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Research Article

Preservative Effects of Gynura Procumbens Powder Used with Broiler Ration on Their Frozen Meat Stored for Different Periods

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Keywords
broiler, meat, medical planet, antioxidant, preservation.

Abstract

This study was conducted to evaluate the effect of feed additives of different concentrations of *Gynura Procumbens* (G.P.) leaf powder on some chemical and physical characteristics and oxidative indicators of broiler breast meat stored for different freezing periods. Sixty Ross 308 broiler chicks, one day old were distributed randomly into 4 treatments. Feeding was standard for all birds. Treatments were as follows: T1: a control treatment, T2: adding of 0.75 kg G.P. / ton of feed, T3: adding of 1.5 kg G.P. / ton of feed, and T4: adding of 3 kg G.P. / ton of feed. Breeding lasted for 35 days. At the end of the period, six birds were slaughtered randomly from each treatment. The carcasses were cleaned and left under refrigeration for 8 hours, and then the breast piece was separated and preserved in polyethylene bags without skin. The preservation periods were as follows: P1: 0-day freeze, P2: 45 days freeze, P3: 90 days freeze. At the end of each preservation period, analyzes were performed. The results showed the following: The increase in the preservation period led to an increase in each of: Cooking loss, Met-Mb, TBA, FFA, TVN, Ether extract, and Ash, and a decrease in Moisture for all treatments. As for the effect of different concentrations of G.P., the results showed a decrease in each of: Cooking loss, TBA, FFA, TVN, Protein, Ether extract, and Ash, and an increase in Mb and Moisture for all preservation periods. It can be said that there are clear positive effects of the feed additives of G.P. powder on the chemical and physical characteristics and oxidative indicators of frozen poultry breast meat.

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1. Introduction

Poultry meat is distinguished by its nutritional value as a source of protein, in addition to its low cost (70). As its products are considered a major component of human balanced diet, as their contents of essential amino acids, fatty acids, and vitamins cover a large part of the daily nutritional need (15). There are several advantages that poultry meat has when compared with the cattle and sheep red

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meat, as it is more suitable for healthy food consumption standards due to low-fat content, and the high percentage of polyunsaturated fatty acids, in addition to the possibility of preparing without the need for high skills, as well, Its suitability for further industrialization. All these advantages increased the global demand for meat, which led to the development of the poultry market in the past 50 years (69).

The development in the poultry market has forced producers to find the best ways to increase production, reduce costs, identify problems and find appropriate solutions (48).

Spoilage is one of the important problems that accompany the meat industry, from slaughtering to consumption, because of the properties that meat possesses. With the high percentage of muscle membranes polyunsaturated fatty acids, oxidative processes are considered one of the most important of these problems after microbial deterioration, affects most components of meat such as fats, proteins, pigments, and vitamins, leads to decrease of sensory qualities and consumer desire, as well as the formation of toxic substances with advanced stages of this process (24). Oxidative stress is a natural condition that occurs as a result of metabolic processes, but the increased presence of free radicals as a reactive species, resulting from the development of the oxidative process, leads to damage in important biomolecules in the human body and animals.

Research tended to find out the effect of using natural materials as feed additives to reduce or stop free radicals and extend meat shelf life, as many studies have recorded positive results in this area (2, 4, 21, 33). The trend was towards the use of these natural substances as an alternative to industrial antioxidants that had human health reservations (52).

Feed additives of natural materials recorded positive results regarding their effect on preserving the produced meat and increasing the storage life by acting as antioxidants and anti-microbial agents that prevent the decrease in quality characteristics of meat and its products. These effects differed according to the type and nature of the additives and their content of the active ingredients. Plant additives such as aromatic plants, herbs, essential oils, plants' leaves and extracts are characterized by their containment of active substances such as phenolic compounds, flavonoids and other substances, which play an effective role as antioxidants (66, 63, 76) and antimicrobial (26, 16, 64, 17).

