LWT - Food Science and Technology 62 (2015) 62–68

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

The impact of addition of shiitake on quality characteristics of frankfurter during refrigerated storage

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ARTICLE INFO

Article history:
Received 8 October 2014
Received in revised form
13 January 2015
Accepted 16 January 2015
Available online 24 January 2015

Keywords:
Shiitake
Frankfurter
Antioxidant
Nitrite
Aerobic bacteria

ABSTRACT

The effect of addition of shiitake levels (0, 0.4, 0.8 and 1.2%) on the quality traits such as physicochemical and microbial properties of frankfurter was studied during refrigerated storage, and its effect was also compared with those produced with 100 ppm $NaNO_2$. Our results showed that the shiitake incorporation did not cause color and texture defects of frankfurters during storage. The TBARS values of frankfurters produced with shiitake were much lower than those of the control and $NaNO_2$ frankfurters in all storage days. Additionally, the addition of shiitake retarded the growth of aerobic bacteria during storage. Furthermore, the shiitake incorporation significantly ($P < 0.05$) improved the sensory quality at day 1 storage; the higher flavor, taste and acceptability scores were given for the shiitake frankfurters than for the control and $NaNO_2$ frankfurters, probably due to its flavor enhancer and taste-active components. Finally, shiitake with its high bioactivity can be utilized to prevent lipid oxidation and microorganisms growth during storage and improve the sensory characteristics of frankfurters at day 1 storage. It is also suggested that the addition of shiitake powder to meat products is an alternative interesting way to instead of synthetic antioxidants or preservatives.

1. Introduction

Lipid oxidation has long been recognized as the major problems causing the negative impacts on quality and shelf-life of meat products for instance, it leads to the development of oxidative off-flavor, discoloration and deterioration of meat and meat products (Morrissey, Sheehy, Galvin, Kerry, & Buckley, 1998). Therefore, there is currently increasing interest in control of lipid oxidation in meat products by using the antioxidant agents from synthetic and natural sources (Deda, Bloukas, & Fista, 2007; Ozvural & Vural, 2011). However, the available synthetic antioxidants have been suspected to cause toxicity problems that negatively affect consumer's health, therefore, these compounds have been restricted use in foods (Botterweck, Verhagen, Goldbohm, Kleinjans, & Brandt, 2000). The other disadvantages of the use of synthetic antioxidants are that high-cost and may impart color and off-flavors to the products (Pokorny, 1991). Therefore, a new trend to substitute these synthetic antioxidants with antioxidants from natural sources have been received the most attention by consumers and meat processors (Ahn, Grun, & Mustapha, 2004; Deda et al., 2007; Yilmaz, Simsek, & Isikli, 2002).

In recent times, the consumed amount of mushrooms has considerably increased, involving a great variety of species, in which shiitake (*Lentinus edodes*) is the most popular and the second largest cultivated mushroom in the world (Chang, 1996). The shiitake has been widely used as part of human vegetable diet and for medical purposes for thousands of years in Asian countries (Chang, 1996; Zhang, Cui, Cheung, & Wang, 2007). Previous workers have reported that shiitake is a rich source of essential nutrients (Choi, Lee, Chun, Lee, & Lee, 2006; Mattila et al., 2001). Additionally, the mushroom has been found to contain high concentrations of bioactive compounds such as phenolics that are potential antioxidants (Choi et al., 2006; Zhang, Chen, Zhang, Ma, & Xu, 2013). In other reports, it was reported that mushrooms contain a high level of taste active compounds such as monosodium glutamate, 5′-guanosine monophosphate and free amino acids which contribute to the umami-like taste or palatable taste (Cho, Choi, & Kim, 2010; Tseng & Mau, 1999). From these advantages therefore, it makes the shiitake become a promising naturally functional ingredient which can be used in the meat processing industry.

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http://dx.doi.org/10.1016/j.lwt.2015.01.032
0023-6438/

Nowadays, people are tending to use ready-to-eat food products because of their conveniences. Of which, frankfurter type-sausage is one of the very popular processed meat products which is widely consumed worldwide due to its palatability and convenience as well. More to the point, refrigerated preservation is a widely used method in food industry aiming to retard lipid oxidation and biochemical changes therefore, allowing safe products storage for long periods. The positive effect of the refrigerated storage method could be further enhanced by combining with applying irradiation techniques or using preservatives such as sodium nitrate/nitrite (Cammack et al., 1999), however, nitrate/nitrite is restricted use in foods due to its toxic effects (Cassens, 1997; Chow & Hong, 2002). Therefore, it is needed to find out a more suitable way which can enhance the oxidative stability in meat products during storage without toxicity to consumers.

While, the shiitake has a pleasant flavor and may exert an antioxidant activity without adverse effects on their acceptability, which can be effectively incorporated into meat products, however, no attention has been paid to the use of edible mushroom as naturally functional ingredients in meat products. Therefore, the objective of this study was to investigate the impact of addition of shiitake powder on the technological quality, lipid oxidation and sensory characteristics of frankfurters during refrigerated storage.

