THE ROLE OF THE RESVERATROL AS ANTIOXIDANT IN IMPROVING THE CHEMICAL AND QUALITATIVE PROPERTIES OF CHILLED GROUND BEEF

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ABSTRACT

This study was conducted to evaluate the effects of resveratrol as a natural antioxidant in improving the chemical properties and some qualitative and microbial properties of chilled ground beef stored at 2 C° for 1, 3, 6, 9, and 12 days. The study included 7 different treatments: T1 (control treatment without addition) T2 (Resveratrol 0.10% g/kg) T3 (Resveratrol 0.20% g/kg) T4 (Resveratrol 0.30% g/kg) T5 (Resveratrol %0.40g/kg) T6 (Resveratrol %0.50g/kg) and T7 (Addition of Butylated hydroxyanisole 0.01% BHA). All addition treatments showed a significant (P<0.05) decreases in dry matter percentage of Fat and Ash and increase in protein, moisture and water holding capacity (WHC) percentage as compared with the control treatment at any refrigerated storage time. Thiobarbituric acid (TBA) were lower (P<0.05) in treatments (Resveratrol) as compared with the control treatment at any refrigerated storage time. Resveratrol treated samples recorded lower (P<0.05) total plate count of bacteria during refrigerated storage times . It can be concluded that the resveratrol had positive significant influence on quality characteristics and microbial safety of ground beef meat when stored under refrigeration at 2 C° up to 12 days.

Key words: polyphenol, beef, thiobarbituric acid, water holding capacity, TBC, good health and well being

***Part of M.Sc. thesis of the 1st author**

دور الريسفيراترول كمضاد للأكسدة في تحسين الخواص الكيميائية والنوعية للحم البقري المفروم المبرد

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المستخلص

أجريت هذه الدراسة لتقييم تأثير الريسفيراترول كمضاد اكسدة طبيعي في تحسين الخصائص الكيميائية، وبعض الخصائص النوعية والميكروبية للحم البقري المفروم المبرد والمخزون عند درجة حرارة 2 م° لمدة 1،3،6،9،12يوم. اذ شملت الدراسة 7 معاملات مختلفة T1 (معاملة السيطرة بدون اضافة)، T2 (الريسفيراترول 0.10% غم/كغم)، T3 (الريسفيراترول 0.20 % غم/كغم)، T4 (الريسفيراترول 0.30 %غم/كغمT5) (الريسفيراترول 0.40% غم/كغم)، T6 (الريسفيراترول 0.50 % غم/كغم) و T7 (BHA 0.01%)، أظهرت جميع المعاملات المضاف اليها الريسفيراترول انخفاضاً معنوياً (P<0.05) في نسبة الدهون والرماد وزيادة معنوية في نسبة البروتين والرطوبة والقدرة على الاحتفاظ بالماء (WHC)، انخفضت قيم حامض الثيوباربيتوريك (TBA) والعدد الكلي للبكتيريا في معاملات الاضافة (الريسفيراترول) مقارنة بمعاملة السيطرة (T1) خلال فترات الحفظ. وعليه يمكن الاستنتاج أن اضافة الريسفيراتول كان له تأثير معنوي إيجابي على خصائص الجودة والميكروبية للحم البقر المفروم المبرد على درجة حرارة 2 م° لمدة تصل إلى 12 يومًا من الخزن.

الكلمات المفتاحية: البوليفينول، لحم مفروم، حامض الثايوباربتيورك، قابلية مسك الماء، العدد الكلي للبكتريا، الصحة الجيدة والرفاه.

