Evaluation of the Antioxidant Potential of Artichoke (*Cynara scolymus L.*) Byproducts Extracts in Raw Beef Patties

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Abstract- **The present study was carried out to evaluate the antioxidant potential of artichoke by-products extract (AE) and butylated hydroxyl toluene (BHT) in raw beef patties during refrigerated storage. Freshly minced beef was assigned to one of the following three treatments: 1) Control (no antioxidant) 2) 38.7 mg AE phenolics per 100 g meat (optimized by using response surface methodology), 3) 20 mg BHT per 100 g meat. The patties formed from the minced meats were stored in polythene bags at 2^0C for 7 days. Total phenolic content, color (L*, a*, b* values), TBARS values and protein oxidation (total carbonyl content) were evaluated during 1, 4 and 7 days of storage at 2◦C. Results showed that artichoke extract is rich sources of phenolic compounds and these compounds showed high efficiency as antioxidant against lipid oxidation during the storage period of pattiesThe AE treatment substantially inhibited ($P < 0.05$) lipid oxidation in raw beef patties to a much greater extent than BHT treatment. The amount of carbonyls from protein oxidation significantly ($p < 0.05$) increased during refrigerated storage, and this increase was significantly higher in the control patties than in their treated counterparts. a* values of refrigerated beef patties decreased with storage. It was concluded that extracts of artichoke by-products have potential to be used as natural antioxidant when compared to BHT in meat products.**

Keywords- **Antioxidant, artichoke, beef**

I.INTRODUCTION

Lipid oxidation is one of the main factors limiting the quality and acceptability of meats and meat products. Lipid oxidation involves degradation of polyunsaturated fatty acids and generation of free radicals, leading to the deterioration of proteins, the oxidation of heme pigments, and the generation of rancid odours[1]. In addition oxidation process leads to discolouration, drip losses, off-odour and off-flavour development, and the production of potentially toxic compounds [2].

In an attempt to control this process, food industry uses synthetic additives with antioxidant properties. However, due to reports of possible toxic effects from synthetic antioxidants and to increasingly demanding consumer preferences for natural products and health benefits, the interest for alternative methods to retard lipid oxidation in foods, such as the use of natural antioxidants, has increased [3]. Therefore, there is a growing interest in natural sources of antioxidants for applications in meat products. Potential use of powders and extracts of different plant derived materials as natural antioxidants in meat and meat products have been studied in recent years.

Artichoke (Cynara scolymus L.) is an ancient herbaceous perennial plant, originating from the southern Mediterranean parts of North Africa [4]. The chemical components of artichoke leaves have been studied extensively and have been found to be a rich source of polyphenolic compounds, with mono- and dicaffeoylquinic acids and flavonoids as the major chemical components [5-8]. Artichoke by-products such as leaves, external bracts and stems produced by artichoke processing could be considered a promising source of phenolics that can be considered as a natural antioxidant for meat and meat products.

The objectives of the present work was to evaluate the antioxidant potential of artichoke by-products extract (AE) on refrigerated stored raw beef patties and compare their effects with that displayed by a synthetic antioxidant (BHT).

II.MATERIALS AND METHODS

A. Materials

Fresh boneless beef was purchased from a local meat processing plant in Pinar A.S., Izmir. Artichoke by-products were obtained from a local canning plant in Izmir. Butylated hydroxytoluene (BHT) was obtained from Sigma Chemical Co., St. Louis, USA.

B. Preparation of artichoke extracts

Artichoke by-products (external bracts and stems) were dried in a tray drier at 40 °C until they reached 12% moisture content and then ground in an analyti-

cal mill to a particle diameter of 0.65 mm. Twenty grams of dried and ground residue were macerated with 100 ml of ethanol 80% (v/v) under constant mechanical agitation on a rotary shaker at 40 °C 4 h. The extract was than filtered (12.5 mm qualitative filter paper), and the filtrate was concentrated in a vacuum rotary evaporator at 45 °C until the solvent was evaporated. The extract was stored in dark glass bottles and kept under frozen storage (-40°C). The amount of artichoke extract for patty manufacturing process was determined with one factor design, response surface methodology by using Design Expert® version 7.0 [9]. For response, TBARS value and antiradical activity were analyzed in raw patties under at 2°C for 24 hours storage conditions.

