International Journal of Current Science, Engineering & Technology
ISSN : 2581-4311
Original Research Article | Open Access | AMCT 2017 Malaysia | *Special Issue*

Effects of Anthocyanin Pigment from Purple Cabbage in Food Packaging

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ABSTRACT. In developing countries, food spoilage and increase in pollution of solid waste, especially from food packaging. Basically, this problem does not only affect the damaging to human being, but also towards environment. Purple cabbage that contain high amount of anthocyanin can be utilized in food packaging production as it bring unlimited number of economic and environmental benefits to the industrial of food. The purposes of this research are to extract anthocyanin pigment in purple cabbage and to study the effect of anthocyanin in food packaging towards storage condition, food product and mechanical properties. Two different types of solvents were used to compare the amount of anthocyanin extracted. Fourier transform infrared (FTIR) and UV-vis region spectra showed compatibility of anthocyanin in plastic film matrix. Based on the effect on food sample, the pH indicator film showed color changes from purple to pink, whereas for the effect of storage; when temperature increases, the physical properties of deteriorates. Overall, pH indicator films that contain anthocyanin from purple cabbage extract has high potential to be used as one of the material in food packaging in order to detect food spoilage since they have reliable response to pH and temperature.

Keywords: *Anthocyanin, Extraction, Food packaging, Purple cabbage;*

Received: 15.10.2017; Revised: 15.12.2017; Accepted: 30.02.2018, and Online: 20.03.2018;

DOI: *10.30967/ijcrset.1.S1.2018.13-18*

Selection and/or Peer-review under responsibility of Advanced Materials Characterization Techniques (AMCT 2017), Malaysia.

1. INTRODUCTION

At present time, food packaging becomes the major concern within the consumer because the function of food packaging itself must act as a protector towards food products. As growth of technology increase, the changes in consumer preferences and demand for safe and high quality food products also increases. This situation leads to innovative developments and improvement of packaging materials. Food packaging is often used as marketing tool to differentiate a product and the materials used must be in environmental considerations [1]. For example, the packaging itself does not produce any adverse effect on the quality of the product through chemical reactions, leaching of packaging materials or absorption. The important factor that should be considered is low in cost, ease of fabrication, availability and regulatory acceptance of the materials.

In this research, purple cabbage extract had been chosen as natural sources that will added during food packaging production. This cabbage contain very low in saturated fat, cholesterol and a source of thiamin but providing large amounts of anthocyanin and giving high antioxidant properties that can decrease the risk of cardiovascular diseases, brain disorders and cancer [2].

2. MATERIALS AND METHODS

Potato starch powder and purple cabbage were bought at the Giant supermarket, Seksyen 7, Shah Alam. This potato starch powder comes from local product which contain 315 kcal energy, 79.0 gm carbohydrate, 0.05 gm protein and 0.05 gm total fat per 100 gm. Extraction of purple cabbage was divided based on two different solvents which was hundred percent distilled water and a mixture of ethanol-distilled water with ratio one to one. For the extraction using distilled water, purple cabbage was cut into small size and boiled using hot plate. The ratio of purple cabbage and distilled water is 1:2. After the solution was boiled, the solution was cooled down for a few min before filter using muslin cloth into scotch bottle. Then, the scotch bottle was wrapped with aluminium foil to avoid the colour diminish before stored in chiller with 4-5 °C.

Same goes when extracting using a mixture of ethanol-distilled water. The molarity used for ethanol was 40% that was diluted with distilled water from 95% molarity that available in laboratory. For extraction process, the ratio used was 1:1. Purple cabbage was cut into small in size and blend using a blender. This process cannot be boiled to avoid ethanol being vaporize since its boiling point is lower than water which is around 78 °C compared to water 100 °C. The solution was filtered using muslin cloth, wraped with aluminium foil to avoid the colour diminish and stored in chiller with 4-5 °C.

