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PERFORMANCE OF EDIBLE COATINGS FROM CARBOXYMETHYLCELLULOSE (CMC) AND CORN STARCH(CS) INCORPORATED WITH *Moringa oleifera* EXTRACT ON *CITRUS SINENSIS*

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ABSTRACT

Two different coatings were developed from Corn Starch (CSME) and Carboxymethylcellulose (CMCME) and their effects were investigated on the quality and storability of orange fruits. The two experimental coatings were: CSME and CMCME both mixed with 75mg/ml of crude extract of Moringa Oleifera. The following parameters were measured: Weight loss, ascorbic acid content and firmness. Four hundred and eighty (480) orange fruits were stored for seven weeks at ambient temperature. The overall result showed that polysaccharides coating from (CSME) and (CMCME) on orange fruits when compared to untreated in the following order: (CSME) > (CMCME) >Control in extending its shelf life.

Keywords: Edible Coatings, *Moringa Oleifera,* Orange, Corn Starch and Carboxymethylcellulose.

INTRODUCTION

Moringa oleifera is considered one of the world's most useful trees, as almost every part of the tree can be used for food or has some other beneficial property. Moringa is a special food for the tropics, because the tree is in full leaf at the end of scarce (Iwu, 1993). It is available allyear round. Almost all the parts of *Moringa Oleifera* are used as food and forage for livestock (Ram, 1994). The part (leaves, fruits, flowers and immature pods) are edible and form part of traditional diet in many countries of the tropics and subtropics (Odee, 1998).

The sweet orange (*Citrus sinensis* L. Osbeck) is the most commonly grown tree fruit in the world (Morton, 1987).Citrus fruits are produced all around the world and world citrus production in selected major producing countries in 2005/2006 is 72.8 million metric tons. Citrus fruits are said to be the first crops in the international trade in terms of values (CIAC, 2002).

Edible films and coatings are an environmentally-friendly alternative method to extend the postharvest life of fresh and minimally processed fruits and vegetables (Baldwin, 1994; Olivas *et al*., 2008; Pérez-Gago *et al*., 2005; Vargas, Pastor, Chiralt *et al*., 2008). They form a semi-permeable barrier to gas and water vapor that reduce respiration and weight loss. In addition, edible films and coatings may help in maintaining firmness and provide gloss to coated fruits.

According to their components, edible films and coatings can be divided into three categories: hydrocolloids (proteins and polysaccharides), lipids, and composites. Antioxidants, flavors and pigments, vitamins, and antimicrobial agents can be successfully incorporated into edible coatings to improve their functional properties. In the literature, several reviews reported on the efficacy of films and coatings containing antimicrobials to control microbial growth on fruits and vegetables (Ayala-Zavala *et al*., 2008; Cagri, Ustunol, & Ryser, 2004).

Carboxymethyl cellulose (CMC) is a linear, long-chain, water-soluble, anionic polysaccharide.

Purified CMC is a white to cream-coloured, tasteless, odourless, free-flowing powder .Keller, J.D. (1986) and Hattori, K., *et al.* (2004).

From the literature reviews, corn starch(CS) appears to be an interesting alternative for edible films due to it is abundance, cheap price, being biodegradable as well as edible Biliaderis, C.G *et al.* (1999), Wing, R. E., *et al.* (1988) ,Bertuzzi, M.A., *et al.* (2007).

The presentstudy was aimed at investigating the suitability of *Moringa oleifera* extract incorporated into CS and CMC as an edible coating to extend the shelf-life of orange fruits during ambient storage.

MATERIALS AND METHODS

Source of Materials: Freshly harvested oranges were procured from Ipata market in Ilorin, Kwara state, Nigeria. They were selected on the basis of sized, color and absence of external injuries. Fresh leaves of *Moringa oleifera* were obtained from Nigeria Stored Products Research Institute (NSPRI) garden at Ilorin, Kwara state Nigeria.

Prepration of*Moringa oleifera extract*

Moringa oleifera leaves were dried in an open laboratory and ground into very fine powderusing an electric blender (supermaster ®, Model SMB 2977, Japan). The powder was further sieved to pass through 1 mm^2perforations. The powder was then packed in plastic containers withtight lids and stored in a refrigerator at 4°C prior to use. Fifty grams of the dried *Moringa Oleifera*leaves was weighed and introduced into conical flask containing 250ml of distilled water. The conical flask was then covered with aluminum foil and placed on mechanical shaker. The suspension was then shaked for 48hours at 190rev.per.min. The extract was decanted and passed through different clean muslin cloth and later filtered with whatman fitter paper. The filtrate obtained was evaporated to dryness at 50^0c and the residues obtained are kept in an aluminum foil.

