4. RESULTS AND DISCUSSION

4.1. Chemical composition of banana, apple and natural extracts:

Data presented in Table (1) showed that the moisture content was the highest content (98.75, 98.00 and 98.90%) in natural extracts cabbage, taro pulp and taro peel respectively, 91% in apple and 89% in banana but it were 85.7% in fresh apple and 83.12% in fresh banana. However, banana and apple fruits could not be considered as a source of protein, where, the percentage of protein was 4.23–3.12%, respectively, but, the percentage of protein was very low 0.37, 0.49 and 0.26% in natural extracts, cabbage, taro pulp and taro peel, respectively. Total carbohydrate were also very low in natural extracts (cabbage, taro pulp and taro peel) but increased in fresh banana and apple fruits 9.22 and 10.21% respectively. Lipids percentage were approximately at similar levels (0.21 and 0.32%) in natural extracts and it were 1.25 and 1.98 in fresh banana and apple fruits, respectively. Ash percentage were approximately at similar levels (0.13 and 0.15%) in natural extracts but increased in fresh banana and apple fruits 1.89 and 1.25%, respectively.

These results in agreement or very closely with the results of **Drake (1999).**

Data presented in Table (1) indicate that moisture content showed the highest content (83-98%, respectively) in natural extracts, banana and apple. A protein content of 3.12 – 4.23% indicated that natural extracts, banana and apple could not be considered as a source of protein.

These results are in agreement with those of **Karathamos *et al.* (1999).**

4.2. Thermal treatments:

4.2.1. Effect of heat treatments on different extracts of polyphenol oxidase (PPO), peroxidase (POD) and catalase (CAT) activities of banana and apple slices:

Blanching of slices banana and apple were carried out by two different methods; boiling water at 100^{o}C and steam at atmospheric pressure. Residual activities of PPO, POD and CAT in the blanched banana and apple samples were determined and recorded in Tables (2 and 3).

From these tables, it could be seen that the activity of the oxidative enzymes in the control (un-blanched banana and apple slices samples) were 3.30, 0.45 and 0.63 units/mg) and (0.097, 0.470 and 0.065 units/mg) for PPO, POD and CAT, respectively. A one minute blanching of samples in water at 100^{o}C and steam was not sufficient for inactivation of PPO and POD enzymes, since the residual activities were (0.44 units/mg) and (0.029 and 0.12 units/mg), respectively. CAT enzyme was totally inactivated after 2 and 5 min blanching at 100^{o}C in water and steam respectively. Steam blanching of fruit samples was less effective than boiling in water with regard to enzyme inhibition, as seen in Table (3).

The residual activities of peroxidase (POD) were at all treatments relatively higher than those of PPO which prove the assumption that POD enzyme is the most heat resistant enzyme during blanching treatment.

Blanching of banana and apple slices was carried out in boiling water (100^{o}C) and steam at 90^{o}C for 30 sec. Residual activity of PPO enzyme in the blanched fruit slices were given in Tables (2 and 3)

From these tables, it could be seen that blanching treatment of 5 min in water at 100^{o}C was sufficient to inhibit the PPO enzyme activity to 97.52% in all bana slices.

On the other hand, steam blanching was the same effect of boiling in water with respect to PPO enzyme inhibition. However, at 5 min steam blanching was sufficient to inhibit the PPO enzyme activity to 97.81% in all fruit slices.

From these results, it could be seen that a high degree of inactivation has been achieved in the first 2 min until 5 min of water and steam blanching treatment. These results are in agreement with those reported by **Eissa (1992).**

The treatment conditions were drastic and produced a slight over cooking of final product, but this treatment is necessary to inhibition the color changes deterioration of stored fruit slices if the simultaneous addition of chemical preservatives is to be avoided **Siddiq *et al.* (1992)** they confirmed that plum PPO of banana and apple seems to be relatively heat sensitive when compared to PPO from some other fruit **Mohamed (1998)**.

From these results, it could be concluded that the blanching of fruit slices for 5 min in boiling water was sufficient to reduce the activity of PPO enzyme to 97.52% in all fruit slices. The residual activity achieved after 5 min of steam blanching were 97.81-79.38% in banana and apple slices.

4.3. Chemical treatments:

The purpose of these experiments was to study the activity and inhibition pattern of some chemical compounds on the oxidative enzymes of banana and apple fruits. The samples were soaked in different mono-component solutions for a period of 10 min. at 60^{o}C, after which they have been tested for enzyme activity (PPO, POD and CAT). The applied chemical components were: ascorbic acid (AA), citric acid (CA) and sodium metabisulfite ($Na_2S_2O_5$). In this part, AA (0.5, 1.0 and 2.0%), CA (0.5, 1.0 and 2.0%) and $Na_2S_2O_5$ (0.05, 0.1 and 0.2%) was used as dipping solutions for banana and apple slices fruits.

4.3.1. Effect of different anti-browning agents on the activity of PPO, POD and CAT in banana slices

From these results, following observations could be drawn: The effect of ascorbic acid (AA) on iron enzymes (POD and CAT) was more pronounced than its effect on copper containing enzyme PPO. Dipping in 2% AA solution reduced the POD and CAT activity to 55.20-75.0% of their original activity, while the corresponding value for PPO was 48.87%. It could be also observed, that AA was non effective inhibitor for PPO enzyme which is the most critical enzyme in banana and apple processing because its browning effect.

The use of citric acid (CA) was effective in the inhibition of the three tested oxidative enzymes to an acceptable level for banana and apple processing. Increasing the concentration of CA in the dipping solution from 0.5 to 2% has reduced the residual activity of POD from 14.58% to 44.79%. The corresponding

values for CAT were 26.19 to 73.81%. Inhibition of PPO was not to much high as POD and CAT, but an increase in citric acid concentration from 0.5 to 2% has reduced the PPO activity to 40.47% (Table, 4).

The most effective treatment for the inhibition of oxidative enzymes in banana and apple fruits were dipping in solutions containing sodium metabisulfite ($Na_2S_2O_5$). Application of 0.2% solution of sodium metabisulfite ($Na_2S_2O_5$) has reduced the enzyme activity to an acceptable level for processing. At this level of concentration, 87.50% of POD and PPO and 100% of CAT activities were inhibited after a 10 min. of dipping treatment.

4.3.2. Effect of different anti-browning agents on the activity of PPO, POD and CAT in Egyptian apple slices:-

The purpose of these experiments were to study the inhibition pattern of some chemical compounds on the oxidative enzymes of red apple fruit slices, pulp and juice. The slices and pulp were soaking in different solutions for a period of 10 min at room temperature. But were added as a solution with different concentrations to juice, after which they have been tested for enzyme activity. The applied chemical compounds were ascorbic acid (AA), citric acid (CA) and sodium metabisulfite ($Na_2S_2O_5$).

4.3.2.1. Effect of dipping apple slices in ascorbic acid (AA):-

For this purpose banana and apple fruit slices were dipped in solution containing different concentrations (0.5, 1.0 and 2.0%) of ascorbic acid as a browning inhibitor after each

treatment oxidative enzymes activities were assayed and the results were given in Table (4).

The effect of ascorbic acid on polyphenoloxidase activity and the ratio of inhibition browning were studied.

From these results following observation could be considered. The effect of AA on PPO enzyme was more efficient in banana and apple. Dipping in 2.0% AA solution reduced the PPO enzyme activity to 48.87 and 75.64% in banana and apple slices respectively of their original activity. It could be also observed that AA was non-high effective inhibitor for PPO enzyme, which is the most critical enzyme in banana and apple processing, because of its browning effect and penetration of the AA solution to banana and apple tissue did not well. Therefore, it could be concluded that an increase of AA concentration to 2.0% would be of a great benefit for the inactivation of PPO enzyme activity in fruit slices. These results are in agreed with the results obtained by **Nasr (1994) and Mohamed (1998)**.

4.3.2.2. Effect of dipping apple slices in citric acid (CA):

For this purpose banana and apple fruit slices were dipped in solution containing different concentration (0.5, 1.0 and 2.0%) of citric acid as a browning inhibitor after each treatment PPO enzyme activity was assayed and the result were given in Tables (4 and 5).

