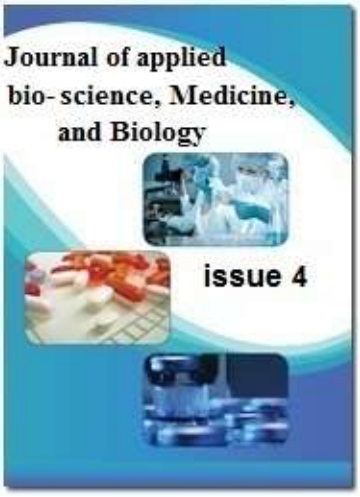
Original research

The design of a novel anti-bacterial meat packaging with polypropylene, silica nanoparticles and cinnamon essence



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ABSTRACT

Background: The objective of this study was to design an anti-bacterial meat packaging, including polypropylene, silica panoparticles and cinnamon essence.

Methods: The first, the value of 0.025 grams of powdered silica nanoparticles (purchased from US Research Nanomaterials) with 100 ml of concentrated cinnamon essence along with 400 microliters sterile distilled water into polyethylene container resistant to acid and heat was added and mixture vigorously. Dense suspension obtained was used for the tests. To prepare a package repository, a piece of sheet lamination layer (polymer polypropylene) in the dimensions of 5 × 5 centimeters was prepared and completely disinfected with alcohol 70 degrees. A layer of cellulose of 4 × 4 cm in size was placed in the middle of it. After these processes packaging structure was examined using scanning electron microscopy. The total color of the novel packaging was calculated by a digigital camera with 13 megapicxell. This measurement was carried out in 0 day, 14 days, and 21 days.

Results: SEM image confirmed cellulose reinforced with nano-silica and essence. The color value reduced after 14 days then increased on days 21th. There is a significant difference at day 14th compared to day zero and 21 ($p < 0.05$).

Conclusion: It can be concluded that the anti-bacterial meat packaging can be prepared with polypropylene, silica panoparticles and cinnamon essence.

Keywords: Anti-bacterial meat packaging; Polypropylene; Silica nanoparticles; Cinnamon essence

Introduction

Packaging is the art and science of food preparation to storage and ultimately sales. (Scott and Rutzke,2002). Active packaging system is defined as a combination of certain substances in packaging systems to increase shelf life and improve sensory properties, increase safety and at the same time maintain or increase the quality (Kerry et al,2006; Lee et al, 2015). The nature of active compounds is very different that can be used include organic acids, enzymes, bacteriocins, fungicides, natural extracts and ethanol. Plastic, paper, metal or a combination of these materials was used for their inclusion (Lee et al, 2015). The ingredients whether are packaged inside materials or and placed inside package (Kerry et al,2006). Active packaging technology is consists of interaction among food, packaging material (or covering) and gas atmosphere inside the pack and it increases the original package systems performance (Kerry et al,2006; Labuza and Breene,1989). Active packaging is required as a food technology to improve the quality and safety of food products (Gutiérrez et al,2009) and in case of different types of food have been used such as bread, cakes, pastries, pizza, fresh dough, cheese, meat and dairy products and fruitage (Appendini and Hotchkiss,2002). The application of active packaging has been developed during recent 25 year. With customer demand for higher quality of meat products at reasonable prices and increased competition, not only manufacturing meat sector have significant changes but also processing system has experienced. The demand for sustainable production of meat products and emphasis on human health has led to the development of innovations in the meat products industry. Hence, expectations about the use of ingredients and additives increased for improving product quality and increased muscle foods (Ozimek et al,2010).

Less than 20 bacterial species of food poisoning factor are associated with bacterias. More than 90% of cases of food poisoning caused by Staphylococcus aureus, Salmonella, Clostridium

Perfringens, Campylobacter, Listeria monocytogenes, Vibrio, Bacillus cereus and E-coli. Antimicrobial properties of plant essences tend to replace it with chemical additives used in the food. In recent years the ability of plant essences has been investigated to inhibit bacterial origin of food and shelf-life increasing of foods (Tabatabaee,2013). According to the effects of artificial preservatives to increase the shelf life among all consumers is raising using natural anti-bacterial. Herbs have not only improves flavor but also have antimicrobial, antioxidantand clinically properties (Asha,2014). The scientific name Cinnamon is Cinnamomum which have two important species such as Cinnamomum verum and Cinnamomumzelanicum. This plant is a bush with orders Laurales, bay laurel family (Lauraceae) and Cinnamon Genus (Cinnamomum). Cinnamon bark has more than fifty different combinations that it forms 65-80 percent of cinnamaldehyde. Other compounds include cinnamic acid, phenolic compounds such as Eugenol, and SafrolePhellandrene, Terpene compounds such as limonene and linalool, Trans-cinnamic aldehyde, tannin, Coumarin, resin. The cause of sweet taste of Mannitol is cinnamon (Palmer and Fyfel,2002). Many studies have been investigated about to antimicrobial activity of essences and cinnamon extract on human pathogenic species and the food pathogens such as Staphylococcus, and Salmonella Typhi murium and E. coli (Dušan et al, 2006;Oussalah et al, 2007). The objective of this study was to design an anti-bacterial meat packaging, including polypropylene, silica panoparticles and cinnamon essence.