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INTRODUCTION

Meat and its products are subjected to various types of natural processes such as oxidative decomposition due to their high protein content and essential amino acids (1, 10), which compromises their safety and acceptability to the consumer by reducing nutritional quality and changing sensory properties such as color, aroma, and flavor (5, 21, 50). As oxidation of meat leads to loss of color due to oxidation of heme pigments (7, 22), It also leads to damage to the properties of muscle tissue because oxidation processes reduce protein solubility and water-holding capacity (4, 43). Recently, current trends in the field of food safety focus on replacing the use of synthetic antioxidants with natural antioxidants, mainly because to the harmful effects of synthetic antioxidants, such as cancer or cardiovascular diseases (13). In recent years various antioxidants have been widely used in the production and processing of meat and meat products to stabilize their quality and prolong their shelf life and consumers have increased the demand for antioxidants (48, 49). Natural antioxidants, especially those of plant origin (12) and phenolic compounds are the main components of plant materials with antioxidant capacity and are widely used in the meat industry (40, 23), Dietary resveratrol improves meat quality and volatile compound content by enhancing antioxidant capacity and inhibiting lipid and protein oxidation was reported by (24). Resveratrol (3,4',5-trihydroxystilbene) a natural stilbene and polyphenol, possesses antioxidant (37), anti-inflammatory (35), antimicrobial (28), and anti-cancer properties (25). In recent years, resveratrol has been widely applied to enhance the antioxidant capacity and improve the quality of meat by inhibiting the oxidation of fat and protein (29). Moreover (36) and (46) reported that resveratrol supplementation improves the meat quality of fish and poultry by enhancing antioxidant capacity (29). Although studies have shown that resveratrol can enhance the antioxidant capacity and cellular capacity of bovine skeletal muscle cells (47). Dietary supplementation with resveratrol (5g/animal/day) improved meat quality. Cows by enhancing the conversion of type II muscle fibers to type I muscle fibers, dietary resveratrol improved beef tenderness and reduced cooking loss, while reducing initial color, but delayed muscle flowering time by 6 hours improved meat color stability during display for 2 days (26). Therefore the current study focused on investigating the effect of different levels of resveratrol on the chemical, qualitative and microbial characteristics of chilled beef meat.

MATERIALS AND METHODS

Samples: The objective of this study was carried out in the Meat Science and Technology Laboratory of animal production department and in the animal nutrition laboratory for postgraduate students at College of Agricultural Engineering Sciences, University of Baghdad. 14kg of fresh meat from the leg of the calf at age of 1.5 years was took immediately after the slaughter process from the local market and it was minced with an electric mincing machine. It was left at the refrigerator for 12 hours to remove the rigor mortis state. Then the minced meat was divided into 7 parts 2 kg for each. After that, Resveratrol was added to 5 part as the 6^{th} part considered the control treatment (with no addition) and the 7^{th} part was treated with BHA.

Treatments: The experiment included seven different treatments: T1 (control treatment without addition), T2 (Resveratrol 0.10% g/kg), T3 (Resveratrol 0.20% g/kg), T4 (Resveratrol 0.30% g/kg). T5 (Resveratrol 0.20% g/kg). %0.40g/kg), T6 (Resveratrol %0.50g/kg), T7 (0.01% BHA). Each treatment was separately homogenized by hand using medical gloves to obtain a separate homogenized sample. The samples were placed in polyethylene bags and stored in the refrigerator for different periods (1, 3, 6, 9 and 12 days) at 2 C° to evaluate the effect of the Resveratrol on the quality and microbial properties of chilled ground beef.

Laboratory analyses: The chemical composition of samples under study (moisture, protein, fat and ash) were determined according to the method of (8). Water holding capacity (WHC) was measured according to (31), TBA was tested separately in duplicate according to the method of (42) and Total

Bacterial Count (TBC) was run according to (33).

Statistical analysis: Data was statistically analyzed using Completely Randomized Design Model (CRD) as a factorial experiment (5× 7). Duncan's multiple rang test was used to determine the significant differences among treatments means (17) and periods using SAS(SAS, 2018) (34).

RESULTS AND DISCUSSION

Results in Table (1) show the interaction between the different treatments and periods of cold storage for the chilled ground beef meat of moisture. All treatments showed a significant ($p<0.05$) increases in moisture percentage with the increases of storage times (1, 3, 6,9 and 12 days), Resveratrol treatments showed a significant ($p<0.05$) increases in moisture percentage as compared with control treatment. T6 showed the highest increasing in the percentage of moisture (74.17%) at day 1 of cold storage than other treatments when compared with the control treatment (71.08%) in the end of cold storage. The increase in moisture content for different addition treatments of ground beef stored in cold storage may be due to the increased of water holding capacity and reduced the drip loss when resveratrol is added during the storage period (26).The periods of cold storage were indicated a significant difference ($P<0.05$) between the periods of cold storage, where the moisture reached its highest level in the beginning (1 days) down to its lowest percentage in the end of cold storage (12 days). Similarly (20) found, as he indicated that the percentage of humidity decreases as the period of cold storage progresses as a result of water evaporation or free water seeping out, and in return, the percentage of dry matter increases, including the percentage of ash, protein, and fat.

