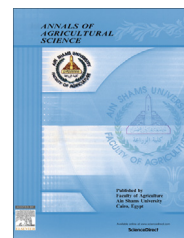




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Quality characteristics of beef sausage containing pomegranate peels during refrigerated storage



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Abstract This study was performed to evaluate the effect of pomegranate peels powder at concentrations of 1%, 2% and 3% on keeping quality characteristics of prepared beef sausage during a storage period at (4 ± 2 °C) for 12 days. Chemical compositions, physical, physicochemical and chemical characteristics, microbiological criteria, cooking quality and sensory characteristics of different prepared beef sausage samples were determined. The addition of different concentrations of pomegranate peels powder caused high storage stability and reduced values of TBA and TVN of prepared beef sausage samples during refrigerated storage compared to control beef sausage samples. The microbiological criteria of prepared beef sausage samples with pomegranate peels powder were also improved. This could be due to the presence of phenolic compounds in pomegranate peels which could act as antioxidant and antimicrobial substances. Prepared beef sausage samples containing pomegranate peels powder recorded high cooking quality and sensory characteristics in comparison with control beef sausage samples.

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Introduction

Meat and meat products are important sources for protein, fat, essential amino acids, minerals, vitamins and other nutrients (Biesalski, 2005). In recent years, much attention has been paid to develop meat and meat products with physiological functions to promote health conditions and prevent the risk of diseases. Oxidation of lipid and auto-oxidation are one of the major

causes of quality deterioration and reduction of shelf life of meat products. This may produce changes in meat quality parameters such as color, flavor, odor, texture and even nutritional value (Fernandez et al., 1997). Meat mincing, cooking and other processing steps prior to refrigerated storage disrupt muscle cell membranes facilitating the interaction of unsaturated lipids with pro-oxidant substances such as non-haem iron, accelerating lipid oxidation leading to rapid quality deterioration and development of rancidity (Tichivangana and Morrissey, 1985). The rate and extent of oxidative deterioration can be reduced through various means such as curing, vacuum packaging, modified atmosphere packaging and most importantly addition of synthetic or natural antioxidants. Although synthetic antioxidants such as butylated hydroxytoluene (BHT) and butylated

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hydroxy anisole (BHA) have been used extensively, recent studies have implicated them to have toxic effects (Lindenschmidt et al., 1986; Shahidi et al., 1992). In response to recent claims that synthetic antioxidants have the potential to cause toxicological effects and consumers' increased interest in purchasing natural products, the meat and poultry industry has been seeking sources of natural antioxidants. Due to their high phenolic compound content, fruits, vegetables and other plant materials provide a good alternative to conventional natural antioxidants, and can serve as a source of natural antioxidants for meat products (Phillips et al., 1993; Slattery et al., 2000; Karre et al., 2013). These antioxidants include fat-soluble vitamins and precursors, such as tocopherols and carotenoids, as well as the water-soluble vitamin ascorbic acid, and flavonoids. Application of plant extracts in meat products as natural antioxidants has been attempted by different researchers. By-products of food processing contain valuable substances such as fibers, pigments, sugars, organic acids, flavors, antibacterial and antioxidants substances (Balasundram et al., 2005). Pomegranate fruit parts contain a high concentration of antioxidants (Sánchez-Zapata et al., 2011). The peel and rind are good sources of tannins, anthocyanins, and flavonoids (Naveena et al., 2008). Devatkal et al., (2010) used kinnow rind powder (KRP), pomegranate rind powder (PRP), and pomegranate seed powder (PSP) in raw goat meat, and prepared cooked goat (80 °C) patties. Goat meat patties were stored for 12 d at (4 ± 1 °C). Incorporation of PRP was effective in reducing TBARS formation up to 67% and *L*-values as color parameter were decreased significantly, but no differences were observed among PSP and control for *L* values. Conversely, redness was reduced when using PRP and PSP compared with the control and KRP-treated goat patties. Sensory evaluation of color, appearance, flavor, and overall acceptability indicated no differences ($p > 0.05$) among the different goat patties. The antioxidant and antimicrobial potential of pomegranate peel and seed extract in chicken products was investigated by Kanatt et al. (2010). The efficacy of pomegranate juice, pomegranate rind powder extract and butylated hydroxyl toluene as antioxidants in cooked chicken patties during refrigerated storage was observed by Naveena et al. (2008). According to Karre et al. (2013) pomegranate components could be used as antioxidants in refrigerated chicken and goat patties. Pomegranate is effective in inhibiting lipid oxidation and does not significantly affect the overall sensory attributes of the finished product. More investigation needs to be conducted for other varieties of meat products with a focus on different storage conditions. The antimicrobial activity of fruit peels is well documented. For example, pomegranate fruit peels have been widely used in herbal remedies for treating several diseases (Al-Zoreky, 2009). Pomegranate fruit peels extracts have been shown to inhibit the growth of several foodborne pathogens including *Listeria monocytogenes*, *Staphylococcus aureus*, *Escherichia coli*, *Yersinia enterocolitica*, and *Bacillus cereus* (Agourram et al., 2013; Al-Zoreky, 2009; Kanatt et al., 2010). Pomegranate peel extract was more effective against Gram-positive bacteria even at a concentration of 0.01%. However, in the case of Gram-negative bacteria, extract was effective against *Pseudomonas* spp. at a higher concentration of 0.1% and less effective against *E. coli* and *Salmonella typhimurium* at the same concentration (Kanatt et al., 2010).

