Development of Intelligent Food Packaging with Rosa Sp Extract

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Abstract: Rosa extract containing anthocyanin was integrated into starch-chitosan based film with glycerol as a plasticizer to develop a biodegradable film with acid base dye indicator. Anthocyanin is a pH sensitive compound that changes color when exposed to different pH. The color changes varied depends on the pH. A film aliquot was prepared by mixing rose extract, starch solution, chitosan solution with glycerol. The aliquot was casted in a petri dish at 40°C for 2days. Several tests were done to determine the biological, chemical and physical properties of the film. The tensile strength of the film was found to be in the range of 4.17MPa and 5.42MPa. The film was placed at 2 different temperatures for 4 days to determine the performance of the films and the effects of the temperature towards the film.

***Keywords*: pH indicator, food packaging, rosa extract.**

I. INTRODUCTION

Currently, the food packaging exist in the industries are mostly from non-biodegradable polymers, which contribute the worldwide pollution. Tons of plastic debris were discarded every year and most of the sources of the debris come from food packaging. Approximately 30% of the plastics generated across the globe were utilized for packaging application. The used of plastic are still increasing around 12% annually [1].

To reduce plastic wastes, an alternative is taken as to replace the non-biodegradable polymer with biodegradable. Nevertheless, in the last decades, active and intelligent food packaging was introduced based on the interactions between food and its environments [2]. In this context, the concept involves integrating the active compound into packaging material to introduce active and intelligent packaging.

Intelligent refers to the ability of the packaging changing its color due to the condition of the food. Anthocyanin is one of the bio compound that is commonly integrated into the biofilm. The ability of the indicators to accept and donate proton determine the changed in the colour of the indicators [3]. Previous studies of intelligent packaging is reported in [4]-[6].

In this study, the pink purplish pigment extracted from rosa flower petals represents the existence of anthocyanin bioactive compound. The pigment was utilized as an acid-base dye indicator. The extract is then mixed with starch-chitosan base and glycerol to form a biofilm aliquot. The film performance under different temperatures and conditions were observed.

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II. METHOD

A. Materials

Rosa flower petals was purchased at a florist at Shah Alam, supply by local farmers in Cameron Highland, whereas starch powder was obtained from Merck, chitosan and glycerol anhydrous was obtained from Sigma Chemical Co.

B. Preparation of Rosa petals extract.

Rosa petals of rosa sp. was obtained from local florist in Shah Alam, Selangor. The petals were washed and rinsed with distilled water to reduce impurities and contaminants such as dirt. The petals were then torn into smaller pieces where 10mg of petals were soaked in 100ml of pure ethanol solution that undergoes sonication process for approximately 2 hours at 45 ℃. The extract were filtered and collected.

C. Preparation of starch solution

6g of Merck starch powder was added into 100ml distilled water filled beaker under continuous stirring at 85℃ and 650 rpm for 30 minutes. 1.5 ml of glycerol was added into the solution and the stirred for another 15 minutes to ensure well mixing.

D. Preparation of chitosan solution

2g of Chitosan powder obtained was added into 100ml distilled water filled beaker under continuous stirring at 65℃ and 650rpm for 24 hours.

E. Preparation of biofilm with rosa extract

To prepare the film aliquots, 10ml rosa extract was mixed starch solution, chitosan solution, and 1.5mL of glycerol. As for film casting, 20mL of aliquots was poured into each 90mm x 55mm petri dish and was dried in the oven at 40℃ for 48 hours.

F. Film thickness

The films thickness was determined with a hand-held digital micrometer which were applied at five distinct location on the film to obtain the average value [7].

G. Color measurement

Color measurement of the films were obtained using Chroma meter CR-400. The measurement of color was taken at 4 different positions on each of the film. The L*, a*, b* value which specified the film lightness, greenness/redness and blueness/yellowness respectively was documented by referring to the Fig. 1.