C. Preparation and storage of beef patties

Beef at 1–2 days of post-mortem trimmed of all visible fat and connective tissue. The beef was minced in a conventional meat grinder through a plate with 3mm holes. Freshly minced beef was assigned to one of the following three treatments: control (no antioxidant additive); 38.7 mg (optimized with response surface methodology) AE per 100 g meat; 20 mg BHT per 100 g meat. 1.5% NaCl added to each formulation. The patties formed and were stored in polythene bags at 2°C for 7 days.

D. *Analysis*

The AE and raw beef patties were analyzed for total phenolics using the Folin–Ciocalteus (F–C) assay [10]. The amount of total phenolics was calculated as gallic acid equivalents (GAE) from the calibration curve using standard gallic acid solution. Instrumental color analysis was performed using a Hunter lab Miniscan XE Plus colorimeter. CIE L* (lightness), a* (redness) and b* (yellowness) values were measured on the outer surface of raw patties from randomly chosen spots[11]. The thiobarbituric acid reactive substances (TBARS) value (mg malonaldehyde/kg) was determined using the extraction method described by Witte, Krauze, and Bailey [12]. Protein oxidation was measured by the total carbonyl content was assessed following the 2,4- dinitrophenylhydrazine(DNPH) coupling method described by Oliver, Ahn, Moerman, Goldstein, and Stadtman [13].

E. *Statistical Analysis*

The data was analyzed using SPSS (SPSS version 15.0 for windows). Results from experiments were analyzed, with treatments and storage time as main effects using two-way ANOVA. The least significant difference (LSD) was calculated at $P < 0.05$.

III.RESULTS AND DISCUSSION

The total polyphenol content of AE was found 4389.35 ±0.81 mg GAE/100g (dry weight). Wang et al. [14] reported that artichoke leaves contained 6800 mg GAE/100g (dry weight) which is similar to the polyphenol content of AE used in the present study. The total phenolic content of raw beef patties is given in Table 1. The total phenolic content was significantly ($P < 0.05$) higher in AE samples compared to control and BHT samples at each evaluation period. Phenolic content of all samples decreased by the storage period however AE treatment had the highest phenolic content on day 7. Depending on the results showed that TBARS values were found lowest on day 7 in AE groups (Table 2). Between all treatments AE showed the highest phenolic content. Neevana et al, [15] found similar results with our findings.

Table 1 Total phenolic content(mg/100g) of patty samples during storage at 2°C

Treatment	Storage Period (Day)		
	1	4	7
Control	29.64 ± 2.98^{cA}	25.09 ± 4.11^{cAB}	24.26 ± 3.32^{cB}
BHT	40.26 ± 2.80^{bA}	34.21 ± 4.52^{bB}	25.06 ± 2.80^{bcC}
AE	50.61 ± 2.90^{aA}	37.67 ± 2.42^{aBC}	33.70 ± 2.86^{aC}

[a-c] Means within a column with different letters are significantly different ($P < 0.05$).
[A-C] Means within a column with different letters are significantly different ($P < 0.05$).
± Standard deviations

The TBARS value has been widely used to measure lipid oxidation in meat and meat products. There were significant differences between the TBARS values of patty samples ($p<0.05$) (Table 2). Treatment with AE resulted lower TBARS values at each evaluation period. Similar to our results Mansour and Khalil [16] showed the antioxidant activity of freeze dried extracts from potato peel in ground beef patties. All treatment groups showed significant ($P <$

0.05) increase in TBARS values during storage period. Natural, antioxidants are believed to break free radical chains of oxidation by donation of a hydrogen from the phenolic groups, thereby forming a stable end product [17].