Table 1. Effect of Resveratrol on moisture of chilled ground beef meat

Treatments No.	Moisture (%) Storage periods (days) 1	3	6	9	12	Range
T1	71.08±0.01 i	69.35±0.01 m	67.80±0.10 q	66.55±0.05 t	65.55± 0.05 w	68.06±0.65 G
T2	72.27±0.01 f	70.75±0.01 j	68.85±0.05 n	67.95±0.05 q	66.35±0.05 v	69.23±0.69 E
T3	73.20±0.05 d	71.15±0.01 i	69.35±0.05 m	68.20±0.10 p	67.12±0.02 s	69.80±0.72 D
T4	73.88±0.01 c	71.90±0.10 g	69.70±0.10 l	68.65±0.05 o	67.90±0.05 q	70.40±0.73 C
T5	74.17±0.02 b	72.30 ±0.05 f	71.11±0.01 i	70.85±0.05 j	69.31±0.01 m	71.54±0.54 B
T6	74.95±0.01 a	73.12±0.10 d	72.65±0.05 e	71.60±0.05 h	70.30±0.03 k	72.52±0.51 A
T7	71.20±0.05 i	70.40±0.05 k	68.50±0.10 o	67.60±0.05 r	66.15±0.05 v	68.77±0.61 F
Range	72.96±0.38 A	71.27±0.32 B	69.70±0.42 C	68.77±0.46 D	67.52±0.44 E	---

The averages that bear different letters, differ significantly ($P<0.05$) among them (capital letters are main effect of treatments and storage times and small letters are the effect of the intraction between treatments and storage times).

Table (2) shows the effect of the interaction between the different treatments and periods of cold storage on the protein percentage of the chilled ground beef. Is noticed a significant increase ($P<0.05$) in the percentages of protein between different treatments with the progression of the cold storage periods; T6 (Resveratrol 0.50 g/kg) recorded a highest protein percentage (18.9%) across different treatments and as compared with control treatment. In the beginning of the cold storage (1 days) up to 21.25 % in the end of the cold storage (12 days), while T1 (control without addition) had the lowest protein percentage (16.05%) in the 1-day storage period and for all subsequent periods. Also shows from table 2 a significant differences ($P<0.05$) between the values of different treatments, where T6 (Resveratrol 0.50 g/kg) outperformed the rest of the treatments, followed by T5, then T4, T3,

T2 and T7 then T1. Some studies have indicated that resveratrol works to increase the content of crude protein (44) by increasing the activity of Ca2+-Atpase, and a significant decrease in free amino groups (23), as resveratrol directly removes reactive oxygen species and also increases the level of... Mitochondrial antioxidant enzymes and modulates cell signaling pathways and kinase activities and thus the antioxidant properties of resveratrol are expected to reduce protein degradation (41, 45). The results of the statistical analysis indicated that the percentage of protein increased with the progression of the periods of cold storage, as it was at its lowest percentage in the first storage period (1 days) and its highest percentage in the 12 day cooling period, where protein, fat and ash increase at the expense of moisture percentage with the progression of the cold storage period, which led to an increase in the percentage of protein in all treatments and for all storage periods (1, 3, 6,9 and 12 days) as compared with the control treatment.

