EFFECTS OF ARTICHOKE EXTRACT ON OXIDATIVE CHANGES IN BEEF PATTIES DURING STORAGE AT 2°C

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Abstract-. The present study was carried out to evaluate the antioxidant potential of artichoke extract (AE) in raw beef patties during refrigerated storage. Freshly minced beef was assigned to one of the following three treatments: 1) Control (no antioxidant) 2) 27.3 mg AE phenolics per 100 g meat (optimized by using response surface methodology), 3) 10 mg BHT per 100 g meat. The patties formed from the minced meats were stored in polythene bags at 2°C for 7 days. Peroxide value and TBARS and total carbonyl content were evaluated during 1, 4 and 7 days of storage at2°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 patties. The AE treatment substantially inhibited (P < 0.05) lipid and protein 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. It was concluded that extracts of artichoke by-products have potential to be used as natural antioxidant when compared to BHT in meat products.

Key Words –Artichoke, oxidation, beef patty, antioxidants

I. INTRODUCTION

Besides the nutritional properties for a healthy and balanced diet, red meat also more suspicious to quality deterioration due to high concentrations of unsaturated lipids, heme pigments, metal catalysts and a range of oxidizing agents [1]. Especially, oxidative changes is the major deterioration type in meat and meat products. Oxidation leads to loss off color, flavor, texture, nutritional quality and also shelf life of any type of meat [2]. Particle size reduction as in ground meat shows greater lipid oxidation than whole muscle since the grinding process incorporates oxygen, mixes reactive components, and increases surface area of meat [3]. Antioxidants are the substances that effective at low concentrations delay or retard the oxidation of lipids and proteins in meat products [4]. Due to possible toxicological effects the demand for natural antioxidants, especially of plant origin because of their high content of phenolic compounds has increased in the recent years [5]. Artichoke (*Cynara scolymus L.*) is an ancient herbaceous perennial plant, originating from the Mediterranean area, which today is widely cultivated all over the world [6]. Artichoke is a natural source of phenolic acids, with cynarin (1,5-dicaffeoylquinic acid) and chlorogenic acid (5-caffeoylquinic acid) being the most abundant[7,8].The objectives of the present work was to evaluate the antioxidant potential of optimized artichoke byproducts extract (AE), by using response surface methodology (RSM) on refrigerated stored raw beef patties and compare their effects with that displayed by a synthetic antioxidant (BHT).

II. MATERIALS AND METHODS

Artichoke bracts were dried in a laboratory-type tray drier (Armfield UOP8, UK) at 40 °C until they reached 12% moisture content and then ground in an hammer mill (Brook Crompton Control, UK) to a particle diameter of 0.65 mm.

Extract was obtained by using ethanol 80% (v/v). 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. For response, thiobarbituric acid reactive substances (TBARS) value and DPPH (1,1-diphenyl -2-picrylhydrazyl) radical scavenging activity were analyzed in raw patties under at 2°C for 24 hours storage conditions. One factor design including 7 experiments formed by a central points design was used. Experimental data were fitted to a second order polynomial model and regression coefficients obtained. The desirability function method was used to optimize multiple responses, simultaneously. In the present study, desirability function were developed for the criteria that minimum TBARS and maximum DPPH.

Freshly minced beef was as-signed to one of the following three treatments: control (no antioxidant), 27.3 mg (optimized with response surface methodology) AE per 100 g meat, 10 mg BHT per 100 g meat. 1.5% NaCl was added to each formulation. The patties formed with a circle stainless steel shaper (5 cm diameter and 1 cm thickness) and were stored in polythene bags at 2°C for 7 days under atmospheric conditions. At sampling (days 1, 4 and 7), peroxide value [9], TBARS [10] and carbonyl content [11] were measured in beef patties. Analyses of variance (ANOVA) and Duncan tests by SPSS for Windows (v. 15.0) were carried out to study the effect of the addition of artichoke extracts on the measured parameters. Differences were considered significant at $p < 0.05$. The average values were reported along with standard deviation (± SD).

III. RESULTS AND DISCUSSION

The primary products of lipid oxidation are hydroperoxides, therefore it seemed reasonable to determine the concentration of peroxide in the meat samples to study the extent of oxidation [12]. PV of patty samples are presented in Table 1. PVs of all samples were below 25 meq of active O2/kg meat, which is considered the maximum limit of acceptability in fatty foods [13]. In comparison to day 1, the PV value of all patty samples increased ($P < 0.05$) during 7 days of storage. BHT and AE added samples had significantly ($P < 0.05$) lower PV as compared with the control on all storage periods. Even, at day 7 AE samples had the lowest PV values. When compared to BHT, AE samples found more effective to prevent the formation of hydroperoxides. It is believed that AE in raw patties markedly inhibited lipid peroxidation as measured by decreasing PV, probably because their polyphenolic constituents function as antioxidants by terminating free radical chain-type reactions.