Gynura Procumbens (G.P.) is a herbal plant belonging to the Order Asterales (20), spread in the countries of Southeast Asia (49). It contains many compounds such as phenols, flavonoids, glycosides and sterols (44). The active substance is concentrated in the leaves of the plant (14). The chemicals and active substances present in this plant act as antibacterial and antioxidant (29). Plant extracts are used as a treatment for various diseases because these plants possess bioactive ingredients with medicinal properties. G.P. is considered one of the plants acceptable to many people in China, Malaysia, the Philippines, Indonesia and Thailand, and it is used in these countries as anti-inflammatory, anti-diabetic, anti-viral, treatment of vasodilation and antispasmodic (85, 60).

This research aimed to study the effect of adding different concentrations of G.P. leaf powder with broiler diet on chemical, physical and oxidative properties of the produced meat which preserved in freezing for different periods.

2. Materıals and Methods

2.1. Birds, feeding, and treatments

Sixty one day old Ross 308 broiler chicks were reared in an enclosed room with 16 cages and a bed of sawdust. Chicks were distributed randomly into 4 treatments with 3 replicates for each treatment, for each replicate 5 birds. The replicates were distributed randomly to the treatments and the cages, starting from the first day. G.P. leaf powder obtained from University of Putra / Malaysia. Table No. 1 shows the chemical composition of the leaves of G.P. (72)

Table 1. Chemical composition of G.P. leaves

Ingredients	% of G.P. leaves powder extract
Humidity	19.17
Dry matter	80.83
Ash	18.11
Carbohydrates	0.0537-0.1968μg
Protein	4.51
Fat	0.023

Chicks were fed with the aforementioned mash diets, their components and chemical composition and quantities in the Ross broiler management guide (75), G.P. leaves powder was added to the treatments as follows: T1: a control treatment without additives, T2: adding 0.75 kg G.P. / ton of feed, T3: adding 1.5 kg G.P. / ton of feed, and T4: adding 3 kg G.P. / ton of feed.

Water was freely provided during the 35-day breeding period. Temperatures, lighting program, ventilation and humidity, and vaccination schedule were conducted typically according to the instructions provided in the Ross broiler management guide as well.

2.2. Slaughter, samples, and preservation

Fodder was cut off at the end of search period, and 6 birds were randomly selected then slaughtered from each treatment. The carcasses were cleaned and left in the refrigerator for 8 hours. The carcasses were cut up and the breast piece meat was taken without the skin and kept in polyethylene bags. The preservation periods were as follows: P1: 0-day freeze, P2: 45 days freeze, P3: 90 days freeze (-18 °C).

3. Measurements

At the end of each preservation period, chemical, physical, and oxidative indicators analyses were performed and several parameters were taken from meat samples as follows: pH values, according to Verma (88). Water holding capacity (WHC), as mentioned by Dolatowski and Stasiak (23). Cooking loss, as in Purchas and Barton (73). Thiobarbituric acid (TBA), as the method of Gheisari et al. (36). Free fatty acids (FFA), according to Pearson and Duston (67). Total volatile nitrogen (TVN), as reported by Pearson and Muslemuddin (68). Myoglobin (Mb), as mentioned by

Zessin (91). Metmyoglobin (Met-Mb), according to Krzywicki (47). Chemical composition, following the methods mentioned in AOAC (1).

4. Statistical analysis

A simple factorial experiment was applied using a complete randomized design (CRD) to study the effect of each treatment and period on different parameters, and the significant differences between means were compared using Duncan's (25) multinomial test and SAS (79) statistical analysis program.

5. Results

From Table 2, we note that there was no significant effect of different concentrations of G.P. in meat pH, and for all storage periods, although there was an increase in the values for all additive treatments. We also note that there is no significant effect for the different preservation periods in the aforementioned measurement, although there is an increase in the values for all treatments with the increase of preservation period.

Table 3 shows no significant effect of different concentrations of G.P. in WHC of breast meat for all periods of preservation, although there is an increase in the studied character for additive treatments and all periods of preservation. Also, there were no significant effects for the different preservation periods in the studied character, despite the decrease in the values of all treatments with the increase of the preservation period.