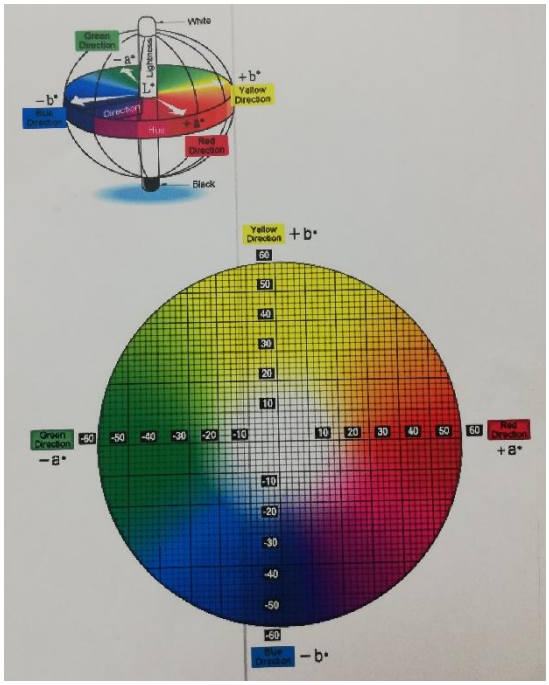


Fig. 1: L*, a* and b* value reference chart.

H. Performance analysis

The films were placed under two distinct temperatures to determine the performance of the films. One at 30 ± 2℃ and the other was placed within refrigerator temperature of 18 ± 2℃ for 2 days. Any visual changes were recorded.

I. Tensile Strength (TS) and Elongation at Break (EAB)

The tensile strength (TS) and elongation at break (EAB) of films were assessed by using Universal Testing Method (ASTM D1708-10. Preconditioned test films with a dimension of 20×60 mm^2 were used for testing. Evaluation were done by using 2.5 kN load cell with crosshead speed, 50 mm/min.

J. Functional group analysis

The presence of functional group in the extract (liquid), film aliquot (liquid) and the film (solid) itself was determined using Fourier-transform infrared spectroscopy (FTIR). The frequency range was obtained from the spectra.

III. RESULTS AND DISCUSSION

A. Film thickness

Film thickness is one of the imperative parameters that affects chemical and mechanical properties of the film. Methods and conditions set up during drying and preparation influence the thickness of the films [8]. The film thickness is relatively thin with approximately 0.01 mm for each film. The dispersion of starch and chitosan within the solution affected the thickness of the film. So, ensuring there was no precipitate within the solution is absolutely necessary. The thickness of the film did affect the mechanical properties. The range varies where thin film resulted in brittle and less flexible film and vice versa.

B. Color measurement

The result collected from the testing displayed and the color dispersion quality was within equivalent range. The color variations of the film was resulted from rosa sp. extract due to the presence of anthocyanin. From the test, the value of L*, a* and b* were determined. The values tabulated in Table I determined the colour of the film. In the L*a*b* diagram, a spherical colour solid, L* indicates lightness, and a* and b* are the chromaticity coordinates. Here the a* and b* indicate colour directions (+a* is the red direction, −a* is the green direction, +b* is the yellow direction, −b* is the blue direction). The test was conducted on three different films in which the colour exhibit on each film is on the same quadrant but with different values. The average values of L*, a*, and b* obtained for film 1 are 37.93, 1.21 and - 1.12 respectively. Values of sample 2 were 47.87, 1.47 and - 0.61 correspondingly. The values recorded from the last sample were 40.42, 1.36 and -1.01. This means, the resulting colour was nearly the same as it's look. The colour exhibit was pale pink colour which can be clearly seen when placed on the top of white surface.

Table I: Colour measurement for film in class L*, a* and b*

Film Sample	Chroma meter CR-400 (D65)		
	L*	a*	b*
1	38.08	1.19	-1.08
	37.85	1.23	-1.14
	37.87	1.21	-1.15
2	48.36	1.47	-0.57
	46.91	1.48	-0.69
	48.35	1.47	-0.56
3	41.51	1.43	-0.81
	40.17	1.34	-1.08
	39.58	1.35	-1.14

C. Performance analysis

To determine the shelf life of the sample, the sample were placed under two distinct temperatures. One at 30 ± 2°C and the other was placed within refrigerator at temperature of 18 ± 2°C for 4 days. At each temperature, two samples were placed, where one was wrapped with the film and the other was without the film. The one without the film was set to be the control sample. Any visual changes were recorded.

