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Antioxidant effect of rosehip seed powder in raw and cooked meatballs during refrigerated storage

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Abstract: The aim of this study was to learn the usage ability of rosehip seed powder (RSP) as an antioxidant agent to prevent lipid oxidation in raw and cooked meatballs during refrigerated storage. For this purpose, 4 different formulations (without RSP and with 1%, 2%, and 4% RSP) were prepared. Thiobarbituric acid reactive substances (TBARS) values of the raw and cooked meatballs were determined at 0, 3, 6, 9, and 12 days of storage. Both the raw and the cooked meatballs containing 2% RSP had lower TBARS values at the end of storage compared to the control meatballs. Moreover, the difference in sensorial properties between the cooked control sample and cooked RSP-added test samples was not significant. These results indicated that RSP may be utilized as a natural antioxidant in cooked meatballs.

Key words: Antioxidant, lipid oxidation, meatball, rosehip seed powder

1. Introduction

Lipid oxidation is the main reason for deterioration of meat products (1). A series of chemical reactions altering the physicochemical and sensorial parameters (color, flavor, and odor) and shelf-life of meat products occur during the lipid oxidation process (2). Lipid oxidation leads to the degradation of fat-soluble vitamins and essential fatty acids, which results in a reduction in the nutritional value of meat products (1). The use of antioxidants retards oxidation, which prevents the deterioration of meat quality. Synthetic antioxidants have been used to prevent lipid oxidation in foodstuffs. Butylated hydroxytoluene and butylated hydroxyanisole are the most commonly used synthetic antioxidants for the prevention of the oxidation process (3). Synthetic antioxidants may show toxic effects on human health. The adverse effects of synthetic antioxidants have prompted searches for antioxidants from natural sources. Pomegranate seed power (1), red grape pomace (2), grape seed (4), and rosemary and oregano extracts (5) have been evaluated for their use in meat products as antioxidants.

The use of byproducts has gained much interest since they may offer an economic and practical source of natural antioxidants. Rosehip seed, the byproduct of the rosehip industry, includes phenolic compounds, tocopherols, carotenoids, and ascorbic acid. The antioxidant activity of rosehip seed has been determined (6). Therefore, the aim of this study was to learn about the usage ability of rosehip seed powder (RSP) as an antioxidant in raw and cooked meatballs during refrigerated storage.

2. Materials and methods

2.1. Materials

Fresh beef was obtained from a local butcher and stored at 4 °C until use. Rosehip was purchased from a local market. Rosehip seed was separated by hand and ground using a grinder (IKA M20, Staufen, Germany). Solvents were of analytical grade and obtained from Merck (Darmstadt, Germany). Thiobarbituric acid (TBA), 1,1,1,3-tetraethoxypropane (TEP), 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,4,6-Tris-(2-pyridyl)-s-triazine (TPTZ), and gallic acid were purchased from Sigma-Aldrich (St Louis, MO, USA).

2.2. Preparation of meatballs

Four kilograms of meat was minced using a meat mincer. Four different meatball formulations were prepared (Table 1). Each formulation was divided into 2 batches. One batch was cooked in an oven at 230 °C for 30 min. Raw and cooked meatballs were stored at 4 °C for 12 days.

2.3. Sensorial properties

The sensorial properties of the cooked meatballs were evaluated by 12 semitrained panelists. The appearance, color, odor, chewiness, juiciness, taste, and overall acceptability of the meatballs were rated. The panelists

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Table 1. Formulations of the meatballs (g).

Ingredient	C	S1	S2	S4
Meat	824	824	824	824
Bread	80	80	80	80
Onion	30	30	30	30
Garlic	5	5	5	5
Spice	41	41	41	41
Salt	20	20	20	20
Rosehip seed	-	10	20	40

C: control, S1: with 1% rosehip seed, S2: with 2% rosehip seed, S4: with 4% rosehip seed.

rated the samples using a 7-point scale. The sensory scores ranged from 0 (extremely bad) to 6 (extremely good). Water was given to panelists for rinsing the mouth between samples.