2.1 Preparation of film as food packaging.

The procedure was started by preparing the water bath method. 250 ml of extract solution was pour into a beaker and heat until 40 °C. Then, 7.5 g of potato starch powder was added into the solution for about 10 min for starch to dissolve. After that, the temperature was increased up to 80-95 °C to ensure the starch solution gelatinize completely. Next, 1.93 ml glycerol was added which act as plasticizer to the plastic film. After 10 min, the solution was cooled down and 20 ml solution was poured into each of petri dish. Finally, all the petri dish were put into the oven with temperature 35 °C for 24 hours.

2.2 Fourier transform infrared (FTIR) spectroscopy.

FTIR analysis was carried out using a Perkin Elmer with model Spectrum One. FT-IR spectra of pH indicator films (with and without purple cabbage extract) were measured between 4000 and 515 cm^{-1} wave number range.

2.3 Colour response analysis of pH indicator films on Strawberry Fruit.

The colour changes of food packaging will be observed with different temperature. The temperature were varied from cold temperature (4 °C), room temperature (25 °C) and warm temperature (60 °C).

2.4 UV-vis Spectroscopy of pH indicator film.

UV-vis spectra of plastic films (with and without purple cabbage extract) were measured using a Perkin Elmer UV-vis spectrophotometer (Shelton, CT 06484, USA) with model 750 lambda. The spectra of pH indicator films in pH values of 6 to 7 were measured in the range of 400 to 700 nm after the pH films were undergo analysis on food sample. A standard curve of anthocyanin extract was used to compare and confirm the incorporation of purple cabbage extract into those pH indicator films.

3 RESULTS AND DISCUSSION

3.1 Fourier transforms infrared (FTIR) spectroscopy.

Fig. 1 shows a few of peaks in absorbance wavenumbers spectrum range from 4000 cm^{-1} to 515 cm^{-1}. From the result obtained, all samples have broad absorption range between 3200 cm^{-1} and 3400 cm^{-1} showed the chemical has intermolecular hydrogen bond (H-bond) which is stretching vibration of free, inter and intra-molecule. Almost all the samples have sharp absorption between 1600 cm^{-1} and 1650 cm^{-1}, shows that C=C stretching vibration was conjugate.

By comparing both curves, curve that used ethanol as solvent has deformation of alkane group and there was C-O-C stretching vibration of ester acetates. This deformation will help in plastic film production. While, curve that used distilled water do not have much deformation of alkane. Another difference between those curves is at wavelength 1217.25 nm from ethanol curve. At this peak, there is anthocyanin which is flavonoid, under phenolic compound. In organic chemistry, sometimes phenolic also called phenol. It is a class of chemical compounds consisting of a hydroxyl group bonded directly to an aromatic hydrocarbon group. Basically, this anthocyanin plays an important role to colour the purple cabbage.