Table 1 PV values of patty samples during storage (meq O_2/kg)

	Storage Period Days		
Sample	1	4	7
Control	8.39 ± 0.24^{aC}	10.78 ± 0.59^{aB}	13.95 ± 0.26^{aA}
BHT	5.38 ± 0.11^{bC}	7.30 ± 0.52^{bB}	11.28 ± 0.61^{bA}
AE	3.60 ± 0.17^{cC}	6.13 ± 0.20^{cB}	9.16 ± 0.40^{cA}

a-c Means within a column with different letters are significantly different ($P < 0.05$).A-C Means within a row with different letters are significantly different

TBARS analysis measures the formation of secondary products of lipid oxidation, mainly malondialdehyde, which may contribute off-flavor to oxidized meat and meat products [14]. Effect of AE and BHT treatment on TBARS values in beef patties are shown in Table2. All the treatments significantly ($P < 0.05$) reduced the TBARS values throughout storage compared to control. The lipid oxidation inhibition effect was highest ($P < 0.05$) in AE compared to BHT at all storage times and thus, it is clear that AE could be good alternative to BHT. It was observed that the TBARS values of AE-treated patties were below the acceptable sensory threshold limit for exhibiting rancid flavor (1 mgMA/kg) at the end of storage periods (0.72 mgMA/kg).

Table 2 Thiobarbituric acid reactive substances (TBARS) value (Mg MA/kg) of patty samples during storage at 2°C for 7 days

	Storage Period (Days)		
Sample	1	4	7
Control	0.63 ± 0.02^{aC}	1.07 ± 0.03^{aB}	1.28 ± 0.03^{aA}
BHT	0.52 ± 0.03^{bC}	0.87 ± 0.01^{bB}	0.90 ± 0.03^{bA}
AE	0.47 ± 0.01^{cC}	0.59 ± 0.02^{cB}	0.72 ± 0.05^{cA}

a-c Means within a column with different letters are significantly different (P < 0.05).A-C Means within a row with different letters are significantly different

Recently, extracts from some plants have been added to muscle foods as inhibitors of lipid oxidation. Black currant extract inhibited TBARS values in pork patties during 9 days of storage at 4°C [15]. Jabuticaba peel extract decreased the TBARS value of Bologna-type sausages compared the control [16]. Lychee seed water extract in raw meat paste during a storage period of 0-15 days at 4°C were found to reduce TBARS [17]. In many studies at similar conditions which is applied in this work (chilled storage of raw patties) were obtained similar results [18,19,20].

Table3 Total carbonyl content (nmolcarbonyl/mg protein) of patty samples during storage at 2°C for 7 days

	Storage Period (Days)		
Sample	1	4	7
Control	1.30 ± 0.03^{aC}	2.41 ± 0.02^{aB}	4.40 ± 0.05^{bA}
BHT	1.27 ± 0.02^{aC}	2.10 ± 0.03^{bB}	4.55 ± 0.05^{aA}
AE	1.05 ± 0.02^{bC}	1.74 ± 0.04^{cB}	2.80 ± 0.06^{cA}

a-c Means within a column with different letters are significantly different (P < 0.05).A-C Means within a row with different letters are significantly different

Total protein carbonyl content was used as a measure of protein oxidation and the increase of protein carbonyls showed that muscle proteins are susceptible to oxidative reactions leading to carbonyl gain [21]. Total carbonyl content of patty samples are seen in Table 3. Protein carbonyls are oxidation products of certain amino acids such as proline, arginine and lysine and their detection using the DNPH method has been employed as an assessment of protein oxidation in muscle foods. Oxidizing lipids, heme and non-heme iron play major roles onset of protein oxidation. Lipid oxidation would take place faster than in muscle foods thus, secondary lipid oxidation products promote protein oxidation[22]. The addition of AE significantly inhibited the formation of protein carbonyls in beef patties. On day 1 and 7, control and BHT treated patties had similar carbonyl content but not lower than AE samples. Overall the storage period efficiency of AE against protein oxidation was higher than BHT.

IV. CONCLUSION

In recent years, both the consumers and meat industry with a great interest on natural antioxidants mainly because of adverse toxicological reports on many synthetic compounds. Due to their high phenolic compound content, plant materials provide good alternatives to conventional antioxidants. On this occasion artichoke byproducts addition to meat matrices which has rich in polyphenols has not been studied previously yet. The present results highlight the potential usage of extracts from artichoke byproducts as efficient inhibitors of oxidative reactions.

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