The use of citric acid was effective in the inhibition of the PPO enzyme to an acceptable level for fruit slices processing. Increasing concentration of CA in the dipping solution to 2.0% has reduced the residual PPO activity to 40.47 and 75.00% in

banana and apple, respectively, concentration on PPO activity in different fruit slices.

It could be also observed that CA was non-high effective inhibitor for PPO enzyme, which is the most critical enzyme in apple, banana and pear processing, because of its browning effect and penetration of the CA solution to apple, banana and pear tissue did not well.

Therefore, it could be concluded that an increase of CA concentration to 2.0% would be of a great benefit for the inactivation of PPO enzyme activity in fruit slices, especially banana and apple slice. This could be attributed to the inhibition of PPO by soaking and as the percentage inhibition increased the degree of browning decreased.

These result are in agreement with **Eissa (1992) and Abd El-Wahab 1999)** published that dipping of the fruit slices in citric acid and sodium chloride solution caused a great inhibition of polyphenoloxidase.

4.3.3.3. Effect of dipping apple slices in sodium metabisulfite ($Na_2S_2O_5$)

For this purpose banana and apple fruit slices were dipped in solution containing different concentration (0.05, 0.1 and 0.2%) of sodium metabisulfite as a browning inhibitor after each treatment PPO enzyme activity was assayed and the result were given in Tables (4 and 5).

The most effective treatment for the inhibition of PPO enzyme in fruit slices was dipping in solution containing sodium metabisulfite. Application of a 0.2% solution of sodium

metabisulfite reduced the enzyme activity to an acceptable level for processing. At this level of concentration 96.74 and 87.17% of PPO activity were inhibited in banana and apple slices, respectively. Therefore, it could be concluded that an increase of $Na_2S_2O_5$ concentration to 0.2% would be of a great benefit for the inactivation of PO enzyme activity in fruit slices, especially banana slice.

This results are in agreement with the results obtained by **Siddiq *et al.* (1992), Nasr (1994) and Mohamed (1998)** they confirmed that increasing concentration of $Na_2S_2O_5$ and dipping time enhanced the inactivation of banana, papaya and pear slices.

From the previous resulted could be concluded that the best concentration of ascorbic acid (AA) was 2.0% to effect in improving final acceptability and to make inhibition of PPO activity in various fruit slices, especially for banana and apple. Also, the best concentration of CA was 2.0% to inhibition of PPO in banana and apple. However, it could be noticed that addition of $Na_2S_2O_5$ at 0.2% in the soaking solution took place as the inhibition of PPO increased. The results indicated that the blanching of fruit slices for 5 min in boiling water was sufficient to reduce the activity of PPO enzyme to 100% in all fruit slices. The residual activity achieved after 5 min of steam blanching were 100% in banana and apple slices.

4.4. Effect of Natural extracts (as pretreatments) on oxidative enzymes (PPO-POD-CAT) in dried banana and apple rings or banana and apple puree or slices.

Prevention the browning of apple slices has been difficult to achievement because of rapidity of the enzymatic oxidation for phenolic substrates **(Annese *et al.*, 1997 and Kim *et al.*, 1993)**. A common approach for enzymatic browning prevention is the use of antibrowning agents that act primarily on the enzyme or react with substrates and/or products of enzymatic catalysis so that pigment formation is inhibited **(McEvily *et al.*, 1992)**.

Pre-drying treatments, subsequent drying and re-hydration induce many changes in structure and composition of plant tissue. Hence, re-hydration can be considered as a measure of the injuries to the material caused by drying and treatments preceding dehydration. The porous structure of dried fruits and vegetables can affect both transport properties and quality characteristics **(Lewicki, 1998)**.

Natural extracts treatment i.e. cabbage, taro pulp and taro peel were used as natural inhibitor or as natural inhibitor of enzymatic browning (PPO, POD and CAT) in fresh banana and apple puree or slices and dried banana and apple rings, compared with the effectiveness of steam and water blanching or chemical pretreatments.

4.4.1. Effect of natural extracts on oxidative enzymes in pulp and dried banana slices:

The effect of natural extracts treatments (cabbage, taro, pulp and taro peel) at different concentrations, 5, 10, 15, 20 and 25% on polyphenoloxidase (PPO), peroxidase (POD) and catalase (CAT)in pulp and dried banana slices were evaluated. The obtained results are recorded in tables (6 and 7). From the obtained results, it could be seen that the activity of polyphenoloxidase (PPO) in fresh banana slices (control) was 0.064 units/mg but the activity of PPO in 5%cabbage treated slices 0.046 units/mg) was slightly higher than the activity of PPO in (15%) taro pulp treated slices 0.051 units/mg). The activity of peroxidase (POD) in fresh banana slices was 0.054 units/mg but the activity of POD in (15%) cabbage treated slices 0.031 units/mg) was slightly higher than the activity of POD in (15%) taro pulp treated slices 0.030 units/mg). Also, the activity of catalase (CAT) in fresh banana slices was 0.452 units/mg but the activity of CAT in 15%cabbage treated slices (0.223 units/mg) was slightly higher than the activity of CAT in (15%) taro pulp treated slices (0.206 units/mg).

The maximum percent of inhibition (%) of polyphenoloxidase PPO enzymes were 51.56, 54.00 and 50.0% in banana slices treated by cabbage, taro pulp and taro peel (15%), respectively. But, the maximum low residual activity percentage of peroxidase enzyme were 44.44, 42.59 and 40.37% in banana pulp treated with (15%) of cabbage, taro pulp and peel.

At the same natural extracts and same concentrations the maximum percent of inhibition % of catalase CAT enzymes were 50.66, 54.42 and 41.81%. The values of inhibition of the treated slices with taro extracts were higher than that of the cabbage extract and untreated banana slices.. However, the percent of inhibition (%) was very low in untreated banana slices. At least three different modes of inhibitors action can be theorized include: the direct inhibition of PPO enzyme, the chemical reduction of O-quinones back into O-diphenolic compounds, and the manipulation or removal of the phenolic substrates of PPO. A process for the inhibition of enzymatic browning (PPO) in fruit juices by the third mechanism, involving the use of cyclodextrins, was described by **Sapers *et al.* (1989)**.

4.4.2. Effect of natural extracts on oxidative enzymes in pulp and dried apple slices:

The effect of natural extracts on oxidative enzymes in pulp and dried slices were studied. The data are presented in Tables (8 and 9). From the obtained results, it could be seen that the activity of polyphenoloxidase (PPO) in fresh apple pulp was (0.0045 units/mg) but the activity of PPO in (15%) cabbage treated apple (0.0016 units/mg) slightly higher than the activity of PPO in (15%) taro pulp treated apple (0.0017 units/mg). The activity of peroxidase (POD) in fresh apple pulp was (0.185 units/mg) but the activity of POD in (15%) cabbage treated pulp (0.0062 units/mg) was slightly higher than the activity of POD in (15%) taro pulp treated apple (0.064 units/mg). Also, the activity of catalase (CAT) in fresh apple pulp was (0.366 units/mg) but

the activity of CAT in (15%) cabbage treated apple (0.241 units/mg) was slightly higher than the activity of CAT in (15%) taro pulp treated apple (0.261 units/mg).

On the other hand, the percent of inhibition (%) of PPO and POD was high in (15%) of taro pulp treated apple pulp (62.22-65.40%) versus in (15%) in cabbage treated apple.

From the data presented in Table (7), it could be seen that the activity of polyphenoloxidase (PPO) in dried banana rings was (0.078 units/mg) but the activity of PPO in 15% cabbage treated rings (0.045 units/mg) was slightly higher than the activity of PPO in (15%) taro pulp treated slices (0.043 units/mg). The activity of peroxidase (POD) in dried banana rings was (0.093 units/mg) but the activity of POD in (15%) cabbage treated rings (0.052 units/mg) was slightly higher than the activity of POD in (15%) taro pulp treated rings (0.050 units/mg). Also, the activity of catalase (CAT) in fresh banana rings was 0.045 units/mg but the activity of CAT in (15%) cabbage treated rings (0.020 units/mg) slightly higher than the activity of CAT in (15%) taro pulp treated slices (0.018 units/mg).