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Reconstitution and sterilization of extract

The dried residue was weighed into McCartney bottles and appropriate volume of distilled water was added to make a stock solution of 75mg/ml, for example 750mg in 10mls of distilled water. The stock solution was then sterilized using 0.65 membrane filter by suction pump. The sterilized extract was stored inside McCartney bottle and kept in a refrigerator.

Surface preparation of the Oranges: The primary purpose of surface preparation was to remove all contaminants that would hinder proper coating adhesion and to render a sound clean substrate suitable for firm bonding. The surface should be in paint ready condition. Mold, mildew and/or algae were removed and sterilized with a 25% hypochlorite solution (1 gallon household bleach to 3 gallons water). The oranges were soaked in the 25% hypochlorite solution for two minutes.

Preparation of edible coatings:

1. Carboxy Methyl Cellulose (CMC) coatings (3%) was prepared by dissolving 6.0 g of methyl cellulose powder (Hangzhou Hongbo Chemical Co. Ltd, China) in 200 ml of water ethyl alcohol mixture (3:1L/L) at 80°C and stirred for 10 min by using magnetic stirrer. Ethyl alcohol was used to reduce drying time and obtain a transparent and shinny coating. 2% propylene glycol was also added in the formulation as plasticizer.

2. Corn Starch films were prepared as follows. Aqueous suspension of 3g CS/100 g with plasticizers was preheated at 100°C for 30 min in boiling water-bath, gelatinized at 160±5 °C in an oil bath for 30 min, cooled to 80°C, cast on the round polypropylene (PP) plate (300mm ID, 305mm OD and 10mm depth), and then dried at 50°C for 24 h in an oven. Glycerol was added to 100g of corn starch as plasticizers. In order to cook the Corn starch at 160±5°C, special stainless-steel high-pressure container (10mm thick) was then designed.

Treatments

T_o (control):- T_0 was selected as the control (untreated oranges)

T_1 Oranges was coated with Corn Starch containing 70% *Moringa oleifera* (CSME)

T_2 Oranges was coated with Carboxymethylcellulose containing 70% *Moringa oleifera* (CMCME)

The treated and untreated oranges were packed in small plastic basket and each basket contains 20 orange fruits. The basket was stored at ambient temperature (27+2°C) and at 50-60% relative humidity .Physiochemical analysis was then carried out from 1-7weeks of coating.

Firmness: - Firmness was measured as the maximum penetration force (N) reached during tissue breakage, and determined with a 5 mm diameter flat probe. The penetration depth was 5 mm and the cross-head speed was 5 mm s^{-1} using a TA-XT2 Texture Analyzer (Stable Micro Systems, Godalming, UK), MA. Oranges were sliced into halves and each half was measured in the central zone.

Ascorbic acid: - Ascorbic acid content was measured using 2, 5-6 dicholorophenol indophenols' method described by A.O.A.C 1994.

Percentage weight loss: - The weight loss of the orange fruit was determined using the Equation (1).Weight loss (%) 100 x $\frac{M_1 - M_2}{M_1}$

Where: M_1 = Mass of sample before drying in g. M_2 = Mass of sample after drying, in g.

Statistics

All results are means ± S.E., SPSS software (version 12.0, SPSS Inc., US) was used for all statistical analysis for Analysis of variance. The significance level used was 0.05.

RESULTS AND DISCUSSION

Firmness(lb/kg/N)

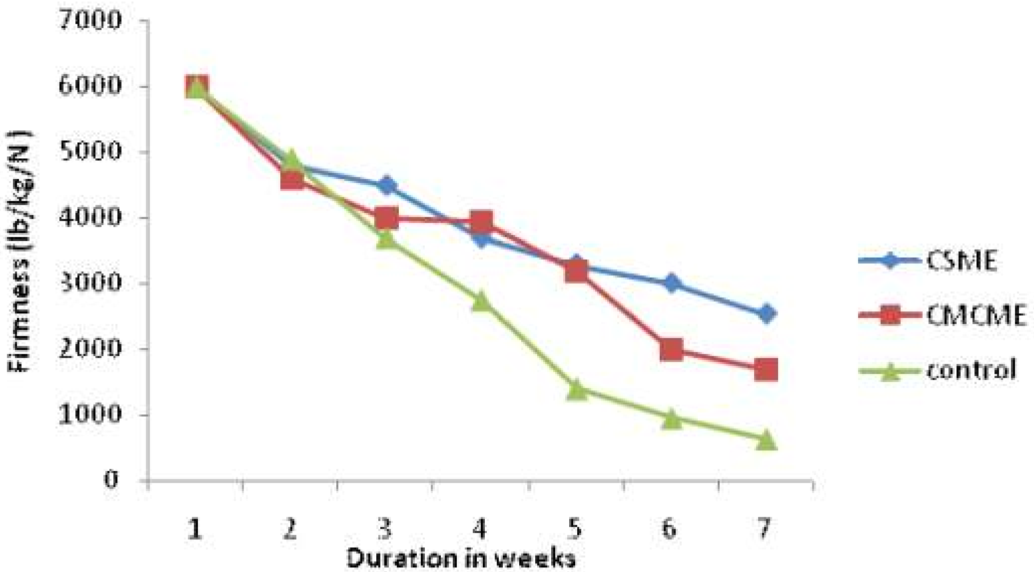

Fig 1.Effect of edible coatings from CS and CMC with Moringa extract on firmness of orange at ambient temp