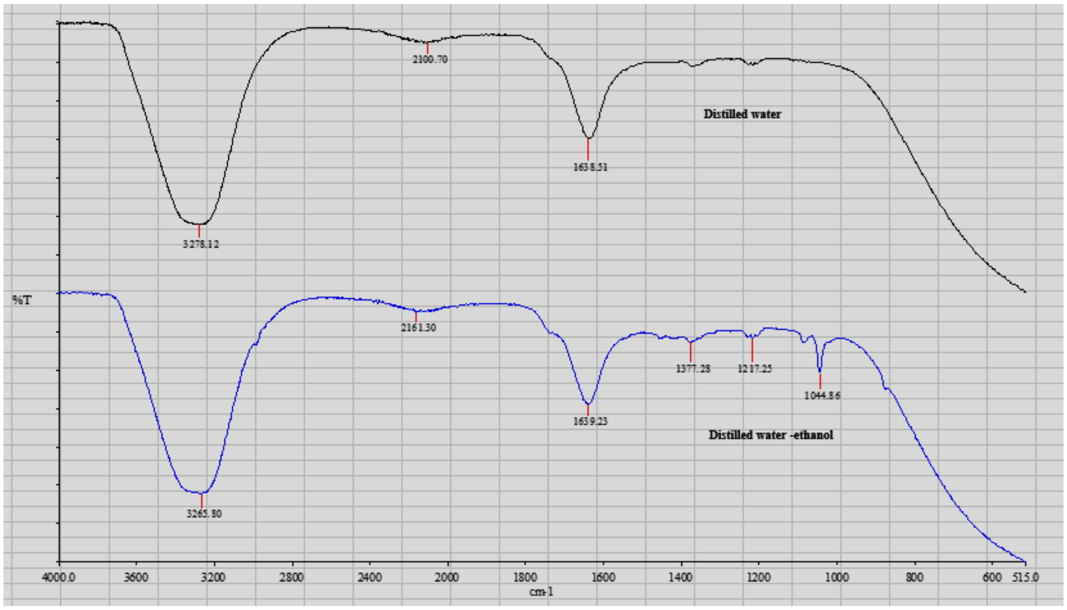


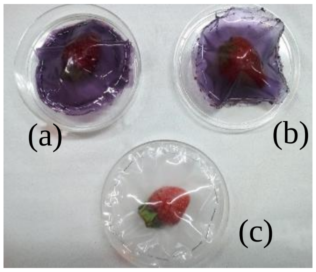
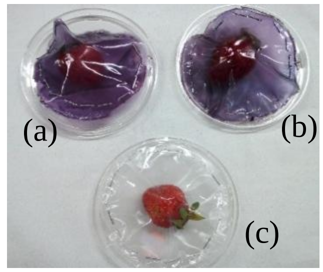
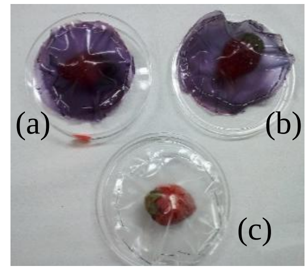
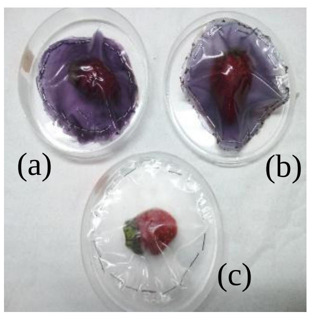
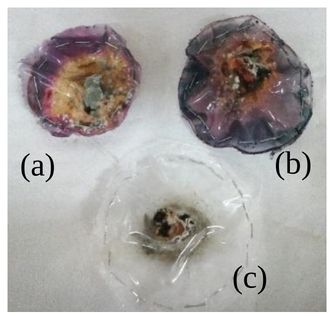
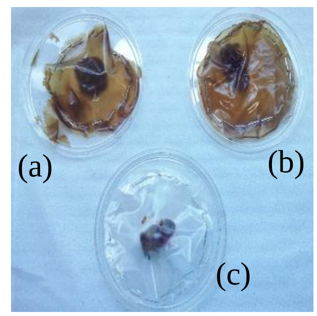
Fig. 1 Graph of FTIR on extraction of purple cabbage solution with two different type of solvents

3.2 Colour response analysis of pH indicator films on strawberry fruit.

Anthocyanin that comes from extract purple cabbage can also act as pH indicator to food packaging technology. In other words, this food packaging not only biodegradable, edible but also can help consumers during product selections. The analysis was carried out by wrapping a strawberry as food sample using different type of solvent with different storage temperature. The result and observations of the analysis was tabulated in the Table 1 below. The pH of all packaging in this analysis are around 6, while the pH of purple cabbage is around 6 to 7.5. Strawberries are acidic and the pH for ripe strawberries are around 3.3 to 3.6 [3]. Packaging that contain purple cabbage extract is said will change its original colour based on the pH of materials. If the materials is in neutral state, the colour is purple and if the materials in alkali state, its colour is blue and for the strongest alkali is green. Lastly, if the element is in acid state, the colour is pink and for the strongest acid is red. Purple cabbage can be used as a pH indicator because it turns red in acid and blue in basic solutions [4].

