EFFECT OF ELASTIN HEDROLYSES ON THE CHEMICAL COMPOSITION AND SOME OXIDATION INDICATORS IN COLD-STORED GROUND BEEF

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ABSTRACT

This study was aimed to investigate the effect of elastin hydrolysates extracted from bovine skin on the chemical composition and some indicators of oxidation in minced beef stored in refrigeration at a temperature of 2 °C for a period of 12 days. The study included 6 treatments T_1 (without addition), T_2 addition (1000 ppm) of elastin hydrolysates per kg of meat, T_3 addition (500 ppm) of elastin hydrolysates per kg of meat, T_4 addition (1000 ppm) of collagen hydrolysates per kg of meat, T_5 addition (500 ppm) of collagen hydrolysates per kg of meat and T_6 addition of the antioxidant BHA (0.01) per kg of meat. the transactions were stored by cold storage for periods 1, 3, 6, 9 and 12 days, and some chemical tests were conducted for them, The results of this study showed that treatments to which elastin hydrolysate was added showed a significant improvement in the chemical composition (moisture, protein, fat and ash) of ground beef stored in cold storage compared to the control treatment. It also showed a significant decrease ($P<0.01$) in oxidative stress indicators through a decrease in TBA values in chilled ground beef compared to the control treatment. We conclude that the addition of elastin hydrolysate to minced meat stored in cold storage at different storage periods improved the chemical composition of the meat and achieved high antioxidant effectiveness through a decrease in oxidation indicators represented by a decrease in the TBA value. And improve the water holding capacity of WHC, From the above, this study aimed to know the effect of elastin hydrolysate in maintaining chemical properties and reducing oxidation and thus prolonging the period of cold preservation of meat.

Keywords: antioxidants, MDA, protein.

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تأثير متحللات الإيلاستين على التركيب الكيميائي وبعض مؤشرات الاكسدة في لحم العجل المفروم المخزن بالتبريد

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المستخلص

هدفت هذه الدراسة الى معرفة تأثير متحللات الايلاستين المستخلصة من جلد الابقارعلى التركيب الكيميائي وبعض مؤشرات الاكسدة للحم العجل المفروم المخزون بالتبريد بدرجة حرارة 2م° لمدة 12 يوم، شملت الدراسة 6 معاملات: T_1 بدون اضافة، T_2 إضافة (1000 جزء في المليونل/كغم لحم) و T_3 إضافة (500 جزء في المليون/كغم لحم) من متحللات الإيلاستين المنتجة بأنزيم الايلاستيز(E.H.E)، T_4 إضافة (1000 جزء في المليون/كغم لحم) و T_5 إضافة (500 جزء في المليون/كغم لحم) من متحللات الايلاستين المنتجة بأنزيم الكولاجينيز(E.H.C)، T_6 إضافة إضافة مضاد الأكسدة الـ BHA (0.01)لكل كغم لحم، خزنت المعاملات بالتبريد بفترات خزن 1 و3 و6 و9 و12 يوم، واجري لها بعض الاختبارات الكيميائية، بينت نتائج هذه الدراسة أن معاملات اضافة متحللات الإيلاستين للحم العجل المفروم والمخزون بالتبريد أظهرت تحسنا ملحوظا في التركيب الكيميائي (الرطوبة، البروتين، الدهن والرماد) مقارنة مع معاملة السيطرة وأظهرت انخفاضاً معنوياً ($P<0.01$) في مؤشرات الاكسدة بانخفاض قيم TBA للحم العجل المفروم المبرد مقارنة بمعاملة السيطرة. نستنتج أن إضافة متحللات الإيلاستين إلى اللحم المفروم المخزن بالتبريد وبفترات خزنية مختلفة حسن من التركيب الكيميائي للحم وحقق فعالية عالية كمضاد للأكسدة من خلال انخفاض الـTBA وتحسين قابلية حمل الماء WHC. مما سبق فان هذه الدراسة هدفت إلى معرفة تأثير متحللات الإيلاستين في الحفاظ على الخواص الكيميائية وتقليل الأكسدة وبالتالي إطالة العمر الخزني للحوم.

الكلمات المفتاحية: ،مضادات الاكسدة، مالوندايالديهايد، بروتين.

