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Packaging of Bread in Paper Made From Edible Red Algae and Coated with Antimicrobials Retards Microbial Growth in Bread during Storage

– Research Note –

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Abstract

To utilize edible red algae paper for food packaging, red algae paper coated with green tea extract or catechin was prepared and microbial growth in bread wrapped with the paper was determined during storage. The paper coated with green tea extract or catechin had antimicrobial activity against *Escherichia coli*. Packaging of bread with the red algae paper coated with green tea extract or catechin decreased the populations of total aerobic bacteria and yeast and mold after 2 days of storage by 0.41 and 0.63 log CFU/g, respectively, compared to the control. These results suggest that bread can be packaged by edible red algae paper coated with green tea extract or catechin, resulting in inhibit microbial growth during storage.

Key words: antimicrobials, bread, red algae paper, shelf life

INTRODUCTION

Bread and other bakery products are part of a balanced diet (1), but unpreserved bread is easily susceptible to microbial spoilage. In particular, spore forming bacteria can grow to levels of public health concern (2), although vegetative pathogenic microorganisms should be inactivated during baking. Thus, microbial spoilage is the major problem causing deterioration of bread products during storage (2).

Edible films containing nisin or chitosan as functional materials in the formulation (3,4) are used as a packaging. In addition, for coating of edible films, green tea extract or catechin can be used as anti-oxidative as well as antimicrobial material to extend shelf life of food products (5).

Recently, the use of red algae pulp has been investigated for manufacturing papers (6), and its application in food industry is considered because it is edible. Therefore, the objectives of this study were to prepare edible red algae paper coated with antimicrobials for food packaging, and to determine the microbial growth in bread packaged with the paper during storage.

MATERIALS AND METHODS

Materials

Red algae paper was supplied by Pegasus International Co. (Daejeon, Korea). Green tea extract powder was purchased from Dongsuh Co. (Siheung, Korea), and catechin was purchased from Sigma-Aldrich Chemical Co. (St. Louis, MO, USA). White bread (butter added) was purchased from a local market in Daejeon, Korea.

Coating of red algae paper with antimicrobials

Red algae paper was coated with green tea extract (1.42%, 2.83%, and 5.6%, w/w) or catechin (50, 100, and 200 mg/100 mL) solution by spraying, and drying at 120°C for 1 min.

Antimicrobial activity of red algae paper coated with antimicrobials

Antimicrobial activity of the red algae paper coated with green tea extract or catechin was determined according to a modified method of Ko et al. (7). *Listeria monocytogenes* and *Escherichia coli* were cultured in Tryptic Soy Broth and Luria-Bertani broth (Difco Co., Detroit, MI, USA) at 37°C, respectively, until they reach 10^9 CFU/mL. The coated red algae paper was cut into 10 cm × 10 cm squares, treated with UV for 3 hr, and then 40 μL of the bacterial suspension was placed onto the paper. The paper was then incubated at room temperature for 1 hr. After incubation, the paper was placed in 26.95 mL of 0.1% peptone water, and homogenized for 3 min. The solution was then diluted with 0.1% peptone water and the populations of *L. monocytogenes* and *E. coli* were counted. All plates were incubated at 37°C for 24 hr. Each microbial count was the mean of three determinations and was expressed as colony forming units (CFU/g).

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Packaging of bread with red algae paper

Bread was wrapped with the red algae papers coated with green tea extract or catechin. The control was bread in a plain paper box supplied by a manufacturer. Bread was stored at room temperature for 72 hr.

Microbiological analysis of bread during storage

Five grams of bread samples was removed using a sterile scalpel, and placed in 45 mL of 0.1% peptone water. Samples were then homogenized in a sterile stomacher bag using a Stomacher (MIX 2, AES Laboratoire, France) for 3 min, filtered through a sterile cheese cloth, and diluted with peptone water for microbial counting. Serial dilutions were performed in triplicate on each selective agar plate. Total bacterial counts were determined by plating appropriately diluted samples onto plate count agar (PCA, Difco Co., Detroit, MI, USA). Yeast and mold were plated on plate dextrose agar (PDA, Difco Co., Detroit, MI, USA). Both plates were incubated at 37°C for 48 hr and 72 hr, respectively. Each microbial count was the mean of three determinations, and was expressed as log CFU/g.

Statistical analysis

Differences were analyzed by Duncan's multiple range tests and analysis of variance using a SAS program (1999, SAS Institute, Inc., Cary, NC, USA).

RESULTS AND DISCUSSION

Antimicrobial activity of the red algae paper coated with green tea extract or catechin against *Escherichia coli* is shown in Fig. 1. Increasing concentration of green tea extract or catechin increased inhibition of bacterial growth, resulting in a decrease by 0.9 and 0.8 log CFU/g at 5.6% and 200 mg, respectively, compared to the control (Fig. 1). The major component of green tea extract is catechin, which is known to have antioxidant and antibacterial activity (8). Sung (9) reported that addition of 1% green tea extract reduced populations of *Salmonella* Typhimurium by 0.9 log CFU/g within 24 hr. Our results are comparable with the result.