The percent of inhibition (%) of PPO, POD and CAT was high in 15%of taro pulp treated slices (44.87-46.23 and 60%) versus (42.30-44.08 and 55.55%) in 15% in cabbage treated slices.

However, the activities of oxidative enzymes in dried apple rings are recorded in Table (9). The activity of polyphenoloxidase (PPO) enzyme in dried apple rings in (15%) cabbage treated slices (0.401 units/mg) was slightly higher than

the activity of PPO in (15%) taro pulp treated slices (0.395 units/mg). The activity of peroxidase (POD) in dried apple rings was (0.045 units/mg) but the activity of POD in (15%) cabbage treated slices (0.025 units/mg) was slightly higher than the activity of POD in (15%) taro pulp treated slices (0.024 units/mg). Also, the activity of catalase (CAT) in dried apple rings was (0.448 units/mg) but the activity of CAT in (15%) cabbage treated slices (0.413 units/mg) was slightly higher than the activity of POD in (15%) taro pulp treated slices (0.412 units/mg).

The percent of inhibition (%) of PPO, POD and CAT was high in (15%) of taro pulp and peel treated apple slices (44.75-46.66 and 80.35%) vrsus in (43.91-44.44 and 71.72%) cabbage treated slices.

It was also observed that the cabbage, taro pulp and taro peel extracts from 5 to 15% treated apple slices had a positive effect controlling or retarding color changes and inhibition of oxidative enzymatic browning (PPO, POD and CAT) when applied to natural dried banana and apple rings and banana and apple pulp. or all the previous causes the use of cabbage, taro pulp and taro peel extracts for reduced total phenols as well as the inhibition of oxidative enzymatic browning can be suggested to improve quality and safety of the dried banana and apple rings or banana and apple pulp.

Natural LVE-treatments, especially cabbage, taro pulp and taro peel extract may be effective inhibitors of PPO, POD and CAT catalyzed browning. While cabbage extract itself was not as effective as steam chemicals in inhibiting browning in

dried banana and apple rings and pulp, it still may be useful where use of chemicals are to be avoided.

These data suggested that in addition to producing dried apple rings by inhibiting browning and microbial growth without imparting objectionable color and flavor, these treatments (cabbage, taro pulp and taro peel extracts) incorporating the anti-browning compounds also maintained higher pigments levels, retained color stable (white and red peel) higher galactomannan content in taro pulp(ferros sugar) whitch separated between substrate and enzyme, had no browning and had no deterioration in sugar levels indicative of better maintenance of quality after drying of banana and apple slices and pulp. Also, this technique is important to prevent of decrease in market value and the concomitant economic losses **(Eissa and Salama, 2002)**.

4.5. Color:

The surface color of banana pulp was measured with a color difference meter, using the Hunter Lab color scale. Under all tested conditions, $Na_2S_2O_5$ showed much higher efficient values based on a-values than A420 measurements, whereas 7 the other anti-browning agents had an opposite trend. For all tested samples the increase in the concentration of the anti-browning agents revealed increase in the inhibition efficient.

Such trend is in agreement with the studies of **Janovitz-Klapp *et al.* (1990), and Ozoglu and Bayindirh (2002)**. The inhibitory effect of various thermal, chemical (antibrowning agents) and extracts pre-treatments based on measurements at their maximum concentrations are shown in Table (10) for

banana pulp treated in the following decreasing order: steam blanching > sodium metabisulphide > taro peel > taro pulp > cabbage. It is obvious that thermal pre-treatments of banana pulp increased the development of red color a*-value as non-enzymatic browning. The Hunter color values of steam-blanching samples in banana pulp were lower than that of $Na_2S_2O_5$ samples.

Moreover, the Hunter color value of $Na_2S_2O_5$ pretreatment in banana pulp was lower than that of natural extracts, cabbage and taro extracts pre-treatments. These results indicated that the browning (redness) increased in control samples than in steam-blanched, $Na_2S_2O_5$ and natural extracts samples for banana pulp. However, PPO and POD enzyme activity were higher in control samples than in steam-blanched, $Na_2S_2O_5$ and natural extracts samples (Tables 10).

The main color change in untreated banana pulp and those pretreated by thermal, chemical and natural extracts treatments was due to increase in BI and a*-value, which were in high correlation with browning measurement. Other color parameters such as hue angle and chroma also indicated that heat caused a slight color change. Taro extracts samples had a BI higher than $Na_2S_2O_5$ and steam-blanched samples. But BI values of Taro extracts treated samples were lower than those of cabbage-treated samples and lower than that of untreated samples (Table 10).

These results are in good agreement with those of **Janovitz-Klapp *et al.* (1990), Genovese *et al.* (1997), Palou *et al.* (1999), Hayta (2002) and Ozoglu and Bayindirh (2002)**. In

general, taro pulp and peel extracts, steam and sulphiting pretreatments improved the color of banana pulp (Table 10). However, steam-blanched, sodium metabisulphide and taro extracts samples had a higher increase in color as evidenced by optical density (A420 nm), compared with untreated and cabbage extracts treated banana pulp samples (Table 10). The increase in color (browning as A420 nm) could be attributed to the reaction occurring between amino groups and active carbonyl groups (Maillard reaction) after thermal treatments (blanching). Sulphur dioxide has been shown to be effective in preventing browning by combining with carbonyl groups. From the above mentioned results it could be concluded that the pretreated banana pulp with sulphites ($Na_2S_2O_5$) or taro extracts have the best color values (a* and BI) and lower non-enzymatic browning compared with the other pretreatments (Table 10).

The most effective thermal, chemical treatments and natural extracts for the inhibition of oxidative enzymes (PPO and POD), good color characteristics and lower non-enzymatic browning in banana pulp was due to steam blanching for 5 min, and $Na_2S_2O_5$ (0.05 ppm), taro pulp extracts, taro peel extract and cabbage extracts (15%) treatments.

The surface colour of banana drying was measured with a color difference meter, using the Hunter Lab color scale. Under all tested conditions, $Na_2S_2O_5$ showed much higher efficient values based on a-values than A420 measurements, whereas 7 the other anti-browning agents had an opposite trend. For all tested samples the increase in the concentration of the anti-browning agents revealed increase in the inhibition efficient.

Such trend is in agreement with the studies of **Janovitz-Klapp *et al.* (1990), and Ozoglu & Bayindirh (2002)**. The inhibitory effect of various thermal, chemical (antibrowning agents) and extracts pre-treatments based on measurements at their maximum concentrations are shown in Table (11) for banana drying treated in the following decreasing order: steam blanching > sodium metabisulphide > taro peel > taro pulp > cabbage. It is obvious that thermal pretreatments of banana drying increased the development of red colour a*-value as non-enzymatic browning. The Hunter colour values of steam-blanching samples in banana drying were lower than that of $Na_2S_2O_5$ samples.

Moreover, the Hunter colour value of $Na_2S_2O_5$ pretreatment in banana drying was lower than that of natural extracts. However, PPO and POD enzyme activity were higher in control samples than in steam-blanched, $Na_2S_2O_5$ and natural extracts samples extracts, cabbage and taro extracts pre-treatments. These results indicated that the browning (redness) increased in control samples than in steam-blanched, $Na_2S_2O_5$ and natural extracts samples for (Tables 11). The main colour change in untreated banana drying and those pretreated by thermal, chemical and natural extracts treatments was due to increase in BI and a*-value, which were in high correlation with browning measurement. Other colour parameters such as hue angle and chroma also indicated that heat caused a slight colour change. Taro extracts samples had a BI higher than $Na_2S_2O_5$ and steam-blanched samples. But BI values of Taro extracts treated samples were lower than those of cabbage-treated samples and lower than that of untreated samples (Table 11). These results

are in good agreement with those of **Janovitz-Klapp *et al.*, 1990; Genovese *et al.* (1997); Palou *et al.* (1999); Hayta (2002) and Ozoglu & Bayindirh (2002)**. In general, taro drying and peel extracts, steam and sulphiting pretreatments improved the colour of banana drying (Table 11). However, steam-blanched, $Na_2S_2O_5$ and taro extracts samples had a higher increase in colour as evidenced by optical density (A420nm), compared with untreated and cabbage extracts-treated banana drying samples (Table 11). The increase in colour (browning as A420 nm) could be attributed to the reaction occurring between amino groups and active carbonyl groups (Maillard reaction) after thermal treatments (blanching). Sulphur dioxide has been shown to be effective in preventing browning by combining with carbonyl groups. From the above mentioned results it could be concluded that the pretreated banana drying with sulphites ($Na_2S_2O_5$) or taro extracts have the best colour values (a* and BI) and lower non-enzymatic browning compared with the other pretreatments (Table 11). The most effective thermal, chemical treatments and natural extracts for the inhibition of oxidative enzymes (PPO and POD), good colour characteristics and lower non-enzymatic browning in banana drying was due to steam blanching for 5 min, and $Na_2S_2O_5$ (0.05 ppm), taro drying extracts, taro peel extract and cabbage extracts (15%) treatments.