Table 2. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat pH (mean±std error)

Parameter	pH		
Period / Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	6.350± 0.071	6.550± 0.082	6.750 ±0.141
T2 0.75 kg/ ton	6.400± 0.071	6.450± 0.283	6.750± 0.084
T3 1.5 kg/ ton	6.450± 0.283	6.500 ±0.261	6.850± 0.065
T4 3.0 kg/ ton	6.650± 0.212	6.750± 0.212	6.850± 0.141

Table 3. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat WHC (mean±std error)

Parameter	WHC %		
Period Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	71.500 ±2.121	70.500 ±0.707	69.500± 0.257
T2 0.75 kg/ ton	72.500 ±0.707	71.0 ±1.414	69.00± 1.457
T3 1.5 kg/ ton	73.0 ±1.414	70.50 ±0.845	70.00± 0.578
T4 3.0 kg/ ton	74.1± 1.524	71.500± 0.461	71.00 ±1.681

Table 4 data showing a significant effect (p≤0.05) of G.P. forage additives in cooking loss of breast meat, as the added parameters (T2, T3, and T4) were significantly reduced for all periods of preservation, and treatment T4 had the lowest value compared with the rest of the treatments and for all periods of preservation. Regarding the effect of preservation periods, we notice a significant effect (p≤0.05) of increasing preservation period in the studied characteristic, as the values of all treatments increased with the increase in the preservation period.

Table 5 shows a significant effect (p≤0.05) of the forage additives from G.P. in the TBA values of breast meat, the additive treatments recorded a significant decrease for the values of the mentioned trait and for all periods of preservation, and the treatment T4 had the lowest value compared to the rest of the treatments and all periods of preservation as well. Concerning the effect of preservation periods, we note that there is a significant increase (p≤0.05) for TBA values for all treatments with increasing preservation period.

Table 4. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat Cooking loss (mean±std error)

Parameter	Cooking loss %		
Period Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	a B 34.984± 0.240	a A 36.999 ±0.372	a A 37.393± 0.066
T2 0.75 kg/ ton	b B 33.416 ±0.429	b A 36.166± 0.188	b A 36.423± 0.011
T3 1.5 kg/ ton	b B 32.796 ±0.288	b A 35.571± 0.146	b A 35.946± 0.076
T4 3.0 kg/ ton	c C 30.305 ±0.404	c B 31.568± 0.386	c A 33.395± 0.722

- Different lowercase letters indicate significant differences (p≤0.05) between treatments.
- Different uppercase letters indicate significant differences (p≤0.05) between periods.

Table 5. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat TBA (mean±std error)

Parameter	TBA mg malondialdehyde/ kg muscle		
Period / Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	a B 0.504± 0.037	a A 0.908± 0.047	a A 0.934± 0.063
T2 0.75 kg/ ton	b B 0.413± 0.018	b A 0.778± 0.004	b A 0.780± 0.007
T3 1.5 kg/ ton	bc B 0.385± 0.001	c A 0.658± 0.042	c A 0.699± 0.026
T4 3.0 kg/ ton	c C 0.327± 0.022	d B 0.473± 0.051	d A 0.573± 0.045

- Different lowercase letters indicate significant differences (p≤0.05) between treatments.
- Different uppercase letters indicate significant differences (p≤0.05) between periods.

The data in Table 6 show a significant effect (p≤0.05) G.P. forage additives in the FFA values, the treatments T4 for the period P1, T3 for the period P2, T3 and T4 for the period P3 recorded a significant decrease in the FFA values. On the other hand, there was a significant effect (p≤0.05) for the periods of preservation, as the treatments recorded a significant increase for the values of the studied trait with the increase in the preservation period.

Table No. 7 shows a significant effect (p≤0.05) for the forage additives that used in the TVN values, as the T3 and T4 treatments recorded a significant decrease, while the decrease was not significant (<0.05 p) for treatment T2, and treatment T4 recorded the lowest TVN value among treatments. On the other hand, the effect of preservation periods was significant (p≤0.05), as the values of the studied characteristic of all treatments increased with the increase of the preservation period.