Materials and Methods

Active packaging preparing

The first, the value of 0.025 grams of powdered silica nanoparticles (purchased from US Research Nanomaterials) with 100 ml of concentrated cinnamon essence along with 400 microliters sterile distilled water into polyethylene container resistant to acid and heat was added and mixture

vigorously. Dense suspension obtained was used for the tests. To prepare a package repository, a piece of sheet lamination layer (polymer polypropylene) in the dimensions of 5 × 5 centimeters was prepared and completely disinfected with alcohol 70 degrees. A layer of cellulose of 4 × 4 cm in size was placed in the middle of it. After these processes packaging structure was examined using scanning electron microscopy.

The change of packaging color

The total color of the novel packaging was calculated by a digigital camera with 13 megapicxell by **Formula 1**. This measurement was carried out in 0 day, 14 days, and 21 days.

Formula 1. Total color= R2+G2+B2

Statistical analysis

Different groups' data werecollectedandwere studied using SPSS software version 16. Student t-test and one-way ANOVA and Tukey's test was used for pairwise comparison between groups to Statistical analysis. In all calculations of value-P value less than 0.05 was considered statistically significant.

Results

The study of the macro and microstructure of packaging

Figure 1 shows fornt and back of final meat packaging which built in thisb study. **Figure 2** and **figure 3** show the raw cellulose and cellulose reinforced with nano-silica and essence, respectively.

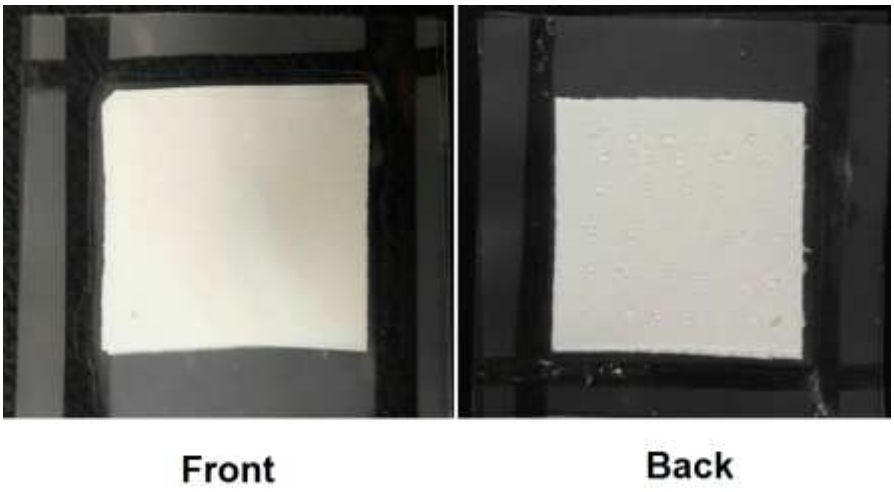

Figure 1. Fornt and back of final meat packaging which built in this study

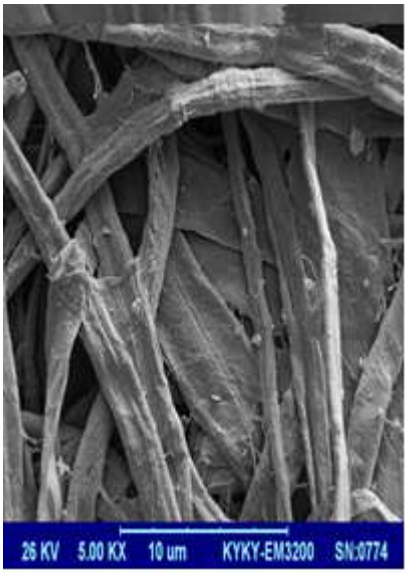

Figure 2. The raw cellulose for preparing meat packing.

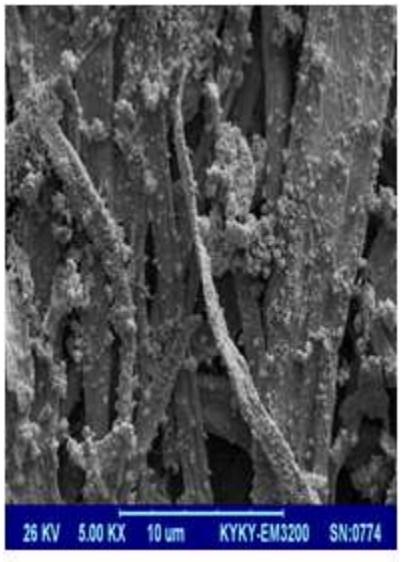

Figure 3. Cellulose reinforced with nano-silica and essence.