The surface color of apple pulp was measured with a color difference meter, using the Hunter Lab colour scale. Under all tested conditions, $Na_2S_2O_5$ showed much higher efficient values based on a-values than A420 measurements, whereas the other anti-browning agents had an opposite trend. For all tested

samples the increase in the concentration of the anti-browning agents revealed increase in the inhibition efficient. Such trend is in agreement with the studies of **Janovitz-Klapp *et al.* (1990), and Ozoglu and Bayindirh (2002)**. The inhibitory effect of various thermal, chemical (antibrowning agents) and extracts pre-treatments based on measurements at their maximum concentrations are shown in (Table 12) for apple pulp treated in the following decreasing order: steam blanching > sodium metabisulphide > taro peel > taro pulp > cabbage. It is obvious that thermal pretreatments of apple pulp increased the development of red color a*-value as non-enzymatic browning. The Hunter colour values of steam-blanching samples in apple pulp were lower than that of $Na_2S_2O_5$ samples. Moreover, the Hunter colour value of $Na_2S_2O_5$ pretreatment in apple pulp was lower than that of natural extracts, cabbage and taro extracts pretreatments. These results indicated that the browning (redness) increased in control samples than in steam-blanched, $Na_2S_2O_5$ and natural extracts samples for apple pulp. However, PPO and POD enzyme activity were higher in control samples than in steam-blanched, $Na_2S_2O_5$ and natural extracts samples (Tables 12). The main colour change in untreated apple pulp and those pretreated by thermal, chemical and natural extracts treatments was due to increase in BI and a*-value, which were in high correlation with browning measurement. Other colour parameters such as hue angle and chroma also indicated that heat caused a slight colour change. Taro extracts samples had a BI higher than $Na_2S_2O_5$ and steam-blanched samples. But BI values of Taro extracts treated samples were lower than those of

cabbage-treated samples and lower than that of untreated samples (Table 12).

These results are in good agreement with those of **Janovitz-Klapp *et al.*, 1990, Genovese *et al.* (1997), Palou *et al.* (1999), Hayta (2002) and Ozoglu and Bayindirh (2002)**. In general, taro pulp and peel extracts, steam and sulphiting pre-treatments improved the colour of apple pulp (Table 12. However, steam-blanched, $Na_2S_2O_5$ and taro extracts samples had a higher increase in colour as evidenced by optical density (A420 nm), compared with untreated and cabbage extracts-treated apple pulp samples (Table 12). The increase in colour (browning as A420 nm) could be attributed to the reaction occurring between amino groups and active carbonyl groups (Maillard reaction) after thermal treatments (blanching). Sulphur dioxide has been shown to be effective in preventing browning by combining with carbonyl groups. From the above mentioned results it could be concluded that the pre-treated apple pulp with sulphites ($Na_2S_2O_5$) or taro extracts have the best colour values (a* and BI) and lower non-enzymatic browning compared with the other pre-treatments (Table 12). The most effective thermal, chemical treatments and natural extracts for the inhibition of oxidative enzymes (PPO and POD), good colour characteristics and lower non-enzymatic browning in apple pulp was due to steam blanching for 5 min, and $Na_2S_2O_5$ (0.05 ppm), taro pulp extracts, taro peel extract and cabbage extracts (15%) treatments.

The surface color of apple drying was measured with a color difference meter, using the Hunter Lab colour scale. Under all tested conditions, $Na_2S_2O_5$ showed much higher efficient

values based on a-values than A420 measurements, whereas the other anti-browning agents had an opposite trend. For all tested samples the increase in the concentration of the anti-browning agents revealed increase in the inhibition efficient. Such trend is in agreement with the studies of **Janovitz-Klapp *et al.* (1990), and Ozoglu and Bayindirh (2002)**. The inhibitory effect of various thermal, chemical (antibrowning agents) and extracts pre-treatments based on measurements at their maximum concentrations are shown in Table (13) for apple drying treated in the following decreasing order: steam blanching > sodium metabisulphide > taro peel > taro pulp > cabbage. It is obvious that thermal pre-treatments of apple drying increased the development of red colour a*-value as non-enzymatic browning. The Hunter colour values of steam-blanching samples in apple drying were lower than that of $Na_2S_2O_5$ samples. Moreover, the Hunter colour value of $Na_2S_2O_5$ pretreatment in apple drying was lower than that of natural extracts, cabbage and taro extracts pre-treatments. These results indicated that the browning (redness) increased in control samples than in steam-blanched, $Na_2S_2O_5$ and natural extracts samples for apple drying. However, PPO and POD enzyme activity were higher in control samples than in steam-blanched, $Na_2S_2O_5$ and natural extracts samples (Tables 13). The main colour change in untreated apple drying and those pretreated by thermal, chemical and natural extracts treatments was due to increase in BI and a*-value, which were in high correlation with browning measurement. Other colour parameters such as hue angle and chroma also indicated that heat caused a slight colour change. Taro extracts samples had a BI higher than $Na_2S_2O_5$ and steam-blanched

samples. But BI values of Taro extracts treated samples were lower than those of cabbage-treated samples and lower than that of untreated samples (Table 13). These results are in good agreement with those of **Janovitz-Klapp *et al.*, 1990, Genovese *et al.* (1997), Palou *et al.* (1999), Hayta (2002) and Ozoglu and Bayindirh (2002)**. In general, taro pulp and peel extracts, steam and sulphiting pretreatments improved the colour of apple drying (Table 13). However, steam-blanched, $Na_2S_2O_5$ and taro extracts samples had a higher increase in colour as evidenced by optical density (A420nm), compared with untreated and cabbage extracts-treated apple drying samples (Table 13). The increase in colour (browning as A420 nm) could be attributed to the reaction occurring between amino groups and active carbonyl groups (Maillard reaction) after thermal treatments (blanching). Sulphur dioxide has been shown to be effective in preventing browning by combining with carbonyl groups. From the above mentioned results it could be concluded that the pre-treated apple drying with sulphites ($Na_2S_2O_5$) or taro extracts have the best colour values (a* and BI) and lower non-enzymatic browning compared with the other pre-treatments (Table 13). The most effective thermal, chemical treatments and natural extracts for the inhibition of oxidative enzymes (PPO and POD), good colour characteristics and lower non-enzymatic browning in apple drying was due to steam blanching for 5 min, and $Na_2S_2O_5$ (0.05 ppm), taro pulp extracts, taro peel extract and cabbage extracts (15%) treatments.

4.6. Total phenols:

The obtained results showed a good relationship between total phenols content (mg/100 ml) and the percent of inhibition of browning with the increasing of cabbage, taro pulp and taro peel extracts concentration from 5% to 15% at room temperature, as seen in Table (14). Total phenols content were 0.167, 0.198 and 0.212 mg/100 ml in cabbage, taro pulp and taro peel extracts with the concentration of 15% respectively. However, total phenols content was increased from 0.250 to 0.256 mg/100 ml in the apple slices and pulp treated with 15% extracts, while total phenols content was increased from 0.130 to 0.141 mg/100 ml in the banana slices and pulp treated with 15% extracts. The obtained results are in agreement with those results of **Singh *et al.* (2006)**.