Table 6. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat FFA (mean±std error)

Parameter	FFA %		
Period / Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	a B 0.213± 0.034	a B 0.372± 0.031	a A 0.896± 0.006
T2 0.75 kg/ ton	ab C 0.087± 0.003	ab B 0.293± 0.037	a A 0.890± 0.127
T3 1.5 kg/ ton	ab B 0.073± 0.025	b B 0.201± 0.052	b A 0.737± 0.052
T4 3.0 kg/ ton	b C 0.032± 0.009	ab B 0.278± 0.160	c A 0.452± 0.013

- Different lowercase letters indicate significant differences (p≤0.05) between treatments.
- Different uppercase letters indicate significant differences (p≤0.05) between periods.

Table 7. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat TVN (mean±std error)

Parameter	TVN mg/ 100 gm muscle		
Period Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	a C 8.422± 0.122	a B 11.982± 0.025	a A 14.002± 0.013
T2 0.75 kg/ ton	a C 7.407± 0.815	a B 11.307± 0.604	a A 13.298± 0.523
T3 1.5 kg/ ton	b C 5.198± 0.790	b B 9.458± 0.690	b A 10.976± 0.573
T4 3.0 kg/ ton	c C 2.416± 0.129	c B 5.008± 0.011	c A 9.753± 0.257

- Different lowercase letters indicate significant differences (p≤0.05) between treatments.
- Different uppercase letters indicate significant differences (p≤0.05) between periods.

From the data of Table 8, we can notice a significant (p≤0.05) effect of G.P. forage additives in Mb concentration of breast meat, treatment T4 showed the highest concentration of pigment, while the concentration of the rest additive treatments (T2 and T3) was insignificantly high (p>0.05) compared with the control treatment and for all preservation periods. On the other hand, there were no significant effects for different preservation periods in pigment concentration, as all treatments recorded a non-significant decrease (p>0.05) with an increasing preservation period.

Table No. 9 shows the absence of a significant effect of the treatments in Met-Mb pigment concentration, except for the presence of a significant decrease (p≤0.05) of treatment T4 in the P1 period when compared with the rest of the treatments. Also, there were no significant effects for the different preservation periods, except for a significant increase (p≤0.05) of T1 control and T4 treatment in pigment concentration with an increasing preservation period. The increase in pigment concentration was insignificant (p>0.05) for the rest of the treatments with an increasing preservation period.

Table 8. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat Mb (mean±std error)

Parameter	Mb mg/gm muscle		
Period Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	c A 0.148± 0.006	c A 0.146± 0.018	c A 0.143± 0.011
T2 0.75 kg/ ton	bc A 0.153± 0.008	bc A 0.149± 0.008	bc A 0.146± 0.010
T3 1.5 kg/ ton	abc A 0.155± 0.005	abc A 0.154± 0.006	bc A 0.150± 0.007
T4 3.0 kg/ ton	a A 0.169± 0.012	a A 0.167± 0.004	a A 0.165± 0.005

- Different lowercase letters indicate significant differences (p≤0.05) between treatments.
- Different uppercase letters indicate significant differences (p≤0.05) between periods.

Table 9. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat Met-Mb(mean±std error)

Parameter	Met-Mb mg/ gm muscle		
Period Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	a B 46.690± 2.178	a AB 47.900± 0.849	a A 50.180 ±0.042
T2 0.75 kg/ ton	a A 46.652± 2.149	a A 47.795± 0.699	a A 48.550± 0.778
T3 1.5 kg/ ton	a A 46.601± 1.797	a A 47.459± 0.759	a A 48.435± 0.658
T4 3.0 kg/ ton	b B 43.603± 1.956	a A 46.910± 0.834	a A 48.300± 0.975

- Different lowercase letters indicate significant differences (p≤0.05) between treatments.
- Different uppercase letters indicate significant differences (p≤0.05) between periods.

Change in the breast meat moisture content is shown in Table 10, where a significant effect (p≤0.05) can be observed for the additive treatments, as treatment T4 recorded the highest moisture percentage for all periods of preservation, while the two treatments T2 and T3 were superior to the control treatment in the P3 period, while the superiority was insignificant for the rest of the periods. About the effect of preservation periods, the treatments recorded a significant decrease (p≤0.05) in the aforementioned measurement in the storage period P3, while the decrease was insignificant (p>0.05) for the P2 period.