Table 2. Effect of Resveratrol on protein of chilled ground beef meat

Treatments No.	Protein (%) Storage periods (days)					Range
	1	3	6	9	12	
T1	16.05±0.01 o	16.44±0.01 mn	17.12±0.01 k	17.8±0.1 ij	18.1±0.1 ghi	17.10±0.26 G
T2	16.30±0.1 no	16.97±0.01 kl	17.9±0.1 hij	18.4± 0.1 g	18.96± 0.01 f	17.70±0.32 E
T3	16.75±0.01 lm	17.69±0.01 j	18.30±0.1 g	19.0±0.5 f	19.45±0.01 e	18.23± 0.327 D
T4	17.2±0.1 k	18.27±0.01 g	18.95± 0.01 f	19.6± 0.1 e	20.15±0.01 d	18.83± 0.34 C
T5	18.15±0.01 gh	18.9±0.1 f	19.45±0.01 e	19.97±0.01 d	20.85±0.01 b	19.46± 0.30 B
T6	18.9±0.1 f	19.45±0.01 e	20.1 ±0.1 d	20.5±0.1 c	21.25±0.01 a	20.04±0.27 A
T7	16.1±0.1 o	16.5±0.1 mn	17.61± 0.01 j	18.25±0.01 g	18.75±0.01 f	17.44± 0.33 F
Range	17.064±0.28 D	17.74±0.3 D	18.49±0.27 C	19.074±0.26 B	19.64±0.29 A	---

The averages that bear different letters, differ significantly (P<0.05) among them (capital letters are main effect of treatments and storage times and small letters are the effect of the intraction between treatments and storage times).

The results of the interaction between the treatments and the periods of cold storage of fat percentage are shown in table (3). All treatments showed a significant (p<0.05) decreases in fat percentage associated with increasing of storage time (1, 3, 6,9 and 12 days), Resveratrol treatments showed a significant (p<0.05) decrease in fat percentage as compared with control treatment. Lowest percentage of fat (4.65%) was associated with T3 in the first storage period (one days of chilling) as compared with the control treatment which showed the highest percentage of fat percentage (13.6%) in the last storage period (12 days of chilling). This may be due to the fact that resveratrol increased the activity of superoxide dismutase, glutathione peroxidase and the activity of catalases, which are enzymatic systems that catalyze reactions to restrict free radicals and reactive oxygen species, thus suppressing fat oxidation in meat (23). For the periods of cold storage. The results of the statistical analysis indicated a significant difference (P<0.05) among periods. The percentage of fat showed the lowest level in the first storage period (1 days) and then began to rise with the passage of storage periods until it reached its highest percentage (10.28%) in period of 12 days of refrigeration. This is normal, as the progression of the storage period reduces the percentage of humidity and raises the percentage of dry matter, which are represented by protein, fat, and ash, as the percentage of fat increases with the progression of the duration of cold storage until it reaches the highest level during the 12-day storage period by refrigerator (31, 2).

Table 3. Effect of Resveratrol on fat of chilled ground beef meat

Treatments No.	Fat (%) Storage periods (days) 1	3	6	9	12	Range
T1	10.95±0.01 h	11.76±0.01 f	12.85±0.01 c	13.1±0.1 b	13.6±0.1 a	12.45±0.32 A
T2	9.33±0.01 n	9.90±0.1 l	10.75±0.01 i	11.15±0.01 g	11.99±0.01 e	10.62±0.31 C
T3	8.0±0.2 p	8.98±0.01 o	9.9±0.1 l	10.20±0.1 k	10.880±0.01 hi	9.59±0.33 D
T4	7.07±0.01 s	7.78±0.01 q	8.86±0.01 o	9.25±0.01 n	9.54±0.01 m	8.50±0.31 E
T5	5.83±0.01 v	6.60±0.10 t	6.98±0.01 s	7.13±0.01 s	7.39±0.01 r	6.78±0.18 F
T6	4.65±0.01 y	4.950±0.01 x	5.35±0.01 w	5.82±0.01 v	6.2±0.1 u	5.394±0.18 G
T7	10.55±0.01 j	10.92 ± 0.01 hi	11.30±0.1 g	11.9±0.1 ef	12.4±0.1 d	11.4±0.22 B
Range	8.05±0.6 E	8.69±0.62 D	9.42±0.66 C	9.79±0.66 B	10.28±0.6 A	---

The averages that bear different letters, differ significantly (P<0.05) among them (capital letters are main effect of treatments and storage times and small letters are the effect of the intraction between treatments and storage times).