Table (15) showed that the percent inhibition of PPO was higher in taro extracts treated banana and apple slices than cabbage extracts, also was lower in taro peel extracts in banana and apple pulp than other treatments. However, taro and cabbage extracts were inhibited of PPO enzyme activity to higher than about 41.02-64.44% in all banana and apple products.. These results are in agreement with that reported by **Alonso *et al.* (2006)**.

Table (16) showed that the percent inhibition of POD was higher in taro extracts treated banana and apple slices than cabbage extracts, but it was lower in taro peel extracts in banana pulp than other treatments.

However, taro and cabbage extracts were inhibited of POD enzyme activity to higher than 42.22-66.48% in all banana

and apple products. These results are in agreement with that reported by **Unal (2007)**

Table (17) showed that the percent inhibition of CAT was higher in taro extracts treated apple slices products.

However, taro and cabbage extracts were inhibited of CAT enzyme activity to higher than about 34.15-80.35% in all banana and apple products.

Also, the percent inhibition of CAT by all extracts was in all banana and apple products higher than PPO and POD inhibition (Table 17). These results are in agreement with the results of **Singh *et al.* (2006)**.

4.7. Evaluation of different enzymes under investigation:

4.7.1. Effect of pH on the enzymes activity:

In general, pH is an important factor that significantly influences the catalytic activity of PPO, POD and CAT enzyme activity. Changes in ionization of prototropic groups in the active site of an enzyme at lower acid and higher alkali pH values may prevent proper conformation of the active site, binding of substrates, and/or catalysis of the reaction. In addition, irreversible denaturation of the protein and/or reduction in the stability of the substrate as a function of pH could also influence the catalytic activity of enzymes.

The effect of pH on the reaction activities of different enzymes were investigated in a batch system at 25°C. The reaction mixtures were prepared in different solutions at pH values of 5.0, 5.5, 6.0 and 7.0 with 0.1 M sodium phosphate

buffer and different substrate concentrations of catechol, O-phynelenediamine and sodium perorate for polyphenoloxidase (PPO), peroxidase (POD) and catalase (CAT) in Table (18) and Fig (1). From these results showed that the optimum pH of polyphenoloxidase was found to be at 6.0 and the maximum activity amounted to 1.682 units/mg. However, peroxidase enzyme exhibits the maximum activity at pH 6.0 and recorded to 0.598 units/mg. On the other hand, the optimum pH of catalase enzyme was 5.5 and maximum activity was found 0.098 units/mg. Then, the activity halls down on either side of the optimum.

The optimum pH for banana and apple extracts of PPO, POD and CAT, was reported to be dependent on cultivars and experimental factors used during the determinations, range from 6 to 7 **(Janovitz-Klapp *et al.*, 1989)**. These results were found to be in accordance with **Oktay *et al.*, (1995)**, who mentioned the maximum activity of PPO and POD from banana fruit at pH 7 with catechol and O-phynelenediamine as a substrate, acidic pH is common for banana PPO and POD. However, some researchers found a single pH optimum at pH 5.5-6.0 **(Janovitz-Klapp *et al.*, 1989)**. Whereas others noted the existence of two pH optima, one at around pH 7 and the other at around pH 6.0.

4.7.2. Effect of temperature on reaction activity of enzymes:

The activities of different enzymes were decreased with increasing temperature showing less activity at 70^{o}C. Our findings are in agreement with **Oktay *et al.* (1995)** they found that the optimum temperature of PPO enzyme from Amasya

apple and Stanley plum was 40°C. **Duangmal and Apenten (1999)** reported that at high temperature heat-denaturation of the enzyme occurred after 10min of incubation at 60°C, the drop in activity is actually due to the unfolding tertiary structure of the enzyme to form the secondary structure.

The effect of temperature on the activities of different enzymes under investigation were evaluated. Four different temperatures, i.e. 40, 50, 60 and 70°C were chosen to investigate the optimum of enzymes preparations. The experiments were carried out at optimum pH for each preparations for one min. The results are recorded in Table (19) and Fig. (2).

Maximum activity for peroxidase (POD) and catalase (CAT) enzymes polyphenyloxidase (PPO) which extracted from banana and apple were obtained at the same temperature, 40°C. However, maximum reaction activity for polyphenyloxidase (PPO) enzyme extracted from banana and apple was found to be at 60°C.

4.7.3. Effect of substrate concentration on the reaction velocity of different enzymes extracted for banana and apple fruits:

The rate of the most enzyme reaction increase up to a certain point with increasing concentration of substrate. The kinetic parameters of Michaelis-Menten constant (K_m) and maximum reaction velocity (V_{max}) values of different enzymes extraction from banana and apple fruits were determined in a batch system by varying the substrate concentrations.

The effect of substrate concentration on the reaction velocity of different enzymes under investigation were estimated. Different substrate concentrations, 0.05, 0.1 and 0.2 M such as catechol, O-phynelenediamine and sodium perborate are commonly used as substrates for polyphenyloxidase (PPO), peroxidase (POD) and catalase (CAT) enzymes.

The maximum activity was 0.2 M catechol, o-phynelenediamine and sodium perborate with increasing the concentration a corresponding decline in activity was noticed.

The results obtained during catechol, O-phynelenediamine and sodium perborate oxidation by PPO, POD and CAT enzymes in banana and apple extracts are given in Table (20).

The decreased for different enzymes activities could be attributed to enzyme denaturation, inhibits enzyme activity and the reverse reaction takes place, converting the product back into the initial reactant, or the oxidation products may change pH or temperature of PPO, POD and CAT about the optimum values.

From the obtained results indicated that any increase of the substrate concentration was accompanied with the increament of activity until reached its maximum, beyond this concentration any further increase in substrate concentration does not show any positive effect and the reaction rate of enzyme depends on the time necessary for the enzyme to act on the substrate. The maximum reaction velocity (V_{max}) of polypenyleoxixdase (PPO) extracted from banana was 1.82 units/mg with 0.05 M catechol as substrate while. Its equaled 0.193 unts/mg with 0.1 M for the same enzyme from apple fruit. However, peroxidase enzyme exhibited the maximum reaction

velocity at 0.1 M for apple fruit and 0.2 M for apple and banana fruit. On the other hand, the maximum reaction velocity of catalase enzymed extracted from banana and apple fruits were 1.32 and 1.6 units/mg at the same substrate concentration 0.2 M.

The results mentioned above concerning the effect of pH, temperature and substrate concentration derived from the study of crud enzyme combination of isoenzymes and interaction with nonenzymatic proteins. These properties relatively expresses apparent quantities, even where the description (apparent) has not been used. However, the properties of a crude preparation can be exploited as relevant to the food industry than those of the purified or isolated enzyme **(Dungmal and Apenten, 1999)**.

There is little work on the inhibition of PPO, POD and CAT by its oxidation products, and the mechanism is not clear. In a recent attempt to substantiate the hypothesis of an inhibtion of banana PPO, POD and CAT by oxidation products. **Bara (2004)** confirmed the inhibition of banana PPO, POD and CAT by oxidation products of catechol, O-phynelene-diamine and sodium perborate. They found that oxidation products from catechol, O-phynelenediamine and sodium perborate were more effective than those from catechol, O-phynelenediamine and sodium perborate.

In conclusion, physicochemical and enzymatic characterization or properties of PPO, POD and CAT enzyme in banana and apple fruit studied in this work suggest that this enzyme could represent a valuable tool for a number of technological and biotechnological application.

4.8. Storage:

4.8.1. Effect of freezing storage at -18°C on ascorbic acid content in banana pulp:

We used freezing and drying storage were used before and after different treatments and different periods.

Freezing storage on banana pulp period (8 weeks) after treatments with (steaming 5 min., sodium metabisulphide 0.05%, cabbage extract 15%, taro extract 15%, and taro peel extract 15%).

Ascorbic acid content of the banana pulp was determined during freezing storage for 8 weeks as presented in Table (21).