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INTRODUCTION

The quality of meat and meat products depends on the quantity and condition of the proteins contained in them (30) The biochemical reactions that occur during the processing and storage of meat affect the composition and functional properties of meat protein (36). These changes lead to two directions: the splitting of large protein molecules and the aggregation of small protein molecules. Consequently, these changes lead to protein denaturation, which affects the technological properties of the meat, and that changes in the myofibrillar proteins have a significant impact on the texture and properties of meat and other meat products, and to properly preserve the meat, it is necessary to determine the status of the proteins as using several techniques to determine the status of the sarcoplasmic and myofibrillar proteins in meat (21, 30). Scientific progress and the techniques used in the separation and analysis of different protein compounds have produced the so-called bioactive components, which come from many animal and plant foods, and which have had a real role in treating many diseases. Among these biologically active components are what is derived from proteins, fats, or sugars(22). Proteins in foods not only serve as nutrients, but also play physical and chemical roles that promote health, Most of the physiological activities of proteins are carried out by peptide sequences encoded in the original protein, which becomes active when it is cleaved naturally. Bioactive peptides are released during enzymatic proteolysis, such as hydrolysis in vitro using proteolytic enzymes. Bioactive peptides are known for their ability to inhibit protein interactions due to their small size and specificity (14). These bioactive peptides typically contain 3-20 amino acid residues per molecule, and both animal and plant proteins contain bioactive sequences (14,33). Elastin is a protein found in connective tissue with collagen such as the aorta, lung, dermis, ligaments, skin, tendons, blood vessels and vascular wall that provides elasticity to organs Functionally it is a highly hydrophobic cross-linked polymer It is organized as sheets or fibers in the extracellular matrix It is a protein It is hard, insoluble and breaks down by exposing the protein tissues containing it to high thermal conditions and a wide range of pH, resulting in insoluble elastin residues due to its unique chemical composition and highly linked nature(12,13). Since enzymes are naturally produced by living cells to trigger biochemical reactions(8, 12),The hydrolysis of such a protein with acid or base or treatment with an enzyme gives elastin soluble in water. Since water-soluble elastin is of great importance in the field of regenerative medicine, it enters into artificial blood vessels, in the pharmaceutical industry and in the cosmetics industry, as it is one of the most important antioxidants obtained from by-products such as animal skin (28).

MATERIALS AND METHODS

This study was conducted in the graduate laboratories of the College of Agricultural Engineering Sciences, University of Baghdad, It was conducted by taking leg meat from a local calf that had been stripped of its apparent fat, this meat was cooled at a temperature of 2°C for a period of (10-12) hours, after which it was cut with a sterilized knife into small pieces of dimensions 3-4 cm3 to facilitate the subsequent mincing process using sterile gloves. The elastin hydrolysates were produced according to the method described (30, 32). Elastin hydrolysates were added to the minced meat in different proportions. The experiment included 6 treatments according to the concentrations added to the meat. The required tests were conducted after 1, 3, 6, 9, 12 days of refrigerated preservation at 2°C to find out the effect of the aforementioned additives on the Proximate composition (moisture, protein, fat and ash) according to the method described by AOAC (1), The effect of oxidative stress was measured by Thiobarbituric acid TBA and water holding capacity WHC(17.20). The data were analyzed statistically using the SAS program to find out the effect of different coefficients on the studied traits according to the complete random design (CRD) for each period, and the significant differences between the averages were compared with Duncan's multinomial test (16).

RESULTS AND DISCUSSION

Proximate composition of fresh chilled ground beef:

1- moisture & protein

Table (1) shows the effect of the interaction between different treatments and different storage periods on the moisture content of fresh chilled ground beef. As we notice a significant increase ($P<0.01$) in the moisture content of the meat with treatment T_2 (1000ppm of E.H.E), which recorded 75.02% in the period of 1 day, While the control treatment T_1 recorded the least significant difference ($P<0.01$) in the percentage of meat moisture (69.01%) in the 12 day period, and there were varying differences between the treatments and the different storage periods.

