F-test) were found during storage for 0.5% and high significant differences (F-test, P<0.01) were found in 3.0%. TP/DM% ranged between 70.52±7.08 and 80.4±2.33% for control and 3.0%, respectively at zero day these value after 60 days become 60±1.2 and 67.1±4.24% at the same respect, non-significant differences (F-test) were found among concentrations at zero and 45 days and significant

differences (P<0.05, F-test) were observed at 15 and 60 days while high significant differences (F-test, P<0.01) were found at 30 days, during storage period non-significant differences (F-test) were found in control while significant differences (P<0.05, F-test) were found 1.0 and 2.0% and high significant difference (F-test, P<0.01) were found at 0.5 and 3.0%.

Non-significant differences were found in fat content among concentrations at all storage periods except 60 days which had high significant differences (F-test, P<0.01) also non-significant differences (F-test) were observed during storage periods at all concentrations except 3.0% which had significant differences (P<0.05, F-test). At zero day fat content ranged between 0.8±0.09 and 0.94±0.09% for control and 3.0%, respectively while after 60 days it reach 0.96±0.04 and 1.21±0.07%, at the same respect. Fat/DM% ranged in zero day between 3.13±0.38 and 3.82±0.38% for control and 3.0%, respectively and become 3.56±0.15 and 4.74±0.3%, at the same respect after 60 days, non-significant differences (F-test) were found among storage periods at all concentrations also among concentrations for zero and 30 days while significant differences (P<0.05, F-test) were found at 15 and 45 days and high significant differences (F-test, P<0.01) were found at 60 days.

Salt% ranged in zero day between 1.68±0.16 and 1.79±0.06% for control and 3.0% respectively these values after 60 days reached to 2.27±0.15 and 3±0.09% at the same respect, high significant differences (F-test, P<0.01) were found among storage periods at different concentrations except control which had significant differences (P<0.05, F-test), also non-significant differences (F-test) were found among concentrations at zero, 15 and 30 days and high significant differences (F-test, P<0.01) were found at 45 and 60 days. Salt in water % ranged between 2.25± 0.21 and 2.37±0.08% for control and 3.0% in zero day at

the same respect, it reach after 60 days to 3.12±0.21 and 4.04±0.12%. High significant differences (F-test, P<0.01) were found among storage periods at different concentrations except control which had significant differences (P<0.05, F-test), also non-significant differences (F-test) were found among concentrations at zero, 15 and 30 days while significant differences (P<0.05, F-test) were found 45 days and high significant differences (F-test, P<0.01) were found at 60 days.

d. Organoleptic properties:-

Non-significant differences (F-test) were found among concentrations of cumin extract in all properties the best scores in zero, 15, 30, 45 and 60 days were for 0.5, 3.0, 2.0, 1.0 and 3.0% respectively while in case of thyme extract it reported for 1.0, 1.0, 1.0 0.5 and 0.5%, respectively.

B- Domiatti cheese:-

a. Coagulation time:-

Coagulation time of Domiatti cheese supplemented with cumin extract at different concentrations were 15 min while those supplemented by thyme extract were 17 min while in control were 20min.

b. Microbiological properties:-

Total bacterial count in cheese supplemented with both of cumin and thyme extracts were lower than control sample, data for control, 3.0% cumin and thyme in zero day were 6.93±0.01, 6.14±0.06 and 6.1±0.08 log cfu/g, respectively which increase after 60 days and become 7.18±0.006, 7±0.01 and 6.98±0.017 log cfu/g at the same respect. High significant differences (F-test, P<0.01) were found among concentrations and among storage periods in both extracts.

c. Chemical composition

Regarding to cheese supplemented with cumin extract, acidity content were 0.36±0.009 and 0.42±0.02% for control and 3.0% at zero day respectively these values reach to 0.49±0.01 and 0.59±0.02% at the same respect after 60 days, non-significant differences (F-test) were found among concentrations at zero and 15 days while significant differences ($P<0.05$, F-test) were observed in 30 days and high significant differences (F-test, $P<0.01$) were reported for 45 and 60 days. Ash content increase during storage and it range between 3.16±0.12 and 3.52±0.11% for control 3.0% in zero day to 3.78±0.15 and 4.21±0.27% at the same respect after 60 days non-significant differences (F-test) were found among concentrations during all storage periods except zero day which had significant differences ($P<0.05$, F-test) also high significant differences (F-test, $P<0.01$) were found among storage periods at all concentrations except 3.0% which had significant differences ($P<0.05$, F-test).

Non-significant differences (F-test) were found in TS% neither among concentrations nor storage periods. Values for control and 3.0% at zero day were 33.73±1.16 and 32.52±1.1%, respectively and become after 60 days at the same respect 34.9±0.8 and 33.7±0.84%. SN content at zero day for control and 3.0% were 0.23±0.009 and 0.168±0.007%, respectively and raised to (after 60 days) 0.62±0.02 and 0.53±0.01% at the same respect, high significant differences (F-test, $P<0.01$) were found among storage periods at all concentrations and among different concentrations at all storage periods except 30 days which had significant differences ($P<0.05$, F-test).