From the obtained results the ascorbic acid content of the untreated banana pulp sample was decreased from 2.966 mg/100 g at zero time to 0.734 mg/100 g after 8 weeks storage. By using steaming treatment ascorbic acid content change from zero time to 8 weeks (1.483-1.452 mg/100 g) and by utilization sodium metabisulphide ascorbic acid content was1.471-1.454 mg/100 g from zero time to 8 weeks.

In natural extracts treatment as cabbage extract ascorbic acid content was 1.519-1.428 mg/100 g from zero time to 8 weeks while taro extract was used the values were 1.524 -1.457 mg/100 g from zero time to 8 weeks but in case of taro peel extract ascorbic acid content the values were 1.684-1.435 mg/100 g from zero time to 8 weeks.

4.8.2. Effect of freezing storage on non-enzymatic browning:

Results in Table (22) show that non-enzymatic browning in untreated banana samples at zero time to 8 weeks was 0.077-0.12 by using steaming non enzymatic browning were 0.105-0.115but with used sodium metabisulphide the values were treatment was 0.099-0.159. While in case of natural extracts treatments i.e. cabbage extract non enzymatic browning values were 0.026-0.094 from zero time to 8 weeks, by application taro extract non enzymatic browning values were 0.034-0.098 while in one taro peel extract non enzymatic browning values were 0.029-0.094 also from zero time to 8 weeks.

4.8.3. Effect of freezing storage on inhibition of PPO enzyme from banana pulp:

Results in Table (23) showed that the pulp banana characteristics were affected by different treatments. Treated banana caused inhibition in PPO enzyme compared to untreated banana. For steaming treatment the percentage inhibition was 58.71-32.43 at zero time after 8 weeks, in case of treatment with sodium metabisulphide treatment the percentages of inhibition were 42.42-35.13 in the zero time after 8 weeks. While, cabbage extract inhibited 39.01-29.72%, with taro extract the percentages of inhibition were 45.45-40.54 and with taro peel extract treatment the inhibition values were 39.39-29.72% in the same time.

Also, results indicated that when used natural extracts treatments by using caused inhibition for PPO and it is safe for

health. It was more stable during storage compared to chemical treatment.

4.8.4. Effect of freezing storage on inhibition of POD enzyme for banana pulp:

Results in Table (24) showed that the banana pulp characteristics were affected by different treatments. Treated banana caused inhibition in POD enzyme compared to untreated banana. Steaming treatment the percentages inhibited was 66.66-36.84% at zero time after 8 weeks, by using sodium metabisulphide treatment the percentages of inhibition were 57.42-39.47 in the zero time after 8 weeks. While, used cabbage extract caused 52.49-39.47, while inhibied with taro extract the inhibition values were 54.90-42.10 and with taro peel extract treatment % inhibition were 49.01-36.84 in the same time.

The obtained results indicated that the utilization of natural extracts treatments caused inhibition for POD and it is safe for health. It was more stable during storage compared to chemical treatment.

4.8.5. Effect of freezing storage on inhibition of Cat. enzyme:

Results in Table (25) showed that the pulp banana characteristics were affected by different treatments. Treated banana caused inhibition in Cat. enzyme compared to untreated banana. Steaming treatment caused inhibition was 47.30-36.29% inhibition at zero time after 8 weeks, while by using treatment with sodium metabisulphide the values of inhibition were 52.69-38.70 in the zero time after 8 weeks. While used cabbage extract % inhibition was 52.83-41.93, with taro extract the percentages

of inhibition were 53.12-42.74 and with taro peel extract treatment the values of inhibition were 52.54-42.33 in the same time

Results also indicates that the application of natural extracts treatments caused inhibition for Cat. and it is safe for health. It was more stable during storage compared to chemical treatment.

4.8.6. Effect of freezing storage on carotenoieds of banana pulp:

Carotenoieds content in the freezing banana pulp as affected by storage time (8 weeks) was determined as presented in Table (26)

Results in Table (26) show that the untreated banana pulp at zero time chlorophyll A, chlorophyll B and total carotenoids were 0.530, 0.737 and 0.209 mg/litre, respectively. After 8 weeks chlorophyll A was 0.380, chlorophyll B was 1.076 and total carotenoids were 0.121 mg/litre. Steaming treatment for 5 min at zero time chlorophyll A, chlorophyll B and total carotenoids were 0.695, 0.696 and 0.218 mg/litre, respectively, while after 8 weeks chlorophyll A, chlorophyll B and total carotenoids were 0.313, 1.297 and 0.094 mg/litre, respectively, with sodium metabisulphide treatment at zero time chlorophyll A, chlorophyll B, and total carotenoids were 0.743, 0.673 and 0.070 mg /litre after 8 weeks chlorophyll A, chlorophyll B and carotenoids were 0.490, 1.191 and 0.023 total mg/litre, respectively. By the application of natural extraction cabbage extract at zero time chlorophyll A chlorophyll B and total carotenoids were 0.257, 0.422 and 0.188 mg/litre, respectively

after 8 weeks storage chlorophyll A, chlorophyll B and total carotenoids were 0.353, 1.257 and 0.093 mg/litre, respectively. Taro extraction treatment at zero time chlorophyll A, chlorophyll B and total carotenoids were 0.291, 0.532 and 0.037 mg/litre, respectively, after 8 weeks chlorophyll A, chlorophyll B and total carotenoids were 0.453, 1.429 and 0.190 mg/litre. But with taro peel extract at zero time chlorophyll A, chlorophyll B and total carotenoids were 0.235, 0.495 and 0.095 mg/litre, respectively, after 8 weeks chlorophyll A, chlorophyll B and total carotenoids were 0.357, 1.380 and 0.465 mg/litre, respectively.

4.8.7. Effect of freezing storage at -18°C on total mold and yeast count of banana pulp:

Result in Table (27) showed that log number of mold and yeast count in untreated sample at zero time after 8 weeks was 0.602-1.0791.By using steaming treatment log number of mold and yeast count at zero time-after 8 weeks were 0.523-1.875.With sodium metabisulphate treatment log number of mold and yeast count at zero time after 8 weeks were 1.579-2.255. But when was cabbage extract treatment log number of mold and yeast count was 0.301-2.1818, white in case of taro extract treatment were 0.602-2.330 and taro peel extract treatment were 0.130-2.184 at the same time.

4.8.8. Effect of freezing storage on total bacteria count of banana pulp:

Result in Table (28) showed that log number of bacteria counts in untreated sample at zero time after 8 weeks were 0.477-1.724. Steaming treatment log number of bacteria count at zero time-after 8 weeks were 0-1.653. While with sodium metabisulphate treatment log number of bacteria count at zero time after 8 weeks were 0.301-2.181. But by utilization cabbage extract treatment log number of bacteria count were 0.201-2.178, taro extract treatment was 0.903-2.152 and taro peel extract treatment were 0.477-2.176 at the same time.

4.9. Effect of drying storage on banana slices:

Drying storage on banana slices period (4 months) after treatments with (steaming 5 min., sodium metabisulphide 0.05%, cabbage extract 15%, taro extract 15%, and taro peel extract 15%).

4.9.1. Effect of drying storage on ascorbic acid content:

Ascorbic acid content of the banana slices was determined during drying storage for 4 months as presented in Table (29).

Results in Table (29) show that ascorbic acid content of the banana slices in the untreated sample decreased from 2.25 mg/100 g at zero time to 1.38 mg/100 g after 4 months storage. By using steaming treatment ascorbic acid content changed from zero time to 4 months 1.8-1.49 mg/100 g and by utilization sodium metabisulphide ascorbic acid content ranged.58-1.42 mg/100 g) from zero time to 4 months.

In natural extracts treatment as cabbage extract decreasments in ascorbic acid content were 1.52-1.48 mg/100 g from zero time to 4 months while the values by the application of taro extract were 1.52-1.46 mg/100 g from zero time to 4 months but in case of taro peel extract ascorbic acid decreasments were 1.68-1.46 mg/100 g from zero time to 4 months.