The study of the Nanopackage color spectrum change

The Nanopackage color change at intervals 0, 14, and 21 days is shown in **Figure 4**. The color value reduced after 14 days then increased on days 21th . There is a significant difference at day 14th compared to day zero and 21 ($p < 0.05$).

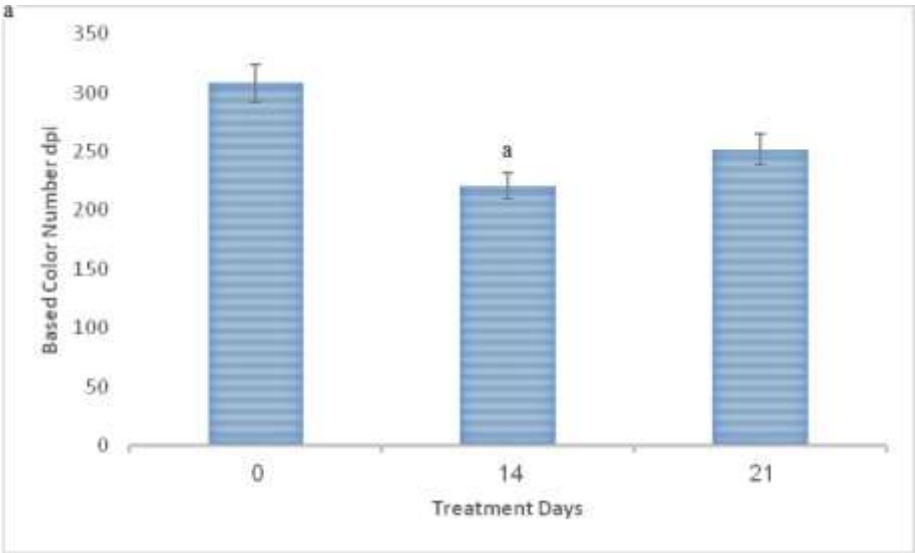

Figure 4. Nanopackage color change in intervals 0-14-21 day. a means significant difference with days 0 and 21 ($p < 0.05$).

4. Discussion

Some studies have shown that the main composition of GC-MS is Cinnamaldehyde with 60.41 percent (Ojagh et al, 2012). In another study, main composition is including Synamaaldhyd (91.04 percent), cinnamyl acetate (8.58 percent) and alpha Kapyyn (0.22 percent) (Zouheyr et al,2014), while El-Baroty research showed that the most compound of essence is trans cinnamaldehyde (45/13%) and methyl eugenol (5.23 percent) (El-Baroty,2010). Mashakand Moradi (2012) showed that major compound is including Synamaaldhyd (79.10 percent) ,Eugenol (4.27 percent) and

cinnamyl acetate (7.23 percent) (Mashak and Moradi, 2012).Cinnamon essence to disk diffusion method against bacteria E.Coli, Staphylococcus aureus and Salmonella Typhimurium has shown strong antimicrobial effect and the most active compound is cinnamaldehyde (Unlu et al,2010). But Bharitet et al. (2013) concluded that the most antibacterial effect against bacteria is Terencecinnamaldehyde. Other researchers support this issue (Pesavento et al, 2015; Silveira et al, 2012).

Lopez et all (2007) studied antibacterial activity of cinnamon, thyme and oregano against gram positive and gram negative bacteria and fungi in the vapor phase and concluded that the inhibitory effect of cinnamon essence is up to 100% for fungi and more than 80 percentfor gram-positive and 60 percent for gram negative bacteria. Shan et al.(2007) examined properties of antibacterial cinnamomumburmannii on pathogenic bacteria food such as Bacillus cereus, Listeria monocytogenes, Staphylococcus aureus, coli and Salmonella Anatomy. These results confirmed the findings of this study, as well as in the studies the most extracted active compound are related to Cynamaaldhydthat their results are similar to our findings (Ojagh et al, 2012;Asha et,2014;Unlu et al,2010). The shelf life of meat inoculated with bacterial strains increased todays 14 by active packaging. Hu et al. (2015) studied the pork meat in LDPE active films containing chitosan nanoparticles impregnated with cinnamon essence that showed the antioxidant and antimicrobial properties in samples during 15 days maintaining at refrigerator. Lu et al(2010)preparing alginatecalcium coverage containing Cinnamon and Nisin could prevent bacterial growth and chemical degradation of fish fillets and it maintains new quality to control samples (Rakshit and Ramalingam, 2013).

Conclusion:

In this study, we design an anti-bacterial meat nano packaging, including polypropylene, silica panoparticles and cinnamon essence. Microscopic evaluation confirmed the presence of nanoparticles. The color value reduced after 14 days then increased on days 21th . There is a significant difference at day 14th compared to day zero and 21 ($p < 0.05$).

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