TN% ranged between 1.64±0.15 and 1.77±0.08% for control and 3.0% at zero day respectively, it reach after 60 days at the same respect to 1.47±0.16 and 1.7±0.23%. Non-significant differences (F-test) were

found during storage periods at all concentrations and among concentrations at all storage periods except 30 days which had significant differences (P<0.05, F-test) and 45 days which had high significant differences (F-test, P<0.01). AN% increased during storage periods from 0.0 at zero day to 0.4±0.01 and 0.92±0.02% at control and 3.0% after 60 days respectively, high significant differences (F-test, P<0.01) were found during all storage periods at all concentrations and among different concentrations during storage periods except zero day which had non-significant differences (F-test).

Non-significant differences (F-test) were found among storage periods at all concentrations in TP% while responding to concentrations, non-significant differences (F-test) were recorded at zero, 15 and 60 days while significant differences (P<0.05, F-test) were found in 45 days and high significant differences (F-test, P<0.01) were found in 30 days. Values of TP% in zero day ranged between 10.48±0.35 and 11.53±0.55% for control and 3.0%, respectively which decreased after 60 days and reach to 9.39±0.16 and 10.5±0.76% at the same respect. Also non-significant differences (F-test) were found among all storage periods at all concentrations in TP/DM% and values were 31.07±2.84 and 34.78±1.69% at zero days for control and 3.0%, respectively these values reached after 60 days to 26.58±2.95 and 31.98±4.37% at the same respect, non-significant differences (F-test) were reported among concentrations at zero and 60 days while high significant differences (F-test, P<0.01) were found at 30 and 45 days and significant differences (P<0.05, F-test) were reported at 15 days.

Fat content ranged between 19.73±0.32 and 19.8±0.1% for control and 3.0% at zero day respectively, these results become after 60 days 20.76±0.25 and 21.23±0.15% at the same respect, non-significant differences (F-test) were recorded among storage periods at all

concentrations except 3.0% which had high significant differences (F-test, P<0.01) also non-significant differences (P<0.05, F-test) were found among all concentrations during storage periods except 45 days which had significant differences (P<0.05, F-test). Fat/DM% reported high significant differences (F-test, P<0.01) among all concentrations at zero, 45 and 60 days while significant differences (P<0.05, F-test) were recorded at 15 and 30 days. Results of Fat/DM% varied between 58.49±0.95 and 60.88±0.33% at zero day for control and 3.0%, respectively and it reach after 60 days at the same respect, to 59.49±0.72 and 61.9±0.45%, non-significant differences (F-test) were reported during storage periods at all concentrations except 3.0% which had high significant differences (F-test, P<0.01).

High significant differences (F-test, P<0.01) were found in salt% among all concentrations except in 60 days which had non-significant differences (F-test) and among storage periods except 1.0% which had significant differences (P<0.05, F-test), results ranged between 1.9±0.09 and 2.58±0.08% for control and 3.0% in zero day, respectively and it ranged after 60 days between 2.76±0.25 and 3.15±0.24% at the same respect, in salt in water%, high significant differences (F-test, P<0.01) were found among storage periods at all concentrations also among different concentrations at storage periods except 60 days which had non-significant differences (F-test).

Regarding to cheese supplement with thyme extract, acidity content ranged between 0.36±0.009 and 0.43±0.02% at zero day for control and 3%, respectively while after 60 days it reached to 0.49±0.01 and 0.59±0.01% at the same respect. High significant differences (F-test, P<0.01) were found among storage periods at all concentrations also among different concentrations at storage periods except 15 days which had significant differences (P<0.05, F-test). Ash content ranged between

3.06±0.2 and 3.54±0.23% at zero day for control and 3%, respectively, while after 60 days it ranged between 3.78±0.15 and 4.24±0.6% at the same respect. Non-significant differences (F-test) were found among different concentrations at all storage periods except 30 days which had significant differences ($P<0.05$, F-test) on the other hand, non-significant differences (F-test) were found among storage periods at all concentrations except in control which had high significant differences (F-test, $P<0.01$) and 0.5% which had significant differences ($P<0.05$, F-test).

Non-significant differences (F-test) were found neither among storage periods nor concentrations in TS% and results for control and 3% at zero day were 33.73±1.16 and 32.76±1.1%, respectively while after 60 days it become 34.9±0.8 and 34.1±1% at the same respect. High significant differences (F-test, $P<0.01$) were found in SN% among storage periods at all concentrations and also, among different concentrations at all storage periods except 45 days which had non-significant differences (F-test). Values at zero day were 0.23±0.009 and 0.17±0.01% for control and 3%, respectively, these values increase during storage and reached after 60 days to 0.62±0.02 and 0.54±0.01%.