2.4. TBARS analysis

Thiobarbituric acid reactive substances (TBARS) analysis was carried out according to a previously described method (7) with some modifications: 30 mL of trichloroacetic acid (7.5 g/100 mL) was added to 5 g of sample, and this mixture was homogenized for 2 min with a blender (Waring Laboratory Blender, Conair Corporation, Stamford, CT, USA). The sample slurry was filtered through a filter paper. Two milliliters of TBA (0.02 M) was added to 2 mL of filtrate. The test tubes were heated at 95 °C for 35 min. After cooling the test tubes, the absorbance at 532 nm was measured. TEP was used as a standard. The TBARS values were expressed as mg malondialdehyde/kg meatballs. Each sample was analyzed in triplicate.

2.5. Total phenolic compounds

Total phenolic compounds content of the rosehip seed was detected using the Folin–Ciocalteu method (8). One gram of seed was extracted with 25 mL of methanol (80%) for 2 h. The slurry was filtered through filter paper and 100 µL of methanolic extract was mixed with 0.5 mL of Folin–Ciocalteu reagent, 0.4 mL of sodium carbonate (1 M), and 4 mL of water. The test tubes were stored in a dark room for 1 h. The absorbance at 760 nm was then measured with a microplate spectrophotometer (Epoch, BioTEK, Winooski, VT, USA). Total phenolic content was expressed as µg gallic acid/g meatballs.

2.6. DPPH radical scavenging activity

DPPH assay was carried out according to a previously described method (9) with some modifications: 100 µL of the extract was mixed with 900 µL of DPPH radical solution (6.0×10^{-5} M). The absorbance was measured at 515 nm after 60 min at room temperature. The results were expressed as µg Trolox/g sample.

2.7. FRAP assay

Ferric reducing antioxidant power (FRAP) assay was carried out according to a previously described method (10) with some modifications. Fresh FRAP reagent was prepared by mixing acetate buffer solution (pH = 3.6), TPTZ solution in 40 mM HCI (10 mM), and $FeCI_3$ (20 mM) solution at a ratio of 10:1:1. Next, 50 µL of the extract was mixed with 900 µL of FRAP reagent and the absorbance was measured at 595 nm after 30 min. The results were expressed as µg Trolox/g sample.

2.8. Statistical analysis

Analysis of variance and least significant difference tests (95% level of confidence level) were carried out to evaluate the significant differences among the samples.

3. Results and discussion

The total phenolic content of the RSP was 1767 ± 102 µg/g. The DPPH radical scavenging activity and FRAP values of the RSP were 8.95 ± 0.80 µmol/g and 6.57 ± 0.26 µmol/g, respectively. The TBARS values of the raw and cooked meatballs during refrigerated storage are presented in Figures 1 and 2, respectively. The addition of the RSP into the raw and cooked meatballs showed no significant effect on TBARS values on day 3 ($P > 0.05$), whereas the RSP (2%) had a negative effect on the TBARS values of the raw and cooked meatballs on day 12 of storage ($P < 0.05$). The sensorial properties of the cooked meatballs are presented in Table 2. The sensorial properties showed no significant differences among the samples ($P > 0.05$).

Our results indicated that the RSP had a higher total phenolics content, exhibiting antioxidant activity as measured by the DPPH and FRAP assays. The use of RSP in the raw and cooked meatballs showed antioxidant

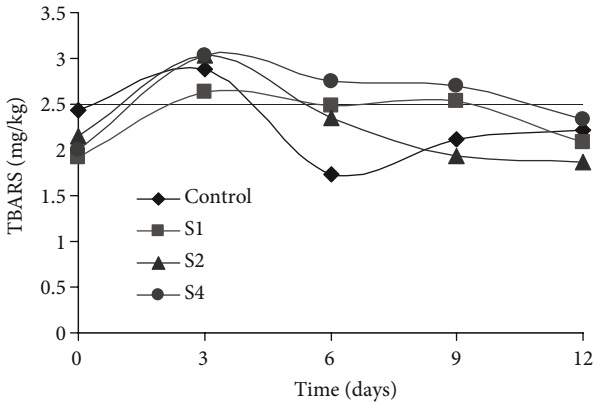

Figure 1. TBARS values of the raw meatballs. Significant differences were found between the samples at 6, 9, and 12 days of storage ($P < 0.05$).