This is consistent with many tudies that indicated an increase in the moisture content of the meat when some medicinal plants or their extracts were added, and that the moisture content decreased with the progression of the storage period as a result of self-decomposition and evaporation of water or exudation of free water, and the percentage of protein, fat and ash increased(14). The incorporation of proteolytic enzymes with meat products increased the tenderness of meat and improved its quality, The results of Soltanizadeh's study showed that adding aloe vera extract to beef increased its moisture content (34). The same Table shows a significant effect ($P<0.01$) for all treatments in protein % during the refrigerated storage periods 1, 3, 6, 9 and 12 days, respectively, as the highest percentage of protein was in T_2 (1000ppm of E.H.E) for the period 12 days, which recorded 20.02% compared to With the control treatment T_1, which recorded the lowest of protein% 17.25% in the period of 1 day. The high of protein% in the treatments is attributed to the ability of elastin hydrolysates added to the meat to protect the protein from oxidation and damage (17,19), as the enzymatic hydrolysis procedure in safe, healthy conditions does not produce side reactions and does not reduce the nutritional value of the protein source (3,19). Several studies indicated an increase in the percentage of protein when natural antioxidants were added, as feeding lambs on a food supplement of rapeseed oil, fish oil, black seed, yeast, carnosic acid and different chemical forms of selenium increased the protein content of meat and preserved it from oxidation (29). This is consistent with the results of previous studies (20,24)The percentage of protein decreases with the progression of storage periods and increases with the increase in the concentration of addition. This is what studies have found (8,37).

2- FAT% & ASH

Data in Table (2) shows the effect of the overlap between the different treatments and periods of cold storage in the fat% in fresh chilled ground beef, as it is noted that there is a significant decrease ($P<0.01$) in the fat% in T_2 (1000ppm of E.H.E) as it reached 6.01% in the period of 1 day. While the control treatment, T_1, recorded the highest percentage of fat, amounting to 9.89%, in the 12 day period. There were varying differences between the transactions and the different storage periods. The reason for the high percentage of fat in the addition treatments is due to the ability of the natural additives to protect the fat from oxidation and decomposition by preventing the formation of free radicals and active oxygen groups (ROS) (17,21). It is normal that with the progression of the storage period, the moisture% decreases and the dry matter increases, which includes protein%, fat% and ash%, and this is consistent with many previous studies (24, 26).

Table 1. Effect of the interaction between the treatment and the period of cold storage on humidity % and protein % ± SE of fresh chilled ground beef:

Periods/ Day	Test	Treatments					
		T_1	T_2	T_3	T_4	T_5	T_6
1	Protein	17.25 ± 0.19^{Q}	17.87 ± 0.02^{NOPQ}	17.72 ± 0.15^{NOPQ}	17.74 ± 0.12 ^{NOPQ}	17.62 ± 0.17^{NOPQ}	17.71 ± 0.07^{NOPQ}
	Moisture	73.27 ± 0.23^{EFGHIJ}	75.02 ± 0.09 ^{A}	74.55 ± 0.14^{AB}	74.52 ± 0.11^{AB}	74.49 ± 0.07^{AB}	74.53 ± 0.07^{AB}
3	Protein	17.73 ± 0.13^{NOPQ}	18.27 ± 0.15^{GHIJKLMN}	18.09 ± 0.19^{KLMN}	18.14 ± 0.21^{KLMN}	18.20 ± 0.11^{JKLMN}	18.25 ± 0.08^{HIJKLMN}
	Moisture	71.95 ± 0.16^{LMN}	74.06 ± 0.21^{BCDE}	73.92 ± 0.25^{BCDEF}	73.70 ± 0.21^{CDEFG}	73.51 ± 0.12 DEFGHI	73.61 ± 0.36^{CDEFGH}
6	Protein	18.66 ± 0.12^{EFGHIJKL}	18.86 ± 0.10^{CDEFGHI}	18.81 ± 0.22 CDEFGHI	18.95 ± 0.26^{CDEF}	18.97 ± 0.13^{CDEF}	18.71 ± 0.36^{DEFGHIJ}
	Moisture	70.54 ± 0.23^{QR}	73.12 ± 0.31 FGHIJ	72.92 ± 0.33 ^{GHIJ}	72.81 ± 0.16 ^{HIJK}	72.66 ± 0.53 JKL	72.68 ± 0.15 IJKL
9	Protein	18.87 ± 0.02^{CDEFGH}	19.85 ± 0.26^{AB}	19.72 ±0.02^{AB}	19.79 ± 0.10^{AB}	19.81 ± 0.34^{AB}	19.40 ± 0.13^{ABC}
	Moisture	69.39 ± 0.27^{S}	72.05 ± 0.63^{KLM}	71.73 ± 0.07^{MNO}	71.67 ± 0.12^{MNO}	71.63 ± 0.43^{MNO}	71.67 ± 0.29^{MNO}
12	Protein	19.01 ± 0.21^{CDEF}	20.02 ± 0.29^{A}	19.89 ± 0.22^{AB}	19.82 ± 0.01^{AB}	19.71 ± 0.31^{AB}	19.65 ± 0.15^{AB}
	Moisture	69.01 ± 0.42^{S}	71.51 ± 0.12^{MNO}	71.29 ± 0.22 ^{MNOPQ}	71.24 ± 0.20 ^{MNOPQ}	71.01 ± 0.31 OPQR	71.14 ± 0.25 NOPQR