The mean±SE value for the Firmness on coatings from CSME and CMCME were 3978.71±451.14 lb/kg/N and 3635.71± 563.17 lb/kg/N respectively while the mean±SE value for the uncoated was 2904±777.60 lb/kg/N.

During storage, the texture of the fruits is likely to soften due to several factors, including loss in cell turgidity pressure, loss of extracellular and vascular air and the degradation of the cell wall and consequent loss of water by the cell breakdown (Martı´nez-Ferrer, Harper, Pe´rez-Mun´ oz, & Chaparro,2002; Somogyi, Hui, & Barret, 1996).

Lerdthanangkul and Krochta (1996) also made similar observations and concluded that coatings and/or films significantly affected firmness of fruits in storage. The softening process in orange has been reported to be dependent on the increase in polygalacturonase, ßgalactosidase and pectinmethylesterase activities (Batisse *et al*., 1996; Gerardi *et al*., 2001; Rem´on *et al*., 2003), being responsible for fruit quality loss. CSME and CMCMEtreatment significantly reduced the firmness losses (more than 50%) during ambient storage compared with control fruits. In addition, CSME and CMCME probably had some effects on the reduction of cell wall degrading-enzymes responsible for cucumber softening. These results show beneficial effects of the CSME and CMCME coatings on increasing the cucumber shelf life, since it has been postulated that fruit softening and texture changes during orange storage determine fruit storability and shelf life, as well as reduced incidence of decay and less susceptibility to mechanical damage (Batisse *et al*., 1996; Vidrih *et al*., 1998).

Ascorbic acid

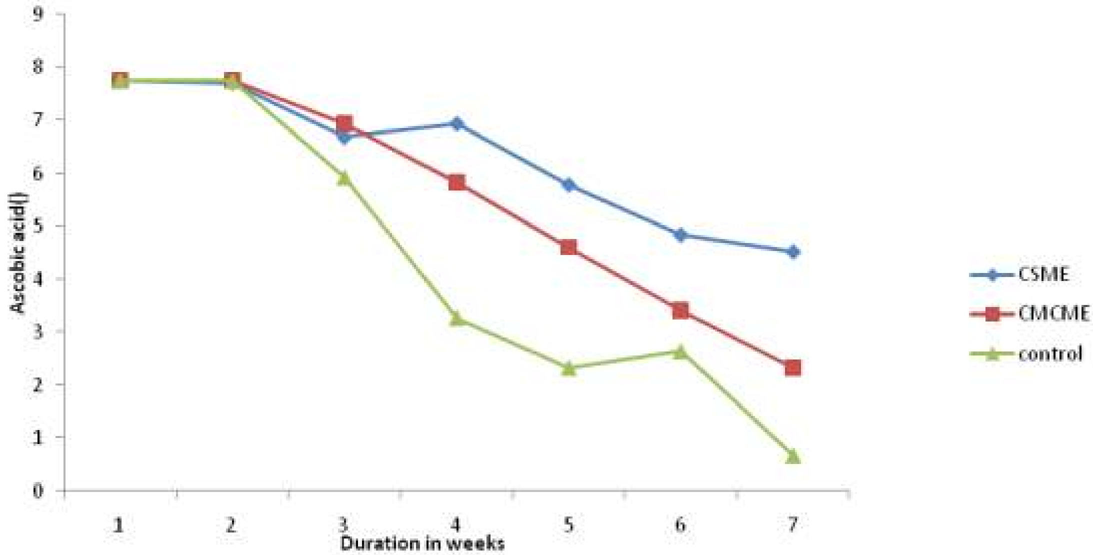

Fig 2: Effect of edible coatings from CS and CMC with Moringa extract on Ascobic acid content of orange at ambient temp

The mean±SE value for ascorbic of the coatings from CSME and CMCME were 44.21±0.49 mg/100g and 38.66± 0.81 mg/100g respectively while the mean±SE value for the uncoated was 30.32±1.06 mg/100g.