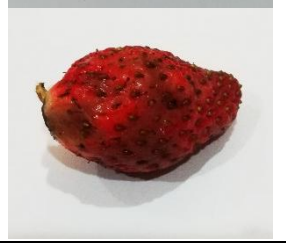
Table II shows the condition of the sample from the first to the fourth days. Through visual observation, it was obvious that the sample with the film at 18 ± 2°C was at the best condition and looked as fresh as the first day. The sample may still be consume safely. The other sample set at 30 ± 2°C was a bit shrunken and affected by the difference in temperature. In

Table III the samples without the film were bruised and shrunken. Small population of microorganism were detected and the sample was not safe to be eaten. Through these observations, it can be concluded that the presence of the film did extend the shelf life of the samples and the temperature do effect the performance of the films. The sample placed at cooler temperature stay fresh longer than at warmer temperature. The film also inhibits and delays the enzyme reaction and the growth of microorganism.

Table II: Condition of fruit sample (strawberries) of day 1 and day 4 with film at two different temperatures.

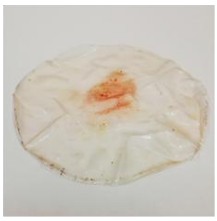
Day	Temperature	
	18 ± 2℃	30 ± 2℃
1		
4		

Table III: Condition of fruit sample (strawberries) without film for day 1 and day 4 at two different temperatures.

Day	Temperature	
	18 ± 2℃	30 ± 2℃
1		
4		

The colour of the film changed when the pH of the sample changed. The film used to wrap the sample changed its colour after 4 days. The presence of anthocyanin in the extract react to the change of pH. Table IV showed the changed in colour of the film after four days. When the condition was acidic, the film changed to a deeper pink. As the condition becomes alkaline, the colour of the film changed to brown or golden The colour changes of the film appeared to be unaffected by the temperature. This means that the pH-dye roses indicator roses are not sensitive to temperature.

Table IV: The changes in colour of the film after 4 days reacted with fruit sample.

y	Temperature	
	18 ± 2℃	30 ± 2℃
1		
4		

D. Tensile Strength (TS) and Elongation at Break (EAB)

Tensile Strength (TS) and Elongation at Break (EAB) test were necessary to determine the mechanical properties of the film. High tensile strength means the film was lacking flexibility and was prompt to be brittle. The tensile strength value for the film was between 4.17 MPa and 5.42 MPa while the elongation at break was at 16.8% to 33.7%. The values obtained from the test showed that the film was less flexible than expected and can easily tare when put under pressure. The composition ratio of compound added into the solution also affected the structure of the films. Too much starch led to a more brittle films. To reduce the brittleness of the film, the composition ratio of the film must be improved as for now the film must be handled with care. Too much rough will cause damage to the film. Fig. 2 showed the graph of stress against strain for the film tested. As the stress increases the strain also increases with time until it reaches certain point, it decreased drastically. The reading dropped as the film begins to tare.

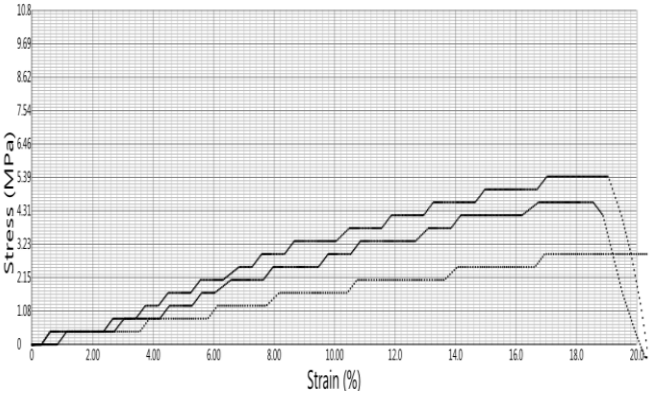


Fig. 2: Graph of stress (MPa) against strain (%) of the film.

Table V The mechanical strength of the film.

Films	Tensile Strength (MPa)	Elongation at break (%)
1	4.58	16.8
2	5.42	17.1
3	4.17	33.7

Functional group analysis

The functional group presence in Table VI was determined based on infra-red characteristic absorption frequencies. In Fig. 3 (a), for rose extract, the most prominent peak shown was the presence of O-H bond which is the presence of anthocyanin within the extract as anthocyanin mostly composed of alcohol [9]. Another prominent bond was the presence of the C=C bond within variable strength. Fig. 3 (b) and (c) shown that the addition of starch, chitosan and glycerol with the extract to form the aliquots revealed new prominent peaks composed of alkyl halide bonds which originated from C-Br and C-F.