The results of the interaction between treatments and the periods of cold storage of ash percentage are shown in table (4). All treatments showed a significant (p<0.05) decrease in ash percentage with the increasing of storage time (1, 3,6, 9 and 12 days), resveratrol treatments showed a significant (p<0.05) decrease in ash percentage as compared with control treatment. Lowest percentage of ash (0.95%) was recorded in T6 in the beginning (one days) when compared with the control treatment which showed the highest percentage of ash percentage (1.85%) in the end (12 days). For the storage periods, the results of the statistical analysis indicated significant differences (P<0.05) in the percentage of ash between the rates of the storage periods, where the highest percentage was in the 12-day storage period, then the 9-day period, followed by the 6-day period, and it was the lowest in the period 1 days, and this is due to the decrease in percentage of moisture with the increase of the cold storage periods, which leads to an increase in the dry matter concentration (3).

Table 4. Effect of Resveratrol on Ash of chilled ground beef meat

Treatments No.	Ash (%) Storage periods (days) 1	3	6	9	12	Range
T1	1.17 ±0.01 jk	1.65 ± 0.01 cde	1.7±0.05 bcd	1.8±0.05 ab	1.85±0.01 a	1.634±0.08 A
T2	1.2±0.01 ijk	1.53±0.01 fg	1.65±0.01 cde	1.75±0.01 abc	1.8±0.02 ab	1.58±0.071 B
T3	1.17±0.01 jk	1.28±0.01 i	1.6±0.01 defg	1.65±0.01 cde	1.7±0.01 bcd	1.48±0.07 C
T4	1.150±0.003 jk	1.3± 0.02 i	1.54±0.01 fg	1.6±0.05 defg	1.66±0.01 cd	1.45±0.06 CD
T5	1.1±0.1 k	1.250± 0.01 ij	1.5±0.05 g	1.55±0.01 efg	1.65±0.01 cde	1.41±0.069 D
T6	0.95±0.01 l	1.25± 0.01 ij	1.4±0.05 h	1.53±0.01 fg	1.66±0.01 cd	1.35±0.08 E
T7	1.2±0.1 ijk	1.55± 0.01 efg	1.62 ± 0.01 def	1.74±0.01 bc	1.8±0.02 ab	1.58±0.07 B
Range	1.13±0.02 E	1.40± 0.04 D	1.57±0.02 C	1.66±0.028 B	1.73±0.02 A	---

The averages that bear different letters, differ significantly (P<0.05) among them (capital letters are main effect of treatments and storage times and small letters are the effect of the intraction between treatments and storage times).

Table (5) shows the effect of the interaction between different treatments and cold storage periods on the water holding capacity (%) of chilled ground beef, where a significant increase (P<0.05) was note in the meat water holding capacity in T6 (Resveratrol %0.50g/Kg). which amounted to 45.1%, which recorded the highest significant difference as compared with control treatment, which amounted to 40.55% in the beginning (1 days), while the control treatment recorded the lowest significant difference of 26.76% in the period 12 days, and there were significant differences between the treatments and different storage periods. Moreover a significant differences (P<0.05) between the rates of the addition treatments, as it was noted a significant increase in T6 (Resveratrol %0.50g/Kg), which amounted to 40.18% as compared with the control treatment (32.38%), followed by the T5, T4, T3, T2 and finally T7 in comparison with the control treatment. (38) also indicated that the reason for the high WHC is that these phenolic compounds contributed to raising the pH of the processed meat, which increased the ability of the meat to retain water in addition to inhibiting microbial reproduction and enzyme activity by means of the phenols present in the natural extracts, which it resulted in slower deterioration of muscle fiber microstructure and higher water holding capacity (14,30). The results of the statistical analysis indicated a significant (P<0.05) differences among cold storage periods, as the ability of meat water holding capacity was at its highest level in the beginning (1 days), reaching (43.0%) and then began to decrease with the passage of the cold storage period. Until it reached its lowest percentage in the 12-day period of cryopreservation, which amounted to (30.09%), This may be due to the reason that the decomposition of meat proteins by hydrolytic enzymes, which are responsible for some subtle changes in the permeability of the cell membrane or the structural structure of the protein, thus reducing the ability of the meat to retain water, as reported by (5, 20)**.**

