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Investigation of the Effects of Rosemary Extract on Barrier and Colorimetric Properties of Mungbean Starch Films

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Abstract: Barrier properties are one of the most important factors in the edible film. In this study, edible mungbean films were prepared containing (0%, 15%, 30%, 45%) concentrations of rosemary aqueous extract. Then the effect of rosemary was investigated on colorimetric and barrier properties (water vapor permeability, oxygen permeability). Rosemary extract increased the absorption of color in the visible region, which in turn led to increase of the parameters a (index color tends toward green) and b (index color tends towards yellow). The results showed that increasing concentrations of rosemary extract have a significant effect($p <0.05$) to reduce the amount of oxygen and water vapor permeability. Also turbidity of mungbean starch was increased with increasing concentrations of rosemary in the film. Improving barrier properties and the colorimetric properties were showed by rosemary extract compounds that these materials can use as the safety of food and pharmaceutical packaging industry.

Keywords: starch film mungbean , rosemary extract , barrier properties , colorimetery.

INTRODUCTION

Improving food quality, nutritional value and biodegradable are the reasons of developing edible films. Edible films can be prepared from proteins, polysaccharides, lipids or their combination. Carbohydrate-based edible films, which have good film-forming ability due to their unique colloidal properties, are particularly attractive. Starch is the most commonly used raw material in agriculture due to its relatively low cost, wide availability and ease of handling [1].

Starch composition mungbean can use as edible film. The benefits of the new packing system encourage consumers and producers alternative to synthetic packaging. Although replacing all plastics biodegradable with synthetic material for long life food is possible. It is useful to consider such alternatives and helps to prevent oil analysis, i.e., the analysis of the amount of water or moisture. Therefore, high moisture transfers in food products, affected on quality, stability and safety. Rapid moisture transfer between the food and the atmosphere completely cover the food with edible film or coating is reduced [2]. Mungbean starch has composition and properties of the polymer film including easy casting mechanical method because it has a high amylose and high tensile strength and the film has a better

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ability to form films. It is clear that it would be classified as a consumer-friendly product [3]. Rosemary is a tonic, astringent, restorative herb that relaxes spasm and increases the rate of perspiration, while stimulating the liver and gall bladder. It improves digestion and circulation and controls pathogenic organisms.

It has antibacterial, antifungal, antiviral, spasmolytic, antioxidant, smooth muscle modulating, analgesic, venotonic, as well as anti-inflammatory properties [3].The purpose of the study was to investigate the effect of adding rosemary extract on barrier properties including water vapor permeability and oxygen permeability of edible starch films as well as determining the film colorimetric parameters on the base of mungbean.

MATERIAL AND METHODS

Mungbean starch (13% moisture) was purchased from SIM companies (penang, Malaysia).Edible glycerol was purchased from liang traco company (Penang, Malaysia). p_2o_5 and magnesium nitrate were purchased to control the moisture from sigma – Aldrich (kualampur, Malaysia).

Preparation of the films

Mungbean Starch dispersion 4% (w/w) heated to $92^{\circ c}$ for 1 hour and it was kept at this temperature for 45 minutes to complete gelatination 40% of the weight of the starch and glycerol as plasticizer were added to complete gelatination. ; The choice of the plasticizers was based on the previous research by Abdorreza et al., [4]; finally, the solution was then cooled to room temperature. A portion (92 g) of the dispersion was cast on Perspex plates fitted with rims around the edge to yield a 16×16 cm^2 film-forming area. Films were dried in the growth chamber at 51% relative humidity and a temperature of $25^{\circ c}$ for 24 hour. Films were removed and layerat a temperature of $22\pm2^{\circ}$ c and relative humidity was maintained at 50 for testing. The film was produced in the second iteration.

Water vapor permeability (WVP)

The modified gravimetric cup method [5] based on ASTM E96-05 [6] was used to determine the water vapor permeability (WVP) of films. The test cups were filled with 20 g of silica gel (desiccant) to produce a 0% RH below the film. The water vapor transmission rates (WVTR) of each film were measured at 55 ± 2% RH and 25 ± 2 ºC. The initial weight of the test cup was measured, and the cup was placed into an incubation chamber with an air velocity rate of 125 m/min. A plot of weight gained versus time was used to determine the WVTR. The slope of the linear portion of this plot represented the steady state amount of water vapor transmission through the film per unit time (g/h). Six samples per treatment were tested. The slopes yielded regression coefficients of 0.99 or greater. The WVP of film was calculated by multiplying the steady WVTR by the film thickness and dividing that by the water vapor pressure difference across the film.