Table VI Characteristic IR absorption frequencies of organic functional groups [10].

Functional Group	Characteristic absorption	Intensity
Alcohol		
O-H	3200 – 3600	Strong, broad
O-H	3500 – 3700	Strong, sharp
C-H	1050 – 1150	Strong
Alkane		
C-H	2850 – 3000	Strong
-C-H	1350 – 1480	Variable
Alkene		
=C-H	3010 – 3100	Medium
=C-H	675 – 1000	Strong
C=C	1620 – 1680	Variable
Alkyl halide		
C-F	1000 – 1400	Strong
C-Cl	600 – 800	Strong
C-Br	500 – 600	Strong
C-I	500	Strong
Alkyne		
C-H	3300	Strong, Sharp
C=C	2100 – 2260	Variable
Amine		
N-H	3300 – 3500	Medium
C-N	1080 – 1360	Medium, weak
N-H	1600	Medium
Aromatic		
C-H	3000 – 3100	Medium
C=C	1400 – 1600	Medium-weak
Carbonyl		
C=O	1670 – 1820	Strong
Ether		
C-O	1000 – 1300 1070 – 1150	Strong
Nitrile		
C-N	2210 – 2260	Medium
Nitro		
N-O	1515 – 1560 1345 – 1385	Strong

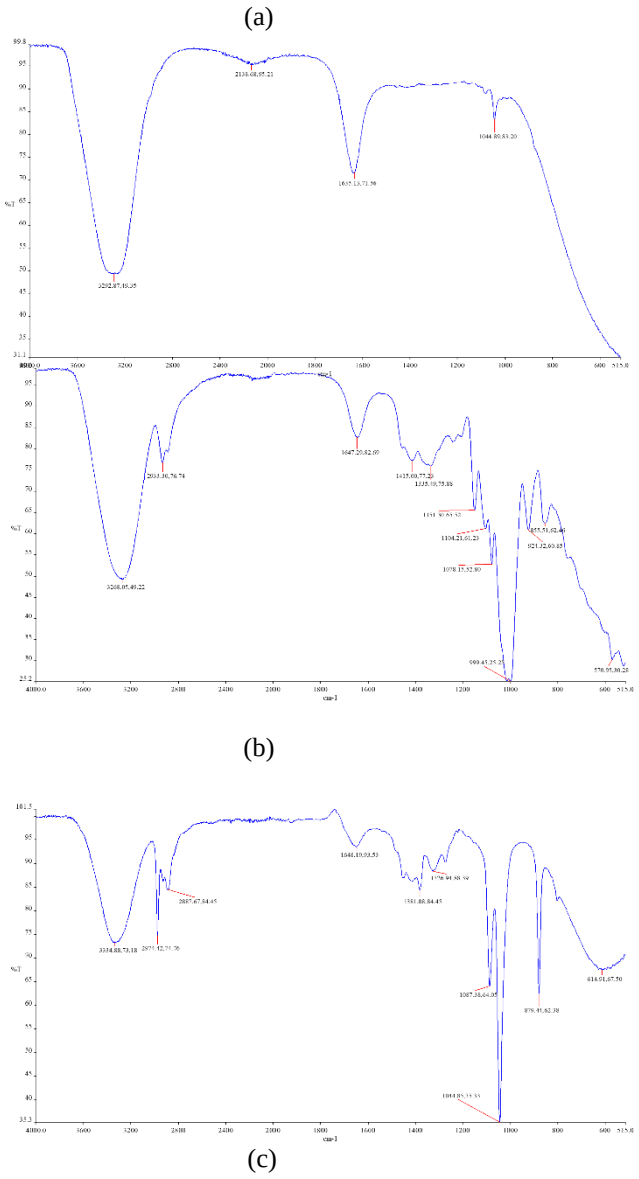


Fig.3: Spectra of (a) rosa sp. Extract, (b) film aliquot and (c) film.

IV. CONCLUSION

In conclusion, rose extract can be used as pH sensitive indicator in food film packaging with correct concentration. It can also delay the growth of microorganisms and extends the shelf life of food samples. Further studies are needed to improve the mechanical properties of the film. From the result, temperature is the main parameter, this indicates by having better film performance at lower temperature condition.

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