2. Material and method

2.1. Materials

Shiitake (*L. edodes*) was purchased from a local supermarket in Suwon, South Korea. Fresh pork ham and back-fat were obtained from a local commercial processor (Suwon, Korea) 24 h after slaughter. The chemicals used for the shiitake extraction process (e.g., ethanol), scavenging assay (e.g., 2,2-diphenyl-1-picrylhydrazyl(DPPH) and Butylated hydroxytoluene(BHT)), and lipid oxidation calculation standard (e.g.,1,1,3,3 tetramethoxypropane) were purchased from Sigma Chemical, CO. (St. Louis, MO, USA). The rest of ingredients such as sodium phosphate and sodium nitrite (Shinyo Pure Chemicals, Co. Osaka, Japan), and sodium chloride (Hanju Co., Ulsan, Korea) were used for frankfurter production.

2.2. Preparation of shiitake powders and antioxidant activity assay

The shiitakes were washed with water to remove any impurities. Thereafter, the shiitakes were sliced into thin slices and then dried by freezing-dry at −50 °C. The dried shiitakes were then powdered using a blender and then used for antioxidant activity assay and frankfurter production.

The shiitake extracts were obtained using the method of Tsai, Tsai, and Mau (2007). Briefly, the powdered shiitake (5 g) was extracted by stirring with 50 mL ethanol at 25 °C on a shaker for 24 h and filtered through No. 1 Whatman filter paper. The residues were re-extracted with 50 mL of ethanol and the filtrates were combined, the combined extracts were evaporated almost to dryness, and then subjected to freeze-drying at −50 °C. The crude extracts were then re-dissolved in ethanol and used to assay their antioxidant activity.

The antioxidant activity of the shiitake extract was determined using scavenging 2,2-diphenyl-1-picrylhydrazyl (DPPH) radicals test following the method of Fu, Shieh, and Ho (2002) with some modifications. Briefly, 2.9 mL of DPPH solution (0.5 mM) was added to 0.1 mL of ethanol solution containing different concentrations of shiitakes extracts (1, 2, 3 and 5 mg/mL). The mixture was shaken and allowed to stand at room temperature in dark for 30 min. The absorbance of the solution at 517 nm was measured using a UV–visible spectrophotometer (ProteomeLab Du-800, Beckman Coulter, Inc., USA). Butylated hydroxytoluene (BHT) was used as positive control. All of the tests were carried out in triplicates. The inhibition of DPPH radical was calculated:

$$\text{The inhibition of DPPH radical } (\%) = \frac{(A_{blank} - A_{test})}{A_{blank}} \times 100$$

where, A_{blank} = Absorbance of the control solution; A_{test} = Absorbance of the test extract.

2.3. Frankfurter manufacture

To determine whether the shiitake exerts its antioxidant and antimicrobial activities in frankfurter, the common seasonings such as onion, garlic and pepper etc. were not added, and the smoking was also not applied because these spices and smoke may also possess some antioxidant and antimicrobial characteristics which may interfere and mask the real effect of the added shiitake content in the product. Five formulations of treatments of frankfurters; four with different shiitake powder levels (0, 0.4, 0.8 and 1.2%) and one with 100 ppm $NaNO_2$ were prepared. Each treatment had 3 batches and each batch was prepared with 10 kg of frankfurter batter. All frankfurters in all treatments were made with the same materials and ingredients including: pork meat (50%), pork back-fat (28%), ice water (20%), phosphate (0.5%) and sodium chloride (1.5%), except the test contents which differed among these treatments. Particularly, 4 shiitake levels, 0, 0.4, 0.8 and 1.2% were added to the meat batter of treatment 1(T1, control), treatment 2(T2), treatment 3(T3) and treatment 4(T4), respectively. For the treatment 5(T5), it was added with 100 ppm $NaNO_2$ (without shiitake). The meat was trimmed off of all connective tissue and visible fats and then was chopped through a 3 mm plate using a silent chopper (Model 7548, Biro MFG. Co, Ohio, USA). For each treatment, the chopped lean meat was placed in a bowl cutter (CR-40, Mainca, Spain), chopped for about 10 s at low speed, and then the mixture of salt, phosphate and shiitake powder were gradually added while chopping. The meat mixture was chopped for further 1 min at high speed and then about one-third of ice-water was added and the batter was continuously chopped for 2 min at high speed. After that, the pork back-fat was added and the rest of ice water was gradually added, the batter was then chopped at high speed for further 5 min. The temperature of batter was maintained below 10 °C during preparation. After chopping the meat batter was immediately stuffed into 28-mm diameter collagen casings (Naturin Viscofan Co, Tajonar-Navarra, Spain) using a vacuum stuffer (Model VF610, Handtmann Co, Biberach, Germany). Finally, the frankfurters were placed in a smokehouse and cooked for 10 min after the internal temperature reached 70 °C. After cooking, the cooked frankfurters were immediately soaked in cold water to cool and left to drain the water. Thereafter, the samples were placed in polyethylene/polyamide bags (3frankfurters/bag) (day 0). The bags containing samples were then simply sealed with a packaging system (Model VP-9900, Roll Pack Co.,Pyengtaek, Korea) and finally assigned into 3 different storage periods; 1, 15 and 30 days and kept at 4 °C.

2.4. Proximate composition

The collagen, moisture, protein and fat contents of frankfurter samples were analyzed using a Food Scan™ Lab 78810 (Foss Tecator Co., Ltd., DK), according to the method of the Association of Official Analytical Chemists (AOAC, 2006).