Ascorbic acid content: Ascorbic acid is lost due to the activities of phenoloxidase and ascorbic acid oxidase enzymes during storage (Salunkhe *et al*., 1991). Weichmann *et al*. (1985), while studying green bean, spinach and broccoli, postulated that the lower the oxygen content of the storage atmosphere, the smaller is the loss of ascorbic acid. The claim was that the oxidation of Vitamin C was mainly regulated by ascorbic acid oxidase and other oxidases, most of which had a low affinity for oxygen. Ascorbic acid content decreased for cherries stored at both ambient temperature and cold temperature. CSME and CMCME coatings were effective in reducing the ascorbic acid loss under the storage conditions (Fig. 2). At the ambient temperature, the ascorbic acid contents of CSME and CMCME coated cucumber were significantly different from the control orange. The reduction of ascorbic acid loss in coated orange was due to the low oxygen permeability of CSME and CMCME coating which lowered the activity of the enzymes and prevented oxidation of ascorbic acid. The effect of low temperature significantly reduced the ascorbic acid loss. This shows the effect of temperature on the activities of the related enzymes.

Percentage weight loss

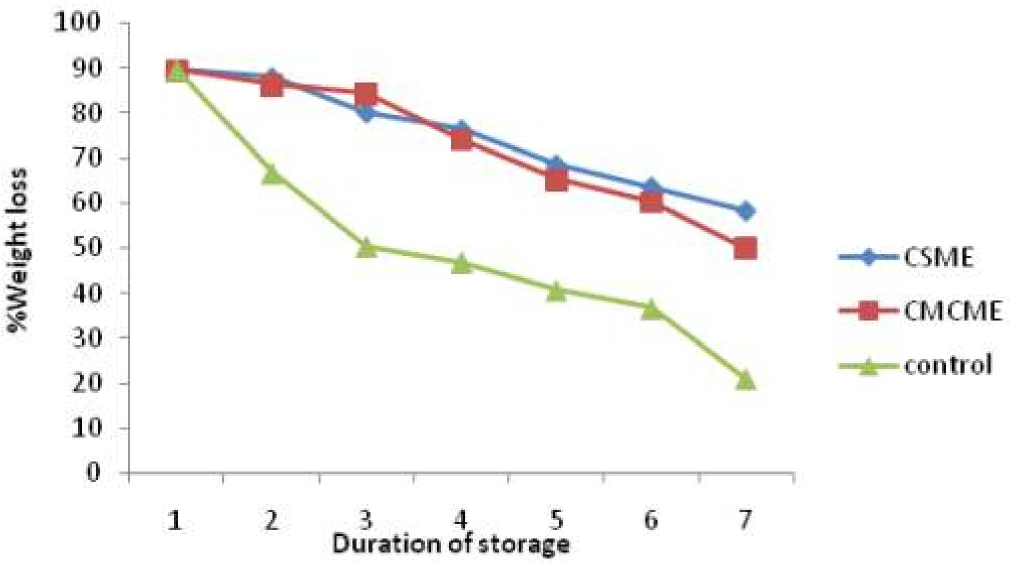

Fig 3: Effect of edible coatings from CS and CMC with Moringa extract on %Weight loss of orange at ambient temp

The coatings (CSME and CMCME) caused a significant (p=0.05) decrease in weight loss compared with control sample as shown in fig 3 above. The mean±SE value for the weight loss of CSME and CMCME were 524.25±4.52g and 510.19±5.60 g while the mean±SE value for the weight loss of uncoated orange was 351.81±8.39g.

These results were in agreement with those of Mahmoud and Savello (1992) and Avena-Bustillos *et al.* (1997) who concluded that coatings and/or films significantly conserved water content. Post harvest weight changes in fruits and vegetables are usually due to the loss of water through transpiration. This loss of water can lead to wilting and shriveling which both reduce a commoditymarketability. Edible films and coatings can also offer a possibility to extend the shelf life of fresh-cut produced by providing a semi-permeable barrier to gases and water vapor and therefore, they can reduce respiration, enzymatic browning and water loss (Guilbert, 1986; Baldwin & Nisperos-CarriedoBaker, 1995).

CONCLUSION

Applications of Polysaccharide coatings to orange were shown to be beneficial in keeping the quality of the fruits in storage. Addition of *Moringa oleifera* extract into the Coatings slowed down the weight loss and reduced the ascorbic acid content. The shelf-life of orange was increased at an average temperature of 27±2°C and relative humidity55-60%. Textural analysis showed that the coatings from CSME and CMCME could have a protective effect on orange, reflected by the greater firmness of coated samples during storage, which could reduce economic losses due to spoilage produced from mechanical damage during handling and transportation. Finally, the overall result showed that the coatings from CSME and CMCME is effective in extending the shelf-life of orange fruits when compared to untreated orange in the following order: CSME>CMCME>Control.

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