Table 5. Effect of Resveratrolon water holding capacity of chilled ground beef meat

Treatments No.	WHC (%) Storage periods (days)					Range
	1	3	6	9	12	
T1	40.65± 0.01 g	34.90± 0.1 o	32.26± 0.01 t	27.5± 0.01 z	26.55± 0.01 b	32.38± 1.71 G
T2	42.33± 0.01 e	35.4± 0.1 n	32.75± 0.01 r	28.69± 0.01 x	27.60± 0.1 z	33.35± 1.76 E
T3	42.9± 0.1 d	36.51± 0.01 l	33.90± 0.1 p	30.8± 0.1 v	29.64± 0.01 w	34.75± 1.57 D
T4	44.25± 0.01 c	39.18± 0.01 i	35.60± 0.1 n	33.8± 0.1 p	31.17± 0.01 u	36.8± 1.5 C
T5	44.7± 0.1 b	40.55± 0.01 g	37.7± 0.1 j	36.10± 0.1 m	33.28± 0.01 q	38.46±1.30 B
T6	45.1± 0.1 a	42.75± 0.01 d	40.15± 0.01 h	37.30± 0.1 k	35.60 ± 0.1 n	40.18± 1.15 A
T7	41.15± 0.01 f	35.1± 0.1 o	32.50± 0.1 s	27.9± 0.1 y	26.85± 0.01 a	32.70± 1.72 F
Range	43.0± 0.44 A	37.77± 0.79 B	34.98± 0.77 C	31.73± 1.03 D	30.09± 0.88 E	---

The averages that bear different letters, differ significantly (P<0.05) among them (capital letters are main effect of treatments and storage times and small letters are the effect of the intraction between treatments and storage times).

The effect of the interaction between treatments and the cold storage periods on the value of thiobarbituric acid (TBA) for chilled ground beef was presented in table (6), It was noticed a significant (P<0.05) increase in the value of TBA (3.18mg MDA/kg) for T1 (control treatment) during the storage period of 12 days of chilling as compared with T6 (Resveratrol %0.50g/Kg) which recorded the lowest significant (P<0.05) difference (0.25 mg MDA/kg) in the period of storage of 1 days, and there were significant (P<0.05) differences between all treatments and for different storage periods. It is noted from the same table that there are significant (P<0.05) differences among the rates of the addition

treatments, as it was noted a significant superiority in the value of T1 (2.07 mg MDA/kg), followed by the effect of the T2, which amounted to (1.3 mg MDA/kg), which did not differ significantly with T7 which amounted to (1.17 mg MDA/kg), followed by T3, T4, T5, and T6 that may be due to the use of natural extracts as protective materials to prevent oxidation during storage, including the addition of the antioxidant resveratrol, which works to reduce the percentage of malondialdehyde in fats in cold-stored beef (24). Moreover that phenolic compounds hinder the oxidation chain reaction by capturing free radicals, reducing Oxygen, deactivating singlet oxygen (O2, removing metal ions, eliminating hydroperoxides and deactivating and stabilizing free radicals by incorporating them into their aromatic ring (6,18). The phenolic subgroup of flavonoids can also act as a metal chelator, mainly for Fe^{+3}, which prevents the oxidation process (27). As for the periods of storage, the results of the statistical analysis indicated a significant ($P<0.05$) difference among the different cold storage periods, as the value of TBA was at its lowest level in the 1-day cold storage period, which amounted to (0.54 mg MDA/kg), then it began to rise with the increase of the storage periods till it reached its highest value during the 12-day refrigeration storage period (1.81 mg MDA/kg), The explanation for the increases in the TBA value of the control treatment over the storage period may be due to the increase in the concentration of malondialdehyde, which is one of the byproducts of fat oxidation due to the breakdown of peroxides resulting from the reaction of oxygen with unsaturated fatty acids (32), and it is noted that all addition treatments did not exceed the upper limit allowed in TBA values of 2 mg (malondialdehyde / kg meat) (15, 19).