4.9.2. Effect of drying storage on non-enzymatic browning reaction:

Results in Table (30) show that non-enzymatic browning in untreated sample at zero time to 4 months was 0.095-0.124 by using used steaming NEB values were 0.094-0.114 but with used sodium metabisulphide treatment these values were 0.116-156. While used natural extracts treatments as cabbage extract non enzymatic browning was 0.117-0.124 from zero time to 4 months. Taro extract treatment cause of non enzymatic browning ranged 0.098-0.124 and used taro peel extract NEB were 0.117-0.123 also from zero time to 4 months.

4.9.3. Effect of drying storage on inhibition PPO enzyme:

Results in Table (31) showed that the slices banana characteristics were affected by different treatments. Treated banana caused inhibition in the percentages of PPO enzyme compared to untreated banana. For steaming treatment % inhibition values were 70.99-35.19 at zero time after 4 months, while by using treatment with sodium metabisulphide inhibition were 85.11-36.12% at zero time after 4 months. Cabbage extextract caused inhibition 89.31-37.36%, in case of taro extract

% inhibition were 91.98-37.82 and with taro peel extract treatment the inhibition were 90.83-37.67% in the same time.

Results also indicates that used natural extracts treatments caused a reasonable inhibition for PPO and that is safe for health.

4.9.4. Effect of drying storage on inhibition POD enzyme:

Results in Table (32) showed that the slices banana characteristics were affected by different treatments. Treated banana caused inhibition in POD enzyme compared to untreated banana. For steaming treatment the percentages inhibition were 79.83-33.33 at zero time after 8 weeks, when we used treatment with sodium metabisulphide the inhibition values were 83.74-35.89% in the zero time after 8 weeks. While cabbage by the application of extract % inhibition values were 81.06-38.46%, in case of taro extract the inhibition values were 81.48-43.58 and with taro peel extract treatment the inhibition values were 81.27-41.02 in the same time.

Also, the results indicated that used natural extracts treatments caused a considerable inhibition for POD and that is safe for health. It was more stable during storage compared to chemical treatment.

4.9.5. Effect of drying storage on inhibition catalase enzyme:

Results in Table (33) showed that the banana slices characteristics were affected by different treatments. Treated banana slices caused inhibition in catalase enzyme compared to untreated banana. For steaming treatment the percentages of inhibition were 34.72-17.15 at zero time after 4 months, while by

using treatment with sodium metabisulphide treatment % inhibition values were 37.50-21.30 in the zero time after 4 monthes. While, used cabbage extract the values of inhibition were 29.86-15.97, with taro extract % inhibitions were 30.55-16.86 and with taro peel extract treatment the values were 29.51-16.56 in the same time

Results also indicates that used natural extracts treatments caused inhibition for catalase and that is safe for health.

4.9.6. Effect of during storage on carotenoieds in banana slices:

Carotenoieds content in the drying banana slices as affected by storage time (4 months) was determined as presented in Table (34).

Results in Table (34) show that the untreated banana slices at zero time chlorophyll A was 0.535, chlorophyll B was 0.780 and chlorophyll C was 0.219 mg/litre. After 4 months chlorophyll A was 0.410, chlorophyll B was 1.067 and chlorophyll C was 0.131 mg/litre.

Steaming treatment for 5 min at zero time chlorophyll A, chlorophyll B and total carotenoids were 0.715, 0.712 and 0.229 mg/litre, respectively after 4 months chlorophyll A, chlorophyll B and total carotenoids were 0.321, 1.315 and 0.106 mg/litre, respectively, with sodium metabisulphide treatment at zero time chlorophyll A, chlorophyll B and total carotenoids were 0.793, 0.702 and 0.081 mg/litre, respectively, after 4 months chlorophyll A, chlorophyll B and total carotenoids were 0.473, 1.043 and 0.034 mg/litre, respectively. When used natural

extraction cabbage extract at zero time chlorophyll A, chlorophyll B was and total carotenoids were 0.267, 0.512 and 0.179 mg/litre, respectively, after 4 months storage chlorophyll A was, chlorophyll B was and total carotenoids were 0.428, 1.162 and 0.087 mg/litre, respectively.

With taro extraction treatment at zero time chlorophyll A, chlorophyll B and total carotenoids were 0.303, 0.543 and 0.045 mg/litre, respectively, after 4 months chlorophyll A, chlorophyll B and total carotenoids were 0.436, 1.582 and 0.251 mg/litre, respectively. But with taro peel extract at zero time chlorophyll A, chlorophyll B and total carotenoids were 0.283, 0.486 and 0.093 mg/litre, respectively after 4 months chlorophyll A, chlorophyll B and total carotenoids were 0.364, 1.243 and 0.399 mg/litre, respectively.

4.9.7. Effect of drying storage on total mold and yeast count in banana slices:

Result in Table (35) showed that log number of mold and yeast count in untreated sample at zero time after 4 months was 0.512-1.107. By using steaming treatment log number of mold and yeast count at zero time-after 4 months were 0.654-1.453. With $Na_2S_2O_5$ treatment log number of mold and yeast count at zero time after 4 months were 325-1.998. But when used cabbage extract treatment log number of mold and yeast count ranged from to 0.210-1.872, taro extract treatment values were 0.412-1.564 and taro peel extract treatment these values were 0.102-1.205 at the same time.

4.9.8. Effect of drying storage on total bacteria count in banana slices:

Result in Table (36) showed that log number of bacteria count in untreated sample at zero time after 4 months was 0.367-1.0. By using steaming treatment log number of bacteria count at zero time-after 4 months was 0- 0.786.With $Na_2S_2O_5$ treatment log number of bacteria count at zero time after 4 months was 0.213-0.845. But the application of extract treatment bacteria count was 0.121-0.663, taro extract treatment was 0.785-0.985 and taro peel extract treatment was 0.334-0.867 at the same time.

4.10. Storage of apple:

Freezing and drying storage were utilized before and after different treatments and different periods.

Freezing storage on apple period (8 weeks)after treatments with (steaming 5 min, sodium metabisulphide 0.05%, cabbage extract 15%, taro extract 15%, and taro peel extract 15%).

4.10.1. Effect of freezing storage on ascorbic acid content:

Ascorbic acid content of the apple was determined during freezing storage for 8 weeks as presented in Table (37).

Results in Table (37) show that the highest ascorbic acid content in apple pulp treated with taro extract (2.768 mg/100 g) at zero time but after 8 weeks was (1.777 mg/100 g) The lowest ascorbic acid content in apple treated with sodium metabisulphate (2.543 mg/100 g) but after 8 weeks was 1.744 mg/100 g) **(Chardonnet, 2003).**

4.10.2. Effect of freezing storage on non-enzymatic browning:

Results in Table (38) show that the highest non enzymatic browning in apple pulp treated with sodium meatbisulphate 0.189 at zero time but after8 weeks was 0.226. The lowest non-enzymatic browning value (0.047) was achieved treated with taro peel extract treatment but after 8 weeks this value was 0.068.

4.10.3. Effect of freezing storage on PPO inhibition enzyme:

Result in Table (39) show that the highest inhibition PPO enzyme in apple pulp treated with taro extract 74.45% at zero time but after 8 weeks was 37.26.35%. The lowest inhibition PPO enzyme was achieved with apple i.e. treated with steaming 73.72 but after 8 weeks this value was 28.01.

4.10.4. Effect of freezing storage on POD inhibition enzyme:

Result in Table (40) show that the highest inhibition POD enzyme in apple pulp treated with taro extract 79.03% at zero time but after8 weeks was 36.87%. The lowest inhibition POD enzyme was occurred with apple treated with steaming 65.50% but after 8 weeks was 11.58%.

4.10.5. Effect of freezing storage on CAT inhibition enzyme:

Result in Table (41) show that the highest inhibition catalase enzyme in apple pulp treated with taro extract 58.28% at zero time but after 8 weeks was 37.0 %. The lowest inhibition

POD enzyme was achieved with apple treated with sodium metabisulphate 45.85.80% but after 8 weeks was 14.17%.

Results also indicates that used natural extracts treatments caused inhibition for PPO, POD and CAT. That is safe for health.