Microbial growth in the bread packaged with the red algae paper was determined during storage. Fig. 2 shows the results of total aerobic bacteria and yeast and mold counts in bread during storage. After two days of storage, populations of total aerobic bacteria in the bread wrapped with the red algae paper coated with catechin or green tea extract were significantly reduced by 0.41 and 0.63 log CFU/g (Fig. 2A), respectively, compared to the control. This is mainly due to the antimicrobial activity of catechin in the paper. Fig 2B shows the change in the populations of yeast and mold in bread

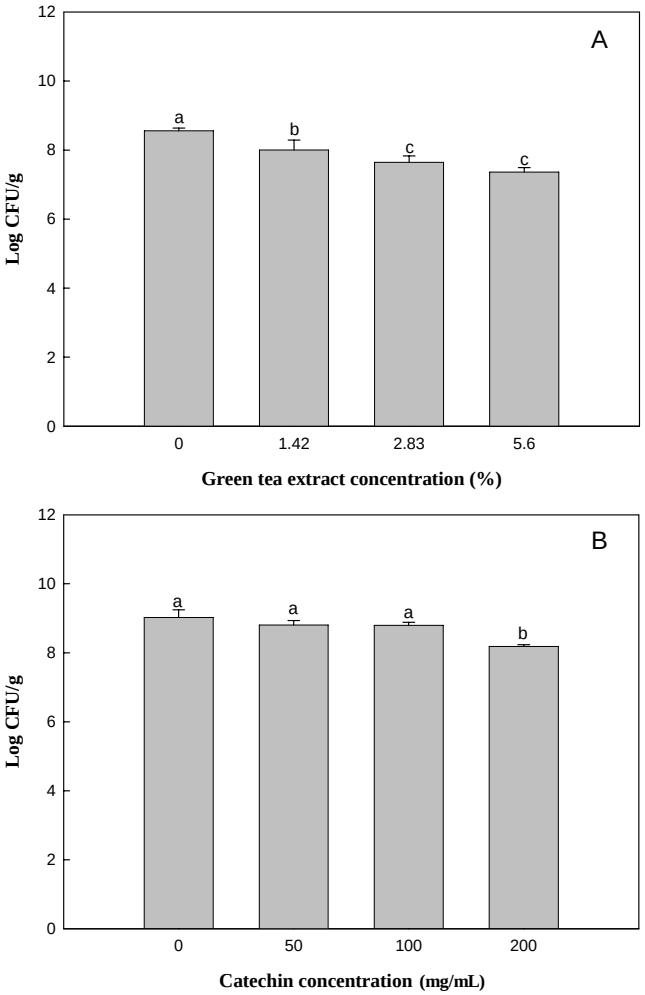

Fig. 1. Antimicrobial activity of red algae paper coated with green tea extract (A) or catechin (B) against *Escherichia coli.* Bars represent standard error. [a-c]Any means with different letters are significantly different ($p<0.05$).

during storage. Like total aerobic bacteria, populations of yeast and mold in bread during storage were also reduced by packaging with the red algae paper coated with catechin or green tea extract. After 1 day of storage, the control reached 4.3 log CFU/g, while packaging with the red algae paper coated with green tea extract had 3.78 log CFU/g. In addition, after 2 days of storage, packaging with the red algae paper coated with catechin decreased the populations of yeast and mold by 0.73 log CFU/g more, compared to the control. Kim (10) reported that populations of total aerobic bacteria and yeast and mold in bread wrapped with poly 3-hydroxybutyric acid (PHB) coated with chitosan were reduced by 1 and 2.2 log CFU/g, respectively, after 3 days of storage. Their results exhibited a similar pattern as the data in this study, although different edible packaging materials were used.

In summary, edible red algae paper coated with green

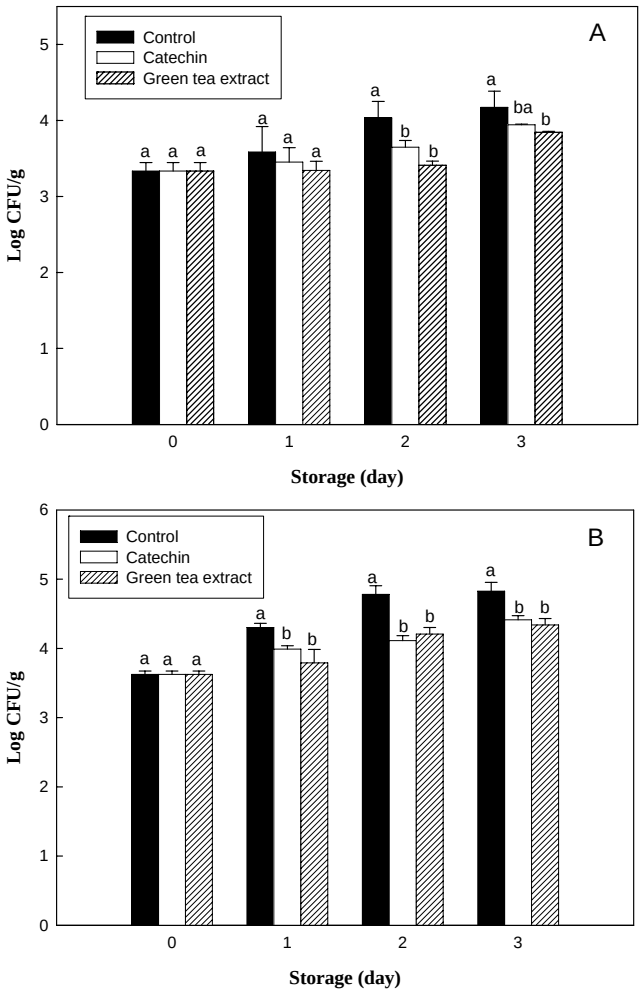

Fig. 2. Changes in populations of total aerobic bacteria (A) and yeast and mold (B) in bread during storage. Bars represent standard error. [a-c]Any means with different letters are significantly different ($p<0.05$).

tea extract or catechin as a package for bread was prepared, and the results suggest that bread can be packaged with the paper coated with catechin or green tea extract, resulting in retardation of microbial growth in the bread during storage.

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