Table 6. Effect of Resveratrolte on Thiobarbituric Acid (TBA) Value of chilled ground beef meat

Treatments No.	Thiobarbituric Acid (mg MDA/kg) Storage periods (days)					Range
	1	3	6	9	12	
T1	0.92±0.02 ij	1.51±0.01 ef	2.10±0.1 c	2.64±0.04 b	3.18±0.02 a	2.07±0.266 A
T2	0.67±0.03 lm	1.12±0.02 gh	1.25±0.05 g	1.61±0.01 e	1.87±0.03 d	1.3±0.1 B
T3	0.55±0.01 mno	0.8±0.05 jkl	1.180±0.02 gh	1.45±0.05 f	1.65±0.01 e	1.126±0.1 C
T4	0.44±0.01 opq	0.73±0.03 kl	1.1±0.1 gh	1.4±0.1 f	1.62±0.02 e	1.058±0.1 D
T5	0.36±0.01 qr	0.51±0.01 nop	0.85±0.01 jk	1.15±0.05 gh	1.39±0.01 f	0.852±0.1 E
T6	0.25±0.01 r	0.39±0.01 oqr	0.72±0.02 kl	0.9±0.1 j	1.10±0.10 gh	0.67±0.1 F
T7	0.65±0.01 lmn	0.85±0.01 jk	1.05±0.05 hi	1.4±0.02 f	1.90±0.1 db	1.17±0.1 C
Range	0.548±0.057 E	0.84±0.09 D	1.178±0.11 C	1.5±0.14 B	1.81±0.17 A	---

The averages that bear different letters, differ significantly ($P<0.05$) among them (capital letters are main effect of treatments and storage times and small letters are the effect of the intraction between treatments and storage times).

Figure (1) shows the effect of the interaction between treatments and storage periods on the total number of bacteria in chilled ground beef. It is noted that the logarithm of the total number of bacteria decreased significantly ($P<0.05$) in T6 (Resveratrol %0.50g/Kg), which amounted to 0.3 colony-forming units/gm of meat in the 1-day of cold storage, while the logarithm of the total number of bacteria increased in the T1 (control) in the 12-day of cold storage, as it recorded 8.1 colony-forming units/gm of meat, and significant ($P<0.05$) differences between treatments and for different storage periods. Table (7) shows a significant effect ($P<0.05$) of the treatment on the total number of bacteria, as the number of bacteria decreased in T6, T5, T4, T3, T2, and T7, respectively, as compared with T1. The decrease in bacterial numbers may be due to the active flavonoids present in natural extracts, which destroy the bacterial cell membrane and cause the contents of the bacterial cell to leak out, leading to its stagnation (9). Natural antioxidants also lead to a disturbance in the outer membrane of the bacteria and work to Releasing

lipopolysaccharides and increasing the permeability of its cytoplasmic membrane, thus making room for other substances to enter the bacterial cell and reach the cytoplasm, and then combine with the proteins and enzymes present in the bacterial cell and neutralize their effect (11). As for the periods of cold storage, Table (7) shows a significant increase ($P<0.05$) in the logarithm of the total number of bacteria in the period 12, 9 and 6 days as compared with one day period of cold storage. The increase in bacterial numbers as storage periods progress is related to the destruction of membranes that occurs inside cells leads to the release of free radicals, which in turn can lead to DNA damage and lipid oxidation. As an adaptive response to this phenolic 'attack' microbes modify their gene expression to reduce aerobic metabolism and increase the production of enzymes. Antioxidants and DNA repair (39). It is noted from the results that the total number of bacteria for all addition treatments was within permissible limits for the total count of bacteria in meat by the Iraqi Central Organization for Standardization and Quality Control (7 logarithmic cycles) (15).