The current investigation was performed to evaluate the effects of adding various levels of pomegranate peels powder

on keeping different quality characteristics of prepared beef sausage.

Materials and methods

Preparation of pomegranate peels

Pomegranate fruits used in preparing pomegranate peel powder were purchased from local markets of Cairo, Egypt. Pomegranate fruits were washed, then peeled and their edible portions were carefully separated. The peels were air-dried in a ventilated oven at 40 °C for 48 h and grounded to a fine powder then packaged in polyethylene bags until used.

Preparation of beef sausage

Beef meat samples including boneless neck, chuck and rounds along with associated fats were obtained from local markets of Cairo, Egypt, and used for preparing beef sausage samples. All subcut fat and inter-muscular fat were also included as fat sources. The beef meat and fat tissue were transported to the laboratory using an ice box. Different ingredients used in preparing beef sausage samples e.g. table salt, starch and spices mixture such as black pepper, red pepper, nutmeg and ginger were obtained from local market of Cairo, Egypt.

Beef sausage samples were prepared according to the method described by Zaika et al. (1978), using the ingredients listed in Table 1. Meat and fat tissues were cut into pieces of about egg-size and frozen at -18 °C for 24 h. The frozen meat and fat were ground to particles of about a rice size, then the ingredients were blended to prepare sausage mixture emulsion, which was then stuffed by hand into mutton casings, and then the casings were closed and chipped (Shehata, 1989). The natural mutton casings were obtained from the slaughterhouse of Cairo and prepared according to El-Deep (1987). For evaluation the effect of pomegranate peel powder as natural preservatives prepared dried pomegranate peel powder was used in concentration of 1%, 2% and 3% of total beef sausage recipe. To evaluate their antioxidant and antimicrobial effects of different prepared sausage samples, T1 (zero % pomegranate peel powder), T2, T3 and T4 (1%, 2% and 3% pomegranate peel powder, respectively) were packaged in polyethylene packages and stored at 4 °C ± 2 for 12 days. Samples were taken at 3, 6, 9 and 12 days interval and subjected to different analysis mentioned below.

Table 1 Ingredients used in manufacturing beef sausage.

Ingredients	Amount (g)	Spices mixture	Amount (g)
Lean meat	70.0	Black pepper	30.0
Fat tissues	12.0	Red pepper	8.0
Sodium chloride	2.3	Cumin	15.0
Water (as ice)	9.3	Nutmeg	8.0
Starch	3.0	All spices	15.0
Garlic	1.0	Cloves	8.0
Onion	1.2	Ginger	8.0
Spices mixture	1.2	Coriander	8.0

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