Regarding protein content (Table 11), the treatment T4 had a significant effect (p≤0.05), as it recorded a decrease in the percentage of protein for all preservation periods, and the same was for treatment T3 in the period P3. As for the effect of preservation periods, their effect also was significant (p≤0.05), as all treatments recorded a significant increase with the increase of the preservation period.

Table 10. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat moisture (mean±std error)

Parameter	Moisture %		
Period Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	b A 75.722± 0.630	b A 75.263± 0.353	b B 73.857± 0.021
T2 0.75 kg/ ton	ab A 76.400± 0.060	b AB 75.355± 0.004	a B 74.554± 0.001
T3 1.5 kg/ ton	ab A 76.505± 0.100	b AB 75.569± 0.097	a B 74.861± 0.276
T4 3.0 kg/ ton	a A 77.996± 0.209	a A 77.307± 0.274	a B 74.871± 0.330

- Different lowercase letters indicate significant differences (p≤0.05) between treatments.
- Different uppercase letters indicate significant differences (p≤0.05) between periods.

Table 11. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat protein (mean±std error)

Parameter	Protein %		
Period Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	a C 20.070± 0.114	a B 21.047± 0.091	a A 22.062± 0.088
T2 0.75 kg/ ton	ab C 19.613± 0.062	ab B 20.788± 0.124	ab A 21.792± 0.030
T3 1.5 kg/ ton	ab C 19.582± 0.292	ab B 20.688± 0.177	b A 21.610± 0.199
T4 3.0 kg/ ton	b C 18.344± 0.062	b BC 18.939± 0.086	c A 21.313± 0.045

-Different lowercase letters indicate significant differences (p≤0.05) between treatments.
- Different uppercase letters indicate significant differences (p≤0.05) between periods.

Table 12 shows the presence of a significant effect (p≤0.05) for additive treatments in the percentage of ether extract, as the additive treatments recorded a decrease in the aforementioned measurement for all periods of preservation, and treatment T4 had the lowest value compared to the rest of the treatments and for all preservation periods as well. There was a significant effect (p≤0.05) also for the periods of preservation, as all treatments recorded an increase in the percentage of ether extract in the P2 period when compared with the P2.

In Table 13, it can be seen that there is a significant effect (p≤0.05) for the different treatments in the Ash percentage, where treatment T4 recorded a decrease in the P1 period, while all the additive treatments recorded a decrease in the other periods, and the lowest percentage was the share of treatment T4. There were no significant effects for the preservation periods, as the Ash values for all treatments increased insignificantly (p>0.05) with the increase of the preservation period except for the control treatment T1, which increase significantly (p≤0.05).

Table 12. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat ether extract (mean±std error)

Parameter	Ether extract %		
Period Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	a B 2.865± 0.023	a A 2.964± 0.023	a A 2.966± 0.023
T2 0.75 kg/ ton	b B 2.748± 0.039	b A 2.869± 0.033	b A 2.825± 0.035
T3 1.5 kg/ ton	b B 2.747± 0.045	b A 2.853± 0.049	b A 2.855± 0.050
T4 3.0 kg/ ton	b B 2.724± 0.023	b A 2.839± 0.055	b A 2.849± 0.054

- Different lowercase letters indicate significant differences (p≤0.05) between treatments.
- Different uppercase letters indicate significant differences (p≤0.05) between periods.

Table 13. Effect of different G.P. powder concentration and freeze-preservation periods on breast meat ash (mean±std error)

Parameter	Ash %		
Period Treatment	P1 0 day freeze	P2 45 day freeze	P3 90 day freeze
T1 control	a B 0.546± 0.044±	a A 0.599± 0.018	a A 0.625± 0.035
T2 0.75 kg/ ton	ab A 0.516± 0.005	b A 0.524± 0.022	b A 0.526± 0.012
T3 1.5 kg/ ton	ab A 0.512± 0.021	b A 0.517± 0.009	b A 0.522± 0.007
T4 3.0 kg/ ton	b A 0.509± 0.015	b A 0.514± 0.006	b A 0.517± 0.005

- Different lowercase letters indicate significant differences (p≤0.05) between treatments.
- Different uppercase letters indicate significant differences (p≤0.05) between periods.