Table 2 TBARS values and carbonyl content of patty samples during storage at 2°C

Treatment	Storage Period (Day)		
	1	4	7
TBARS* values			
Control	0.76±0.16^{aA}	1.01±0.08^{aB}	1.38±0.14^{aC}
BHT	0.55±0.02^{bA}	0.92±0.05^{bBC}	1.00±0.07^{bC}
AE	0.37±0.03^{cA}	0.67±0.06^{cB}	0.83±0.05^{cC}
Carbonyl content**			
Control	1.31±0.19^{aA}	2.40±0.14^{aB}	4.33±0.16^{aC}
BHT	1.29±0.18^{aA}	2.11±0.27^{aB}	4.50±0.51^{aC}
AE	1.08±0.11^{aA}	1.76±0.09^{bB}	2.86±0.19^{bC}

$^{a-c}$ Means within a column with different letters are significantly different ($P < 0.05$).
$^{A-C}$ Means within a column with different letters are significantly different ($P < 0.05$).
* mg malonaldehyde/kg meat
** nmol carbonyl/mg protein

Determination of protein carbonyl content by derived with DNPH is recommended as a general measure for the extent of protein oxidation. Some carbonyl compounds derived from lipid oxidation (e.g. malonaldehyde) increase the protein carbonyl values in the DNPH assay. Results from the present study suggest that the addition AE to beef patties inhibited the development of protein oxidation during refrigerated storage as previously reported for lipid oxidation [18,19]. Using AE significantly decreased the carbonyl content of patties ($P < 0.05$). Siebert, Troukhanova, and Lynn [20] stated that phenolic compounds could inhibit the oxidation of proteins by retarding lipid oxidative reactions and by binding to the proteins to form complexes with them.

Colour parameters (L*, a* and b*) were shown in Table 3. No significant differences were observed either during storage or between treatments for lightness (L* values) ($p>0.05$). Redness (a* value) significantly decreased during the storage period in all treatments. BHT treatment had the highest a* value during storage and showed greater stability with regard to discolouration. Several authors have studied the effect of different antioxidants on colour of meat and meat products [21, 22] and have reported that oxidation resulted decrement in a* values. Although AE treatment had the lowest redness at end of the storage period but showed the lowest TBARSRS value. This findings could be attributed to the decreasing effect of a* values by chlorophyll content of AE extract. BHT and AE treatments decreased the yellowness values (b*) of beef patties significantly during storage ($p>0.05$). Therefore, the differences in b* values observed between treatments can be attributed to the presence of pigments in the AE.

Table 3 Color parameters (L*, a*, b*) of patty samples during storage at 2°C

Treatment	Storage Period (Day)		
	1	4	7
L*			
Control	34.69±1.71^{aA}	36.79±2.16^{aA}	37.62±1.55^{aA}
BHT	37.36±1.34^{aA}	39.29±1.49^{aA}	38.24±1.95^{aA}
AE	35.67±2.02^{aA}	38.46±3.62^{aA}	35.73±2.14^{aA}
a*			
Control	14.37±1.24^{bA}	11.78±3.65^{abA}	9.89±1.96^{bB}
BHT	21.83±4.98^{aA}	12.55±4.56^{aB}	12.58±5.16^{aB}
AE	16.83±2.88^{abA}	10.10±2.96^{bB}	9.59±1.25^{bB}
b*			
Control	14.58±2.88^{bA}	13.68±0.57^{aA}	12.55±0.82^{aA}
BHT	18.21±4.65^{aA}	14.42±0.21^{aB}	13.49±1.35^{aB}
AE	15.88±3.30^{abA}	13.60±0.47^{aA}	12.48±0.65^{aB}

$^{a-b}$ Means within a column with different letters are significantly different ($P < 0.05$).
$^{A-B}$ Means within a column with different letters are significantly different ($P < 0.05$).

III.CONCLUSION

Consumer's interest in meat products formulated with natural ingredients has motivated the researchers to evaluate the effectiveness of naturally occurring compounds in by-products of plant materials. Vegetable by-products have substantial amount of phenolic compounds and artichoke by-product extracts have great amount of polyphenols. Addition of AE would be sufficient to protect beef patties against oxidative rancidity for periods longer than BHT and it was also found effective on the oxidative stability of proteins. The meat industry could use fruit and vegetable by-products as a potential source of phenolics as they have immense nutraceutical value and can be used to produce functional meat products of commercial interest.

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