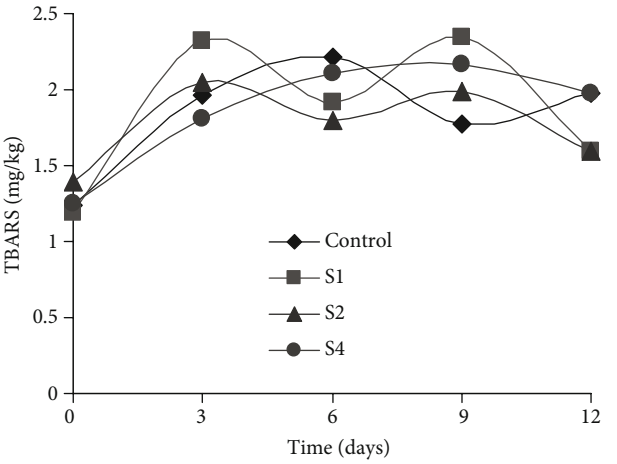

Figure 2. TBARS values of the cooked meatballs. Significant differences were found between the samples at 6, 9, and 12 days of storage ($P < 0.05$).

Table 2. Sensorial properties of the cooked meatballs (mean values).

Sample	Appearance	Color	Odor	Chewiness	Juiciness	Taste	Overall acceptability
C	3.5	3.3	3.8	4.5	3.2	3.8	3.7
S1	4.2	3.8	4.3	4.6	3.9	4.2	4.1
S2	3.3	3.5	3.5	4.7	3.3	3.5	3.4
S4	3.4	3.2	3.9	3.9	3.6	3.5	3.9

C: control, S1: with 1% rosehip seed, S2: with 2% rosehip seed, S4: with 4% rosehip seed.
No significant difference was found among the groups ($P > 0.05$).

effects on lipid oxidation as measured by the TBARS test after 12 days of storage at 4 °C. In the literature, many studies have focused on the use of fruit extracts to prevent lipid oxidation in meat products. The extracts of pomegranate rind power, pomegranate seed power, and kinnow rind power were found to show reducing effects on the TBARS values of cooked goat meat patties (1). Grape seed extract was reported to decrease the TBARS values of raw and cooked pork patties (4). Dejong and Lanari reported a reducing effect of olive polyphenols on the TBARS values of cooked beef and pork (11). Bastida et al. found that carob fruit extract could reduce the TBARS values of cooked pork (12). Rosemary, orange, and lemon extracts were found to have negative effects on the TBARS values of cooked meatballs (13).

In our study, the TBARS values of the samples increased significantly ($P < 0.05$) from day 0 to day 3 of storage. A significant decrease in TBARS values was observed from day 3 to day 6 for the raw control and S2 samples and the cooked S1 sample ($P < 0.05$). However, the TBARS values of the raw S1 and S4 samples and the cooked control, S2, and S4 samples remained constant ($P > 0.05$) from day 3 to day 6. The TBARS values of the raw control, S1, and S4 samples and of the cooked S2 and S4 samples remained constant ($P > 0.05$) from day 6 to 9, as well. The TBARS values of the raw S2 sample and the cooked control sample decreased, whereas that of the cooked S1 sample increased ($P < 0.05$) from day 6 to day 9. The TBARS values of the raw S1 sample and the cooked S1 and S2 samples decreased from day 9 to day 12 ($P < 0.05$). However, those of the raw control, S2, and S4 samples and of the cooked control and S4 samples remained constant ($P > 0.05$) from day 9 to day 12. At the end of storage, the raw meatballs containing 2% RSP and the cooked meatballs containing 1% and 2% RSP exhibited a lower TBARS value compared to the control samples ($P < 0.05$). These findings were partially comparable with the literature. The TBARS values of meat patties were reported to increase gradually (1). Increasing the level of grape seed extract in raw and cooked pork from 50 to 1000 µg/g did not increase antioxidant activity. It was

only 4 times more effective in reducing lipid oxidation (4). In the present study, the TBARS values of the samples first appeared to increase and then generally remained constant. Higher RSP (4%) did not show more antioxidant activity compared to lower levels of RSP. Fluctuation in the TBARS values was observed for some samples, and this could be related to the presence of compounds possessing prooxidant activity. RSP includes ascorbic acid, β-carotene, and phenolic compounds as antioxidant compounds (6). β-Carotene is known to show prooxidant activity at certain concentrations (4).

The addition of the RSP into the cooked meatballs did not have any negative effect on the sensorial properties, indicating that all formulations were equally acceptable. RSP may be used for the prevention of lipid oxidation in meat products. Further studies should deal with the effect of RSP on other quality characteristics and how RSP can be used in meat products.

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