6. Discussion

The ultimate pH importance comes from its relationship with meat quality and hence shelf life. pH is associated with the WHC value, which is an indicator of meat quality (89, 11). No clear effects were observed with the forage additives of G.P. or for the period of storage in the pH of the breast meat in this study, although there was an increase in the pH value with the increase of the additive concentration, and also with an increase in the preservation period. The same case was for the WHC, but with a decrease in values as the preservation period increased. Majid et al. (53) indicated that there was an increase in the pH and WHC with the use of natural antioxidants as feed additives with broiler diets. In the same direction, the results of several other studies (54, 45) indicated that feed additives to poultry diets as a source of flavonoids led to an increase in the WHC due to the positive effect in protecting muscle tissue from oxidative damages and thus reducing cooking loss. Arora and Stasburg (10) reported that protecting the cellular membranes of muscle fiber preserves cellular components, resulting in reduced drip loss and elevated WHC during storage. Ao and Kim (8) confirmed a reduction in cooking loss and improved WHC of meat with feed additives of natural antioxidants. The researchers stated that the use of antioxidants contributes to reducing the rupture of the cell membranes of muscle fibers and increasing the stability of sarcoplasmic components and thus increasing their ability to conserve water (19, 46). The increase in meat pH and WHC with the use of flavonoids sources may be due to a decrease in post mortem lactic acid production of the treated birds (43). A higher pH leads to an elevation of the WHC due to the effect of muscle fiber shrinkage and thus reduced cooking loss (90). On the other hand, several researchers reported that there was no effect of feed additives of flavonoids sources on pH, WHC, and cooking loss (37, 18).

As for the effect of the storage period, the researchers reported that the increase in the meat pH with increasing storage period may be due to the effects of meat lipolysis enzymes, and the effect of microorganisms, which increases the release of the amine groups (3, 62, 87). The total plate count of frozen breast meat increases with increasing storage period (78). Despite the positive relationship between pH and WHC (74), the decrease in WHC with increasing storage period may be due to increased protein hydrolysis, which leads to a decrease in the meat's ability to carry water (61).

Increasing the storage period leads to a decrease in WHC, which increases thaw loss and cooking loss as a result of damage to the cellular membranes due to the physical effect of ice crystals (51) and protein denaturation, which leads to an increase in water loss of meat (13). Progress the storage period leads to an increase in the diameter of the ice crystals and an increase of their damage (32). Increased cooking losses with increased storage time may be due to big changes in cell membranes that lead to changes in protein composition (41, 56).

The value of TBA is important as a measure of lipid oxidation, and this value is determined by the concentration of malondialdehyde (MDA). This value is considered normal for meat if it does not exceed 2 mg malondialdehyde / kg meat (38). Research has reported a decrease in the TBA value of meat with the use of various feed additives containing antioxidants (34, 53, 54). Feed additives containing antioxidants led to the transfer of these antioxidants from feed to meat, and as a result of their inhibitory role of the chain reaction involved in fat oxidation, they reduced MDA (34). Decreased TBA is the result of the presence of antioxidants in the additive treatments leading to reduced lipid oxidation and thus reduced MDA (80). The researchers reported that natural feed additives containing flavonoids reduced meat MDA and that the tissue content of total phenols increased when these feed additives were used (18, 81). Feed additives of flavonoids increase the activity of several antioxidant enzymes and include catalase and superoxide dismutase (43).

As for the storage period, storing the meat increased the MDA concentration (33). The increase in TBA values is normal with an increase in the storage period due to the processes of oxidation and the production of free radicals and active oxygenic groups, as an increase in the secondary oxidative products of fats leads to an increase in the MDA concentration due to the breakdown of peroxides (24, 7).

