EFFECT OF DIFFERENT COOKING METHODS ON THE ANTIOXIDANT POTENTIAL OF ARTICHOKE (*CYNARA SCOLYMUS L.*) BY-PRODUCT EXTRACTS IN BEEF PATTIES

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Abstract- **The present study was carried out to evaluate the antioxidant potential of artichoke by-product extracts (AE) in beef patties cooked by oven or electric grill. Total phenolic content, peroxide and TBAR values were evaluated during 0, 30 and 60 days of storage at -18◦C. Oven cooked samples showed lower phenolic content than grilled samples. Treatments containing artichoke extract exhibited the lowest peroxide and TBAR values for both cooking methods. Results showed that artichoke extracts are rich sources of phenolic compounds and these compounds showed high efficiency as antioxidant against lipid oxidation during the frozen storage of patties.**

Keywords- **Antioxidant, artichoke, beef**

I.INTRODUCTION

Cooking of meat causes several positive effects on meat such as taste and flavour enhancement, microorganism destruction, shelf life increase but also produces some negative effects [1]. In this respect, lipid oxidation in cooked meats occurring during storage is the main reason for the deterioration of the product giving undesirable odours, rancidity, texture modification, nutritional losses or toxic compound production. Phospholipids are the primary contributors to lipid oxidation and WOF (warmed-over-flavour) development in cooked meats [2]. Development of oxidation reactions in meat depends on the cooking method, temperature, time of cooking and storage. High temperatures and long times produce oxidative changes in food which could be really negative for quality[3]. To avoid or delay the autoxidation process in the meat, synthetic and natural antioxidants have been successfully utilised.

Generally, food industry uses synthetic additives with antioxidant properties. However, due to reports of possible toxic effects of synthetic antioxidants and increasingly demand of consumer 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 [4]. 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 [5]. 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 [6-9]. 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 objective of the present work was to evaluate the effect of cooking method and artichoke by-product extracts (AE) on oxidative changes of meatballs stored at -18C.

II.MATERIALS AND METHODS

A. Materials

Fresh boneless beef was purchased from a local meat processing plant. Artichoke by-products were obtained from a local canning plant in İzmir. 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 analytical 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 [10]. For response, TBARS value and antiradical activity were analyzed in raw patties under at 2^{o}C for 24 hours storage conditions.

C. Preparation and storage of beef patties

Beef at 24 h 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 was added to each formulation. Batches of 5 kg of each formulation were mixed by hand and processed into meat patties (1.5 cm thick and 100 mm diameter) by using a petri dish. Two different cooking methods for each treatment were carried on; Electric oven at 180°C for 30 min (OC: oven control, OB:BHT control, OE; oven extract) or electric grill at 190°C for 5 min each side (GC: grill control, GB: grill BHT, GE: grill extract) then patties were stored in polythene bags at -18°C for 60 days.

D. *Analysis*

The artichoke extract and patties were analyzed for total phenolics using the Folin–Ciocalteus (F–C) assay [11]. The amount of total phenolics was calculated as gallic acid equivalents (GAE) from the calibration curve using standard gallic acid solution. Determination of lipid hydroperoxides by peroxide values as described by Shanta and Decker [12]. Results were expressed as milli-equivalents (meq) of hydroperoxides/kg of lipids. The thiobarbituric acid reactive substances (TBARS) value (mg malonaldehyde/kg) was determined using the extraction method described by Witte, Krauze, and Bailey [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 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 cooked patties is given in Table 1. The highest total phenolic content was found in GE compared to other groups. Oven cooked samples showed lower phenolic content than grilled samples. An explanation for this could be the fact that during grilling process the internal temperatures and cooking times of patties were lower than oven cooking. Phenolic content of all samples decreased by the storage period however GE treatment had the highest phenolic content on day 60. Between all treatments GE showed the highest phenolic content. Our results were similar to Neevana et al, [15].

Table 1 Total phenolic content(mg/100g) of patty samples during storage at -18°C

Treatment	Storage Period (Day)		
	0	30	60
OC	$65,76\pm0,52^{dA}$	$62,64\pm0,49^{eB}$	$60,48\pm0,18^{dC}$
OB	$74,94\pm0,56^{cA}$	$70,79\pm0,54^{dB}$	$64,67\pm0,67^{cC}$
OE	$82,27\pm0,95^{bA}$	$76,90\pm0,66^{cB}$	$65,86\pm0,73^{cC}$
GC	$74,21\pm0,85^{cA}$	$70,95\pm0,32^{dB}$	$66,52\pm1,08^{cC}$
GB	$82,35\pm2,02^{bA}$	$78,93\pm2,84^{bAB}$	$75,21\pm3,58^{bB}$
GE	$94,61\pm1,81^{aA}$	$90,69\pm1,15^{aB}$	$82,71\pm2,11^{aC}$

[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 peroxide value has been widely used to measure primary oxidation products. Peroxide values differed significantly ($P < 0.05$) between all treatments during the whole storage period. Treatments containing artichoke extracts exhibited the lowest peroxide values for both cooking methods. In a study

the use of combination of rosemary and chitosan were found effective against oxidation in beef burgers for 180 days[16].

Table 2 Peroxide values (meq of hydroperoxides/kg of lipids) of patty samples during storage at -18°C

Treatment	Storage Period (Day)		
	0	30	60
OC	$6,98\pm0,50^{aC}$	$10,68\pm0,34^{aB}$	$11,70\pm0,46^{aA}$
OB	$6,78\pm0,70^{aC}$	$9,88\pm0,46^{bB}$	$11,98,26\pm^{aA}$
OE	$5,87\pm0,23^{bB}$	$8,18\pm0,71^{cA}$	$8,96\pm0,78^{cA}$
GC	$5,33\pm0,16^{bcC}$	$8,15\pm0,53^{cB}$	$10,57\pm0,29^{bA}$
GB	$4,48\pm0,21^{cC}$	$6,67\pm0,52^{dB}$	$9,01\pm0,20^{cA}$
GE	$3,67\pm0,50^{dB}$	$3,96\pm0,47^{eB}$	$7,88\pm0,75^{dA}$

[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 ($P < 0.05$).

The TBARS value has been widely used to measure lipid oxidation in meat and meat products. There were significant differences between the TBARS value of patty samples ($p<0.05$) (Table 3). Treatment with artichoke extract resulted in lower TBARS values at each evaluation period. Similar to our results Mansour and Khalil [17] 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 in this stıdy. 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 [18].

Table 3 TBARS values (mg malonaldehyde/kg meat) of patty samples during storage at -18°C

Treatment	Storage Period (Day)		
	0	30	60
OC	$0,62\pm0,12^{aB}$	$0,83\pm0,02^{aA}$	$0,87\pm0,05^{aA}$
OB	$0,45\pm0,07^{bB}$	$0,58\pm0,06^{cA}$	$0,69\pm0,07^{bA}$
OE	$0,40\pm0,01^{bA}$	$0,45\pm0,03^{dAB}$	$0,51\pm0,09^{cA}$
GC	$0,64\pm0,04^{aC}$	$0,74\pm0,05^{bB}$	$0,84\pm0,04^{aA}$
GB	$0,50\pm0,07^{bB}$	$0,57\pm0,05^{cB}$	$0,71\pm0,07^{bA}$
GE	$0,39\pm0,01^{bC}$	$0,44\pm0,02^{dB}$	$0,50\pm0,03^{cA}$

[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 artichoke extract would be sufficient to protect beef patties against oxidative rancidity for periods longer than BHT. 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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