4.10.6. Effect of freezing storage on carotenoids in apple pulp:

Carotenoieds content in the freezing apple pulp as affected by storage time (8weeks) was determined as presented in Table (42).

Result in Table (42) show that the highest chlorophyl (A) in apple pulp treated with sodium meatbisulphate 0.643 mg/liter, chlorophyll (B) 0.862 mg/liter, total carodenoids in apple pulp treated with steaming 0.341 mg/liter at zero time. After 8 weeks chlorophyll A, chlorophyll B and total carodenoids were 1.209, 0.675 and 0.327 mg/liter, respectively. The lowest chlorophyll A in apple pulp treated with taro peel extract 0.238 mg/liter, chlorophyll B in apple pulp treated with cabbage extract 0.541 mg/liter, total carodenoids in apple pulp treated with taro extract 0.045 mg/liter at zero time. After 8 weeks chlorophyll A, chlorophyll B and total carodenoids 0.21, 0.472 and 0.103 mg/liter, respectively.

4.10.7. Effect of freezing storage on total molds and yeasts count in apple pulp:

Results in Table (43) showed that the log number of count of molds and yeasts in untreated sample at zero time after 8

weeks was 0.712-1.670. Steaming treatment log number of count of mold and yeast at zero time after 8 weeks was 0.605-1.254. With sodium metabisulphate treatment log number of count of molds and yeasts at zero time after 8 weeks was 1.687-2.346. But by using cabbage extract treatment log number of count of molds and yeasts was 0.410-2.138, taro extract treatment was 0.721-2.015 and taro peel extract treatment was 0.145-2.117 at the same time.

4.10.8. Effect of freezing storage on total bacteria count in apple pulp:

Result in Table (44) showed that log number of bacterial count in untreated sample at zero time and after 8 weeks were 0.557-1.738, respectively. Steaming treatment log number of bacterial count at zero time and after 8 weeks was 0.072-1.672, respectively. With sodium metabisulphide treatment log number of bacterial count at zero time was 0.702, while after 8 weeks was 2.013. But when used cabbage extract treatment log number of bacterial count was 0.610-1.834, respectively, taro extract treatment was 0.835-1.706, respectively and taro peel extract treatment was 0.876-1.724, respectively at the same time.

4.11. Effect of drying storage on apple slices:

Drying storage on apple slices period (4 months) after treatments with (steaming 5 min, sodium metabisulphide 0.05%, cabbage extract 15%, taro extract 15% and taro peel extract 15%).

4.11.1. Effect of drying storage on ascorbic acid content:

Ascorbic acid content of the apple slices was determined during drying storage for 4 months as presented in Table (45).

From the obtained results the ascorbic acid content of the untreated apple slices sample was decreased from 4.025 at zero time to 1.967 mg/100 g after 4 months storage. Steaming treatment was used ascorbic acid content changes from zero time to 4 months were 3.103-1.996 mg/100 g and with used sodium metabisulphide ascorbic acid content were 2.987-1.54 mg/100g from zero time to 4 months.

In natural extracts treatment i.e. cabbage extract ascorbic acid contents were 3.325-1.987 mg/100 g from zero time to 4 months.

When we used taro extract was used there values became 3.486-2.011 mg/100 g from zero time to 4 months but by the application of taro peel extract ascorbic acid values were 3.362-1.997 mg/100 g from zero time to 4 months.

4.11.2. Effect of drying storage on non-enzymatic browning:

Results in Table (46) showed that non-enzymatic browning values in untreated apple sample from zero time to 4 months were 0.116-0.211. Steaming changed there values to 0.127-0.178 but with used by using sodium metabisulphide treatment these values were 0.199-0.286. While used natural extracts treatment i.e. cabbage extract non-enzymatic browning values were 0.123-0.140 from zero time to 4 months, while application of taro extract non-enzymatic browning the values were 0.089-0.118 and used taro peel extract treatment non-

enzymatic browning became 0.132-0.141 also from zero time to 4 months.

4.11.3. Effect of drying storage on inhibition of polyphenol oxidase enzyme in apple slices.

Results in Table (47) showed that the apple slices characteristics were affected by different treatments. Treated apple caused inhibition in polyoxidase enzyme compared to untreated apple. Steam treatment caused 74.27-15.90% inhibition for zero time to 4 months. Sodium metabisulphide treatment led to 75.10-18.86% from zero time to 4 months. While by usingcabbage extract the inhibition values were 76.95-42.72%, with taro extract 78.60-43.93% and with taro peel extract treatments these decreaments in the inhibition were 77.77-43.26% in the same time.

Also, the results indicated that the utilization of natural extract treatments caused inhibition for polyphenol oxidase and that is safe for health. It as more stable during storage compared to chemical treatment.

4.11.4. Effect of drying storage on inhibition peroxidase enzyme from apple slices:

Results in Table (48) showed that the apple slices characteristics were affected by different treatments. Treated apple caused inhibition in peroxidase enzyme compared to untreated apple. For steaming treatment percentage inhibitions were 40.10-11.75% from zero time to 4 months, when we used

treatment with sodium metabisulphite the inhibition were 71.13-12.54% from zero time to 4 months. While when used cabbage extract treatment caused inhibition ranged 87.62-35.79%, wit taro extract 89.17-36.32% inhibition and with taro peel extract treatment the inhibition were 88.40-36.06% in the same time.

From the obtained results indicated that the application of natural extract caused inhibition for peroxidase and that is safe for health. It was more stable during storage compared to chemical treatment.

4.11.5. Effect of drying storage on inhibition catalase enzyme from apple slices:

Results in Table (49) showed that the apple slices characteristics were affected by different treatments. Treated apple caused inhibition catalase enzyme compared to untreated apple. Steaming treatment percentage inhibition were 57.20-13.48% from zero time to months, when we used sodium metabisulphite the inhibition were 58.02-18.35% from zero time to 4 months.

While when used cabbage extract was 61.31-32.20, with taro extract treatment was 62.75-34.83% and with taro peel extraction was 62.13-33.33% in the same time.

From the obtained results indicated that when used natural extract caused inhibition for catalase and it is safe for health. It was more stable during storage compared to chemical treatment.

4.11.6. Effect of drying storage on carotenoids in apple slices:

Carotenoides content in the drying apple slices as affected by storage time (4 months) was determined as presented in Table (50).

Results in Table (50) show that the highest chlorophyll A in apple slices treated with sodium metabislphide was 0.732 mg/liter, chlorophyll B was 0.873 mg/liter total carotenoids were 50.354 mg/liter with steaming treated at zero time. After 4 months chlorophyll A, chlorophyll B and total carotenoids were 0.754, 0.892 and 0.384 mg/liter with steaming treatment. The lowest chlorophyll A in apple slices treated with taro extract was 0.301 mg/liter, chlorophyll B in apple slices treated with cabbage extract was 0.502 mg/liter, total carotenoids in apple slices treated with taro extract was 0.057 mg/liter at zero time. After 4 months chlorophyll A 0.324 mg/liter with taro extract treated, chlorophyll B 0.372 mg/liter total carotenoids 0.124 mg/liter with taro extract treatment.

4.11.7. Effect of drying storage on total molds and yeasts cont in apple slices:

Results in Table (51) showed that log number of molds and yeasts count in untreated sample at zero time to 4 months were 0.502-1.236. While by using steaming treatment were 0.413-1.131 from zero time to 4 months. By using sodium metabisulphide treatment were 1.241-2.237 at the same time. But when used cabbage extract treatment log number of molds and yeasts count were 0.306-1.586, taro extract treatment was 0.643-

1.312 and taro peel extract treatment were 0.437-1.126 at the same time.

4.11.8. Effect of drying storage on total bacterial count in apple slices:

Results in Table (52) showed that log number of bacteria count in untreated sample from zero time to 4 months was 0.452-1.863.

When used steaming treatment log number of bacterial count from zero to 4 months was 0.068-1.542. With sodium metabisulphide treatment log number of bacterial count at zero time was 0.613 after 4 months was 1.749. But when used cabbage extract treatment total bacterial count was 0.532-1.179, taro extract treatment was 0.642-1.113 taro peel extract treatment was 0.764-1.421 at the same time.