- Means with similar letters are not significantly (P<0.01) different between them. The means with different letters are significantly different (P<0.01) among them

- T1 control treatment, T2(1000ppm of E.H.E), T3(500ppm of E.H.E), T4(1000ppm of E.H.C), T5(500ppm of E.H.C), T6 (0.01ppm of BHA)

- E.H.E: Hydrolyzed elastin by elastase, E.H.C: Hydrolyzed elastin by collagenase, BHA: Butylated hydroxy anisole

The same Table also shows the effect of the interaction between treatments and different storage periods in ash % of fresh chilled ground beef, as treatment T_2 (1000ppm of E.H.E) recorded the least significant difference (P<0.01) 0.84% in ash % in the period 1 day of refrigeration While the T_1 control treatment recorded a higher ash percentage of 1.82% in the 12 day period, and from the same table referred to above, it is also clear that there is a significant effect (P<0.01) in ash % in fresh ground beef for all treatments and all periods of refrigerated storage, as it is noted that there is a significant decrease In treatment T_2 (1000ppm of E.H.E), which recorded (0.84, 1.09, 1.17, 1.21, and 1.25)%, respectively, for periods 1, 3, 6, 9 and 12 days, in sequence, followed by treatment T_3 (500ppm of E.H.E), which amounted to The percentage of ash% in it was (0.97, 1.08, 1.29, 1.30 and 1.37)%, respectively, for the same previously mentioned periods, compared with the (control treatment) T_1, which increased significantly as it recorded (1.29, 1.36, 1.41, 1.79 and 1.82%), respectively, for the same

Table 2. Effect of the interaction between the treatment and the period of cold storage in Fat % and Ash % ± SE of fresh chilled ground beef

Periods/ Day	Test	Treatments					
		T_1	T_2	T_3	T_4	T_5	T_6
1	Ash	0.12 ± 1.29 ABCDEF	0.12 ± 0.84^{F}	0.15 ± 0.97^{EF}	0.109±1.03^{EF}	0.02±1.12^{DEF}	0.02±1.07^{EF}
	Fat	± 7.75 0.15^{D}	0.02 ± 6.01^{M}	0.14 ± 6.51 JKLM	0.11 ± 6.53^{JKLM}	0.015 ± 6.56 JKLM	0.27 ± 6.41 KLM
3	Ash	0.11 ± 1.36 ABCDEF	0.12 ± 1.09 DEF	0.19 ± 1.08 EF	0.23 ± 1.17^{CDEF}	0.11 ± 1.20 BCDEF	0.11 ± 1.23 ABCDEF
	Fat	± 8.41 0.13^{C}	0.22 ± 6.31 LM	0.18 ± 6.51 JKLM	0.22 ± 6.76 GHIJKL	0.15 ± 6.80 FGHIJKL	0.16 ± 6.795 GHIJKL
6	Ash	0.11 ± 1.41 ABCDEF	0.10 ± 1.17 CDEF	0.21 ± 1.29 ABCDEF	0.20 ± 1.25 ABCDEF	0.22 ± 1.29 ABCDEF	0.09 ± 1.31 ABCDEF
	Fat	± 9.01 0.10^{CB}	0.12 ± 6.51 JKLM	0.22 ± 6.68 IJKLM	0.21 ± 6.80 FGHIJKL	0.13 ± 6.92 EFGHIJKL	0.36 ± 6.87 FGHIJKL
9	Ash	± 1.79 0.02^{ABC}	0.16 ± 1.21 BCDEF	0.02 ± 1.30 ABCDEF	0.10 ± 1.36 ABCDEF	0.43 ± 1.32 ABCDEF	0.22 ± 1.37 ABCDEF
	Fat	±9.51 0.017^{AB}	0.13 ± 6.67 JKLM	0.16 ± 6.89 EFGHIJKL	0.18 ± 6.93 EFGHIJKL	0.21 ± 7.02 EFGHIJK	0.13 ± 7.16 DEFGHIJ
12	Ash	± 1.82 0.11^{A}	0.02 ± 1.25 ABCDEF	0.22 ± 1.37 ABCDEF	0.25 ± 1.37 ABCDEF	0.31 ± 1.40 ABCDEF	0.15 ± 1.40 ABCDEF
	Fat	± 9.89 0.13^{A}	0.32 ± 7.11 DEFGHIJK	0.25 ± 7.09 DEFGHIJK	0.01 ± 7.38 DEFGHI	0.23 ± 7.39 DEFGH	0.14 ± 7.41 DEFGH