Oxygen permeability

Oxygen permeability measurements were performed on films with Mocon Oxtran 2/21 (Minneapolis, USA) equipped with a patented colometric sensor (Coulox®) and WinPermTM permeability software. The meaurements were done using the ASTM standard method D3985-05. The films were placed on an aluminum foil mask with an open area of 5 cm2 and were mounted in diffusion cells. Tests were carried out at 25ºC temperature, atmospheric pressure, and 50% RH using 21% oxygen as test gas. Transferred oxygen through the films was conducted by the carrier (N_2/H_2) gas to the colometric sensor. Measurements were carried out on “convergent by hour” mode to reach the steady state of oxygen transmission. The permeability coefficients in cc-μm/(m2 day atm) were calculated on the basis of oxygen transmission rate in steady state taking into account the films thickness.

Colorimetric

Film samples in triplicate were measured with a colorimeter (Minolta CM-3500D; Minolta Co. Ltd., Osaka, Japan). The instrument was calibrated with zero transmittance calibration plate CM-A100 and air as fully transmittance prior to use. A large size aperture was used, and CIE color *L*, *a*, *b* values were reported via the computerized system using Spectra Magic software version 2.11 (Minolta Cyberchrom Inc., Osaka, Japan). The *L* value is the psychometric lightness (dark-light) and corresponds to black (*L* = 0) and white (*L* = 100), and the *a* and *b* values correspond to psychometric chromaticity. A positive *a* value represents red, and a negative value denotes green. A positive *b* value corresponds to yellow, whereas a negative value indicates blue.

Statistical analysis

ANOVA and Tukey's Post Hoc tests were used to compare means of barrier properties of mungbean starch films at the 5% significance level. Statistical analysis was conducted using GraphPad Prism 5 (GraphPad Software Inc., La Jolla, USA).

RESULTS AND DISCUSSION

Barrier properties

water vapor permeability

In this study the characteristics of permeability to water vapor at low concentrations did not change due to the addition of rosemary extract. And this means that there is no mean difference between 5% level and 15% and 0% concentrations.

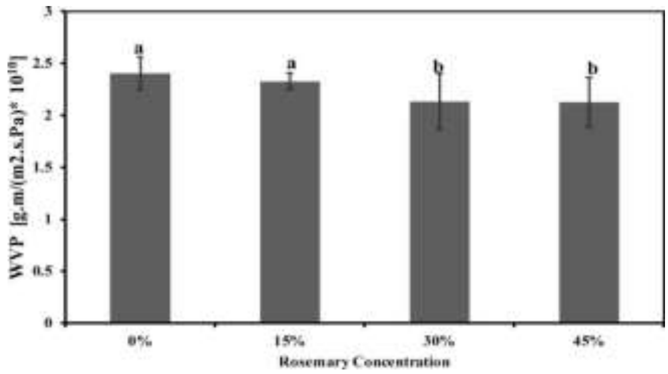

Figure 1: Effects of rosemary extract on water vapor permeability of mungbean starch. Different letters on each column shows significant differences among means (p<0/05)

Park, in 2004, studied mixing mineral and vitamin c to chitosan film. He observed that adding mineral and vitamin c to film matrix increased the reaction between closed molecules in the network and this, in turn, decreased the diffusion of water vapor through film matrix and the hydrophilic tendency of the film [7]. Hernandez, in 1994, showed that water vapor permeability took place in hydrophilic part and it is dependent on hydrophilic and hydrophobic parts [8]. Figure 2 demonstrates the comparison of the effect of the different extract concentrations on the water vapor permeability of the prepared films. Different Latin alphabet on columns represents a significant difference at the level of .05 (p<0/05).

Oxygen permeability

A polymer membrane is composed of intertwined spiral catena. There are empty spaces and pores among the catena. Gas and other material diffuse from these pores. As it is observed in Figure 2, with the addition of the extract a significant decrease in the oxygen permeability occurred (p <0/05). That was due to extract polar phenolic compounds since the more the interactions between polar and ionic groups in the polymer, the more the oxygen inhibition and the less the oxygen permeability[8]. Kanatt et al (2012), in a study investigating polyvenyl alcohol and chitosan films with aqueous extract of mint and pomegranate peel, expressed adding the extract did not affect the permeability characteristics; however, adding chitosan, due to constructing intra-molecular hydrogen bonds with polyvinyl alcohol, restricted the fluidity of the branches and thus reduces the oxygen permeability [9]. Sothornvit (2000) reported that oxygen permeability was dependent on the fluidity of the polymeric branches (moisture content) [10]. Figure 2 demonstrates the comparison of the effect of the different extract concentrations on the oxygen permeability of the prepared films. Different Latin alphabet on columns represents a significant difference at the level of .05 (p<0/05).