FFA is a measure of the stability of fats and their non-degradation due to the presence of microorganisms, as well as lipolytic enzymes. TVN is a measure of the deterioration of proteins and non-protein nitrogenous substances. Deterioration is the result of the presence of proteolytic enzymes in the meat and the action of microorganisms. The permissible limit for FFA is 0.5-1.5 oleic acid (35). The value of TVN should not exceed 15 gm/ 100 gm of meat (27). The use of natural antioxidants leads to a significant decrease in the FFA ratio for the additive treatments and all storage periods, and this decrease is due to the active compounds in these materials such as flavonoids, which reduce the growth of bacteria secreting lipolytic enzymes (6, 55). Feed additions of antioxidants reduced TVN in meat (53, 54). These results are in agreement with the results of many studies (6, 57), as antioxidants protect proteins from oxidative stress and the resulting degradation (71). As lipid oxidation affects protein breakdown in freeze-preserved products, the radicals resulting from lipid oxidation are likely to enhance protein oxidation (28). Therefore, reducing lipid oxidation may increase the stability of proteins (59). Flavonoids have an inhibitory effect on many of the most common bacterial species in meat, such as Staphylococcus aureus, E-coli, and Pseudomonas aeraginosa (39).

As for the effect of the storage period, the increase in FFA with the progression of the storage period is due to the activity of lipolytic enzymes such as lipase and phospholipase, which lead to the release of FFA, the production of unacceptable odors and the decrease in nutritional value (6). The increase in TVN with the increase in the storage period may be due to the degradation of proteins by the internal enzymes of the meat and micro-organisms, and thus the increase in the volatile nitrogen (22, 49). These results are in agreement with the results of research that stated that the rise in TVN is the result of an increase in the numbers of total bacteria and Pseudomonas spp. (77).

Mg is the main pigment in meat, while the unwanted Met-Mg pigment is formed as a result of oxidation of the Mg (30). The meat color is influenced by its Mg content (83). Despite the lack of meat pigmentation in poultry meat, the addition of materials containing antioxidants preserves the natural meat color by reducing the oxidation of the Mg and thus reducing the formation of the Met-Mg with a brown color (12, 84). Fat oxidation may affect the oxidation of Mg, so the added antioxidants that reduce fat oxidation also reduce the oxidation of Mg and reduce the formation of Met-Mg (31). These results are in agreement with the research results that indicated an increase in the Mg and a decrease in the Met-Mg of meat when using feed additives containing antioxidants in the diets of broiler (53, 54).

Antioxidants reduce the oxidation of meat pigments and reduce the formation of brown color, as they provide a reduction state by giving hydrogen, thus preserving the pigment and saturated fatty acids from oxidation and reducing the formation of free radicals (58). The active substances in these additives also affect the reduction of the microbial load, and thus the preservation of meat proteins from decomposition (9).

An increase in the storage period may lead to a decrease in the concentration of Mg and an increase in Met-Mg due to the aerobic conditions of storage, the oxidation state of the pigments by enzymes and the intensity of light (65). The color of the stored meat is affected by many factors such as the storage temperature, the method of packaging, the type of muscle, the difference in the type of meat, and the difference in the type of antioxidant used (50).

The results of the chemical analysis of the meat indicated an increase in the moisture content and at the same time a decrease in the ratios of protein, fats and ash for the additive treatments. These results are in agreement with those of many researchers when using antioxidants (40, 54, 82). The increase in the moisture content of the additive treatments may be due to the role of the active antioxidant substances in preserving cell membranes from the oxidative damage process and free radicals that occur to the lipids of these membranes, and thus preserving their moisture content (10). The superiority of the control treatment over the additive treatments in dry matter ratio (protein, fat, and ash) may be due to the low moisture content of this treatment, and thus the high proportions of other dry ingredients, despite the effect of additives in reducing fat and protein oxidation, increasing WHC, reducing cooking loss, and preserving the nutritional value of meat in additive treatments. These results were in agreement with the results that indicated a decrease in the moisture content and an increase in the dry matter percentage with an increase in the storage period (5). Increased oxidation and denaturation of proteins and the effect of increasing the size of ice crystals with increasing freezing period, the effect of these factors on cellular composition increases fluid and moisture loss from meat with increasing freezing period, which affects raising the percentage of dry matter.

7. Conclusions

Use the leaves powder of G.P. with poultry feed, leads to a reduction in fat and protein oxidation indicators, improvement of the physical and chemical parameters, and an increase in the storage period of the produced and preserved meat under freezing

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