- Means with similar letters are not significantly (P<0.01) different between them. The means with different letters are significantly different (P<0.01) among them

- T1 control treatment, T2(1000ppm of E.H.E), T3(500ppm of E.H.E), T4(1000ppm of E.H.C), T5(500ppm of E.H.C), T6 (0.01ppm of BHA)

- E.H.E: Hydrolyzed elastin by elastase, E.H.C: Hydrolyzed elastin by collagenase, BHA: Butylated hydroxy anisole

Periods. mentioned above, and this is consistent with the results obtained by Fallow et al (17), since with an increase in the concentration of the natural meat additive, the ash percentage increases(19,24)These results are consistent with the results of previous studies (7)

3-THIOBARBITURIC ACID TEST

Results in Table (3) show the effect of the interaction between treatments and cold storage periods on the value of thiobarbituric acid (TBA) of fresh chilled ground beef, It was found that there was a significant decrease (P<0.01) in the value of TBA 0.16 (MDA/kg) in T_2 (1000ppm of E.H.E) compared with the control treatment T_1, which amounted to 0.37 (MDA/kg) in the period of 1 day, and it was also noted that there were differences Significant differences between treatments and different storage periods. It is noted from the same table that there was a decrease in the value of TBA in T_2 compared to all treatments and for all storage periods 1, 3, 6, 9, and 12 days, respectively, as it recorded 0.16, 0.18, 0.43, 0.78, and 1.04 (MDA/kg), respectively, followed by T_3 (500ppm of E.H.E) in which the TBA value was 0.19, 0.28, 0.49, 0.93, and 1.19 (MDA/kg), respectively, for the same aforementioned periods, while the highest value was recorded in the TBA value in T1 (control) and for all periods The aforementioned storages were 0.37, 0.47, 0.71, 1.45 and 2.03 (MDA/kg), respectively. This is consistent with many studies (19,29,40). This is consistent with the results of (2, 24,27), which indicated a decrease in the value of TBA by increasing the concentration of additives, indicating that the reason for the increase in TBA values in (control) T_1 of fresh ground beef stored in cold storage is an increase in the concentration of MDA With continued storage, which is one of the by-products of oxidation of fats in meat and its products due to the breakdown of peroxides, and the gradual increase in the value of TBA during periods of cold storage of meat is a natural matter as a result of oxidation processes and the production of free radicals,

active oxygen groups, peroxides, and others (9,25). The addition of elastin hydrolysates to the meat led to a decrease in the value of TBA during refrigerated storage periods due to the ability of these hydrolysates to suppress free radicals and compounds resulting from fat oxidation. The reason for the low acid values in the coefficients of elastin hydrolysates may be due to the antioxidant properties of the latter(11,14,27). The addition of natural antioxidants reduced the percentage of malondehyde (MDA) in fats and proteins of veal meat chilled at 4°C for 11 days (27). Recent studies also encourage the use of antioxidants that are compounds that are able to donate a hydrogen atom H* to conjugate with other available free radicals to prevent the oxidation process and thus delay the rancidity and oxidation of fats, without any effect on organoleptic properties or nutritional value, leading to preservation of quality. and extending the shelf life of meat products (5, 10, 31), These results agree with the findings of Al-Sudani et al(8) and Huang et al(20). The same Table shows the effect of the overlap between treatments and different storage periods on water holding capacity, as it is noted that there is a significant increase ($P<0.01$) in T_2 (1000ppm of E.H.E), as it reached 45.36% in the period of 1 day, while the (control treatment) T_1 recorded less Significant difference ($P<0.01$) 25.58% in the 12 day period, and it is noted in the same table that there are varying differences between the different transactions and storage periods. This is due to the ability of added hydrolysates to protect meat proteins from oxidation and degradation, and elastin hydrolysates have antioxidant potential, Kristinsson (23) as many studies have shown that protein hydrolysates have an excellent water holding capacity when added to minced meat. Ayat and Shakir (10) indicate that the addition of collagen hydrolysates to the meat improved its water holding capacity.