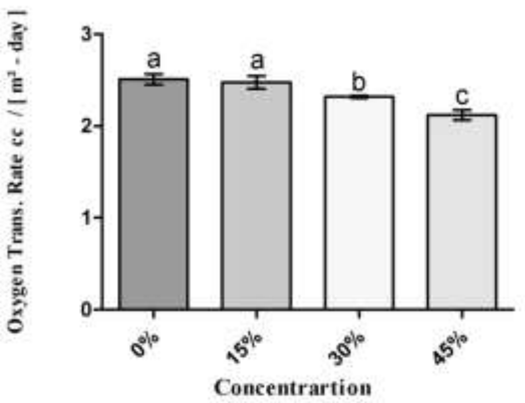

Figure 2: Effects of rosemary extract on oxygen permeability of mungbean starch.
Different letters on each column shows significant differences among means (p<0/05)

Colorimetric properties

As it is observed in colorometric chart, in parameter L, i.e., light, adding extract caused the reduction of the light, or created opacity. The controlled films with rosemary extract concentration until 30% had a significant decrease in the brightness (light); however, there was no statistically significant difference in the range of 30 to 45% concentration. Concerning axis A showing the range of red to green, the control film was 0, l was 95.16 and its color was a bright white. Adding extract increased the negative value of parameter A (the indicator of leaning towards green) and it leaned towards green and statistically all 4 groups were different at the 5% level. It means that adding extract caused the increase in green color. Regarding axis B showing the range of blue to yellow, the control film was almost 0, l was 95.16 and its color sounded white. Adding extract increased the magnitude of B+ (the indicator of leaning towards yellow) and this increase was statistically significant.

Concerning c which shows the rang of purity, adding extract increased the purity of the color. As it is seen, there are statistically significant differences among the color purity of the four films. With respect to h which demonstrates the angle of tint, adding extract caused a change in the parameter; however, the increase of extract did not changed the angle since once the color had changed. First, it was white and the addition of extract caused the creation of color from yellow to green and the color area did not changed anymore so that tint angle changed. Siripatrawan and Haret (2010) obtained similar findings. They found that the addition of green tea extract to chitosan films affected the parameters l (the brightness), a (green / red) and b (yellow/ blue)[11].

Table 1. 1: Colorimetric value of mungbean starch incorporated rosemary extract

	L*	a*	b*	C*	h
Control	95.16±0.07a*	0.04±0.02a	0.017±0.02d	1.03±0.02d	87.74±1.40b
15%	94.83±0.07a,b	-0.99±0.08b	4.02±0.16c	4.14±0.18c	103.83±0.65a
30%	93.78±93.78b	-1.85±0.11c	8.12±0.39b	8.32±0.41b	102.85±0.12a
45%	93.02±0.02b	-3.23±0.01d	14.11±0.33a	14.47±0.33a	102.91±0.26a

Table 1 shows the colorimetric parameters of the films. Data in table represent the mean ± standard deviation. Different Latin alphabet on each column represents a significant difference at the level of .05 (p<0/05). As seen in the diagram, the absorption of electromagnetic waves in the region with wavelength of 400 was at the maximum level and with the increase of wavelength the magnitude of absorption decreased.

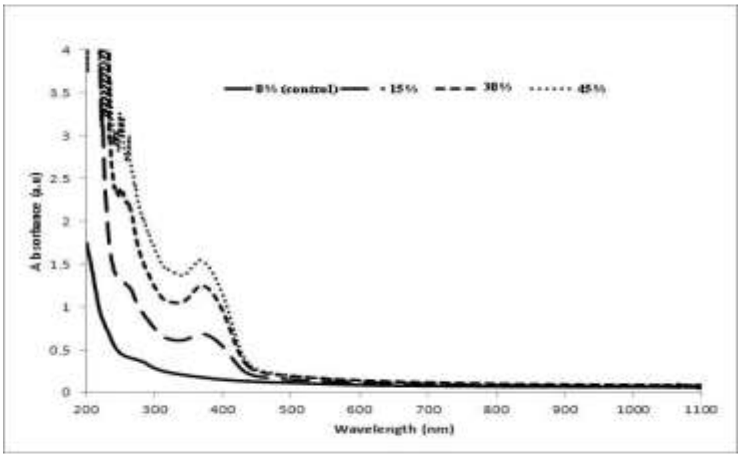

Figure 3: UV-Visible spectra of mungbean starch film incorporated rosemary extract

CONCLUSION

The addition of rosemary extract to the mungbean film caused a slight decrease in its water vapor and oxygen permeability. The added extract reduced the brightness of the film, but, at higher concentration (45%), it did not affect the parameter significantly and did not cause significant effects on the parameters of color from yellow to green. Thus, the film can be used as active packaging and provides new ways for enhancing safety and long Lasting in food systems.

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