TN% results vary at zero day between 1.64±0.15 and 1.93±0.05% for control and 3%, respectively. At the same respect, values after 60 days were 1.47±0.16 and 1.55±0.08%. High significant differences (F-test, $P<0.01$) were found among different concentrations at 30 days while significant differences ($P<0.05$, F-test) were found at zero, 15 and 45 days and non-significant differences (F-test) were found in 60 days, regarding storage periods, high significant differences (F-test) were found among storage periods at 1.0 and 2.0% while significant differences ($P<0.05$, F-test) were found in 0.5 and 3.0% and non-significant differences (F-test) were found in control. AN% results increase from 0.0

at zero day to 0.4±0.01 and 0.98±0.02 at control and 3% after 60 days, respectively. High significant differences (F-test, P<0.01) were found among storage periods at all concentrations also among different concentrations during storage periods except for zero day which had non-significant differences (F-test).

TP% decreased during storage and ranged between 10.48±0.95 and 12.31±0.37% in zero day for control and 3%, respectively and after 60 days it reached to 9.39±0.16 and 9.88±0.51% at the same respect, non-significant differences (F-test) were found among concentrations at 30 and 60 days while significant differences (P<0.05, F-test) were found in zero, 15 and 45 days, on the other hand, non-significant differences (F-test) were observed among storage periods at control while significant differences (P<0.05, F-test) were reported at 0.5 and 3% and high significant differences (F-test, p<0.01) were recorded at 1.0 and 2.0%.

TP/DM% results were 31.07±2.84 and 37.58±1.16% for control and 3%, respectively at zero day while after 60 days these values were 26.58±2.95 and 30.99±1.49% at the same respect. High significant differences (F-test, P<0.01) were found among different concentrations at zero, 15 and 45 days and significant differences (P<0.05, F-test) were reported at 30 days while non-significant differences (F-test) were found at 60 days, on the other hand, high significant differences (F-test, P<0.01) were recorded among storage periods at 0.5, 1 and 2% and significant differences (P<0.05, F-test) were reported at 3% while non-significant differences were found in control.

Fat content at zero day were 19.73±0.32 and 20.73±0.5% for control and 3%, respectively while after 60 days it were 20.76±0.25 and 22.23±0.25% at the same respect. High significant differences (F-test, P<0.01) were observed among different concentrations at 30, 45 and 60 days, while non-significant differences (F-test) were reported at zero and

15 days, on the other hand non-significant differences (F-test) were found during storage periods at control, 0.5 and 1% while significant differences ($P<0.05$, F-test) were recorded at 2% and high significant differences (F-test, $P<0.01$) were recorded at 3%. Non-significant differences (F-test) were found in fat/DM% among storage periods at all concentrations except 3% which had significant differences ($P<0.05$, F-test) while high significant differences (F-test, $P<0.01$) were found among different concentrations during storage except control which had significant differences ($P<0.05$, F-test) with values ranged between 58.49±0.95 and 63.27±1.53% in control and 3% in zero day, respectively while ranged between 59.49±0.72 and 65.19±0.74% at the same respect, after 60 days.

Salt percent ranged at zero day between 1.9±0.09 and 2.59±0.52% for control and 3%, respectively and after 60 days it were 2.76±0.25 and 3.03±0.89% at the same respect. High significant differences (F-test, $P<0.01$) were recorded among different concentrations at 15, 30 and 45 days while non-significant differences (F-test) were found at zero and 60 days, on the other hand, high significant differences (F-test, $P<0.01$) were recorded during storage periods at control and 0.5% while non-significant differences (F-test) were recorded at 1.0, 2.0 and 3.0%. Salt/water percent in zero day for control and 3% were 2.89±0.14 and 4.15±0.78%, respectively while after 60 days these results reached to 4.23±0.4 and 5.03±0.91%, at the same respect, with high significant differences (F-test, $P<0.01$) among different concentrations at 15 days and significant differences ($P<0.05$, F-test) were observed at 30 and 45 days while non-significant differences (F-test) were recorded at zero and 60 days, on the other hand, high significant differences (F-test, $P<0.01$) were recorded among storage periods at control and 0.5% while non-significant differences (F-test) were reported at 1.0, 2.0 and 3.0%.

d. Organoleptic properties:-

Regarding to Domiatti cheese supplemented with cumin extract, the best all over scores for zero, 15, 30, 45 and 60 days were for 3.0, 2.0, 2.0, 2.0 and 1.0% while in case of thyme extract and the best all over scores were for 3.0%, 0.5, 0.5, 0.5 and 1.0%.

From the obtained results, it could be recommended that using aqueous extracts in manufacturing of kariesh and Domiatti cheese resulted in improving both keeping quality and sensory properties. Extracts of aromatic and medicinal plants such as cumin and thyme demonstrated satisfactory antimicrobial activity against pathogens and spoilage microorganisms associated with cheese contamination thus indicating great potential in their use as natural preservatives which has better effect in promoting health.