Table 3. Effect of the overlap between treatments and cold storage periods on the value of TBA and WHC ± SE of fresh chilled ground beef

Periods/ Day	Test	Treatments					
		T_1	T_2	T_3	T_4	T_5	T_6
1	WHC	41.28 ± 0.19^{GHI}	45.36 ± 0.06^{A}	44.12 ± 0.10^{B}	44.32 ± 0.30^{B}	43.15 ± 0.15^{CD}	42.50 ± 0.13^{EF}
	TBA	0.37 ± 0.09^{NOP}	0.16 ± 0.01^{Q}	0.19 ± 0.04P^{Q}	0.28 ± 0.01^{OPQ}	0.30 ± 0.02^{NOPQ}	0.311 ± 0.157^{NOPQ}
3	WHC	39.49 ± 0.24^{KL}	42.98 ± 0.20^{CDE}	42.66 ± 0.11^{DEF}	42.33 ± 0.21^{F}	41.26 ± 0.14^{GHI}	41.67 ± 0.18^{G}
	TBA	0.47 ± 0.12^{LMN}	0.18 ± 0.09^{PQ}	0.28 ± 0.12 OPQ	0.34 ± 0.07^{NOP}	0.41 ± 0.027^{MNO}	0.40 ± 0.05MNO
6	WHC	34.46 ± 0.3^{WX}	40.17 ± 0.13^{J}	39.95 ± 0.12^{JK}	39.36 ± 0.03^{L}	38.24 ± 0.08^{NO}	39.05 ± 0.15^{KM}
	TBA	0.71 ± 0.12^{JI}	0.43 ± 0.02^{MNO}	0.49 ± 0.11^{KLMN}	0.58 ±0.03^{JKLM}	0.62 ± 0.03^{IJKL}	0.69 ± 0.12^{IJ}
9	WHC	27.67 ± 0.21^{Zc}	39.20 ± 0.13^{L}	37.84 ± 0.18^{OP}	37.54 ± 0.12^{PQ}	36.34 ± 0.22^{TU}	36.15 ± 0.08^{U}
	TBA	1.45 ± 0.02^{C}	0.78 ± 0.02^{HI}	0.93 ± 0.03^{GH}	0.96 ± 0.12^{G}	1.02 ± 0.01^{G}	0.98 ± 0.01^{G}
12	WHC	25.58 ± 0.17^{Zd}	37.27 ± 0.10^{QR}	35.09 ± 0.20^{V}	34.35 ± 0.27^{WX}	32.24 ± 0.21^{Z}	32.39 ± 0.08^{Z}
	TBA	2.03 ± 0.11^{A}	1.04 ± 0.02^{FG}	1.19 ± 0.02^{EF}	1.32 ±0.01^{CDE}	1.36 ± 0.01^{CDE}	1.78 ± 0.01^{B}

- Means with similar letters are not significantly ($P<0.01$) different between them. The means with different letters are significantly different ($P<0.01$) among them
- T1 control treatment, T2(1000ppm of E.H.E), T3(500ppm of E.H.E), T4(1000ppm of E.H.C), T5(500ppm of E.H.C), T6 (0.01ppm of BHA)
- E.H.E: Hydrolyzed elastin by elastase, E.H.C: Hydrolyzed elastin by collagenase, BHA: Butylated hydroxy anisole
- MDA: Malondehyde

The natural additive protects the protein and improves the water holding capacity, and it rises as the concentration of the natural additive increases (7) indicated that the reason for the increase in WHC was that these compounds contributed to raising the pH of the processed meat, which increased its ability to hold water. This is consistent with what was found by Al-Rubeii, & Zahir (6). There was a significant increase ($P<0.01$) in the water holding capacity after the addition of antioxidants. From the results obtained from this study, we can conclude that adding elastin hydrolysates to fresh minced beef stored in refrigeration led to an increase in moisture%, protein% and fat%, it also showed a noticeable improvement in water holding capacity for minced beef and reduced oxidation indicators represented by the value of the TBA.

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