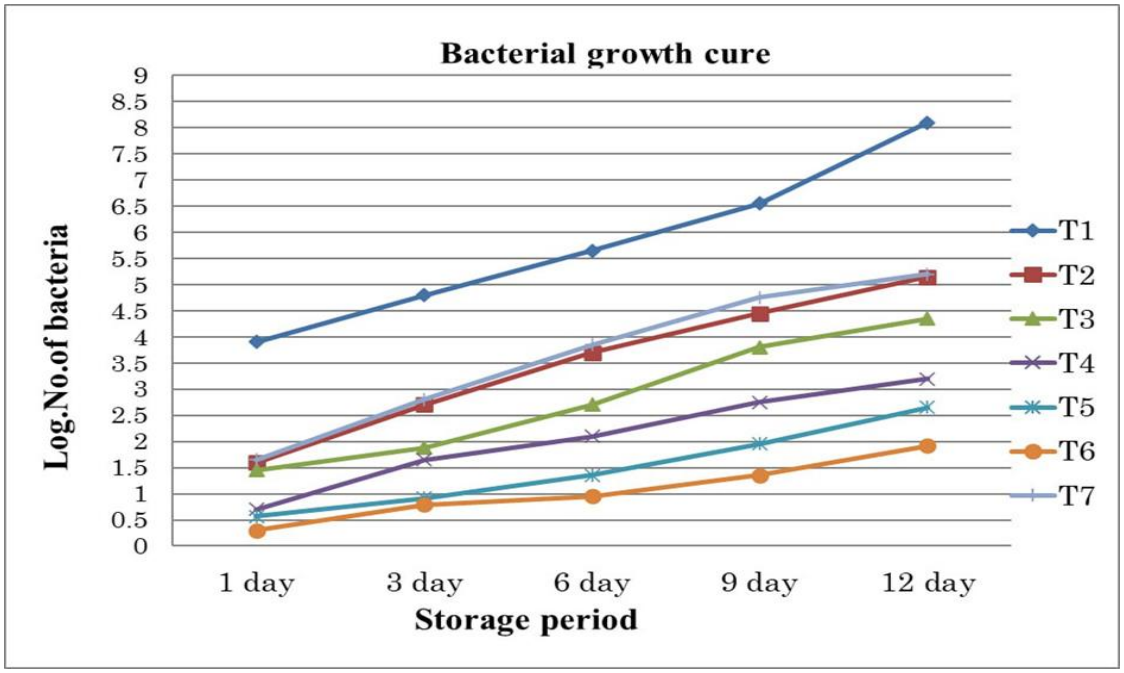

Figure 1. effect of the interaction between treatments and storage periods on the logarithm of the total bacterial count (colony-forming unit/ g of meat) of chilled ground beef meat stored in 2 C°

Table 7. Effect of Resveratrol on the logarithm total bacterial count (TBC) of chilled ground beef meat

Treatments No.	Logarithm of Total Bacterial Count (bacterial colony units/gm) Storage periods (days)					Range
	1	3	6	9	12	
T1	3.9± 0.1 g	4.8± 0.2 e	5.65± 0.01 c	6.55± 0.01 b	8.1± 0.1 a	5.8± 0.48 A
T2	1.6± 0.1 l	2.70± 0.1 I	3.7± 0.05 g	4.45± 0.05 f	5.15± 0.05 d	3.52± 0.42 C
T3	1.45± 0.05 lm	1.88± 0.02 jk	2.7± 0.05 I	3.80± 0.1 g	4.35± 0.05 f	2.83± 0.36 D
T4	0.7± 0.1 op	1.65± 0.05 kl	2.10±0.1 j	2.75± 0.05 I	3.2± 0.1 h	2.08±0.29 E
T5	0.57± 0.03 p	0.92±0.01 no	1.35±0.05 m	1.95± 0.05 j	2.65± 0.05 I	1.48±0.24 F
T6	0.3± 0.05 q	0.79±0.01 nop	0.95±0.05 n	1.35±0.05 m	1.92 ±0.02 j	1.062±0.18 G
T7	1.65± 0.05 kl	2.80± 0.2 I	3.85±0.05 g	4.75±0.05 e	5.20±0.1 d	3.65±0.43 B
Range	1.452±0.31 E	2.220±0.35 D	2.90±0.419 C	3.657±0.46 B	4.36±0.53 A	---

The averages that bear different letters, differ significantly ($P<0.05$) among them (capital letters are main effect of treatments and storage times and small letters are the effect of the intraction between treatments and storage times).

It could be concluded that the addition of the antioxidant Resveratrol can improve the chemical and physical properties of chilled ground beef, and increase the microbial stability of ground beef stored under refrigeration at 2 C° for approximately 12 day.

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