From this table, once the strawberries get spoilt, the packaging that contain extract of purple cabbage turns colour from purple to pink-purple. It can be conclude that extraction of anthocyanin from purple cabbage is one of the important material that can be used in food packaging. This is because anthocyanin play an important role to detect the spoilage of food. But not for packaging without extraction of anthocyanin. Even though the strawberry inside that food packaging get spoilt, the colour of packaging is still in good condition. That is mean anthocyanin can help consumers to notify the spoilage of food sample. The changes in colour of the pH indicator film is a good diagnostic tool in order to detect the food safety and quality [4].

Table 1 Result of plastic film as food packaging. (a) plastic film with purple cabbage extract using distilled water-ethanol as solvent, (b) plastic film with purple cabbage extract using distilled water as solvent, (c) plastic film without purple cabbage extract

Time (day)	Storage temperature		
	Cold (4 °C)	Room (25 °C)	Hot (60 °C)
1			
	○ The strawberry is in fresh and good condition for all temperature. ○ The colour of plastic films are in neutral colour, where (a) and (b) is purple colour and (c) is colourless. ○ The purple colour of (a) is darker compare to (b), means that more anthocyanin extract contain inside that film.		
5			
	○ The strawberry is fresh and good condition. ○ The colour of plastic films are in neutral colour, where (a) and (b) is purple colour and (c) is colourless.	○ More molds produced on the fruit sample. ○ The colour changes in (a) is higher compare to (b).	○ Strawberry totally dry and brown in colour. ○ Plastic film (a) and (b) turn dark brown while plastic film (c) still in original colour.

Besides, as temperature increase, the appearance of packaging changed. As we can see, at the end of the experiment which is at day 5, the packaging in the cold storage still in a good condition. Those packaging is still in their original colour and the texture of those packaging is still soft and glossy in appearance. Compared to packaging in hot storage, the colour of all of the three packaging changed from purple to brown. This changes occurred might be cause by denaturing of protein in purple cabbage. Besides that, the texture of those packaging changed which is turned hard and rough due to high temperature applied to those packaging. Thus, it shows that the optimum storage temperature for package strawberry is in cold storage.

3.3 UV-vis Spectroscopy of pH Indicator Film.

The pigment in purple cabbage comes from a group of compounds called anthocyanin, which is an antioxidant behavior of their phenolic groups. Anthocyanins are important antioxidant where part of a larger group of flavonoids structures. The pigment that come from these anthocyanins are responsible to colour the plant for example red, purple, blue and so on. The colour changes of films with purple cabbage extract were tested in order to verify the use of the extract as a pH indicator dye. Fig. 2 shows a graph of UV-vis spectra of pH indicator films with and without purple cabbage extract after performing analysis on strawberry as a food sample in cold storage condition which is in their optimum storage condition.

The colour concentration in that mixture is proportionally to its absorbance at that wavelength it absorb light [4]. From the result obtained, at wavelength 554 nm, the absorption peak for plastic film with anthocyanin extract using distilled water-ethanol as their solvent and plastic film with anthocyanin extract that using distilled water as their solvent is 0.9111 and 0.9549 respectively. Meanwhile at wavelength 569 nm, the absorption peak for plastic film with anthocyanin extract that using distilled water-ethanol as their solvent and plastic film with anthocyanin extract that using distilled water as their solvent is 0.8748 and 0.9549 respectively.

The different of absorption peak between those two types of pH indicator films is due to the different in pH of that film. Plastic film with anthocyanin extract that using distilled water-ethanol as their solvent has pH 6.1 while plastic film with anthocyanin extract that using distilled water as their solvent has pH 6.5. After that plastic films being analysis on food sample, plastic film that contain ethanol in its solvent change colour to pink more quickly than the other plastic. That is why its pH is low and its absorption peak is lower compare to packaging that do not contain ethanol as solvent.

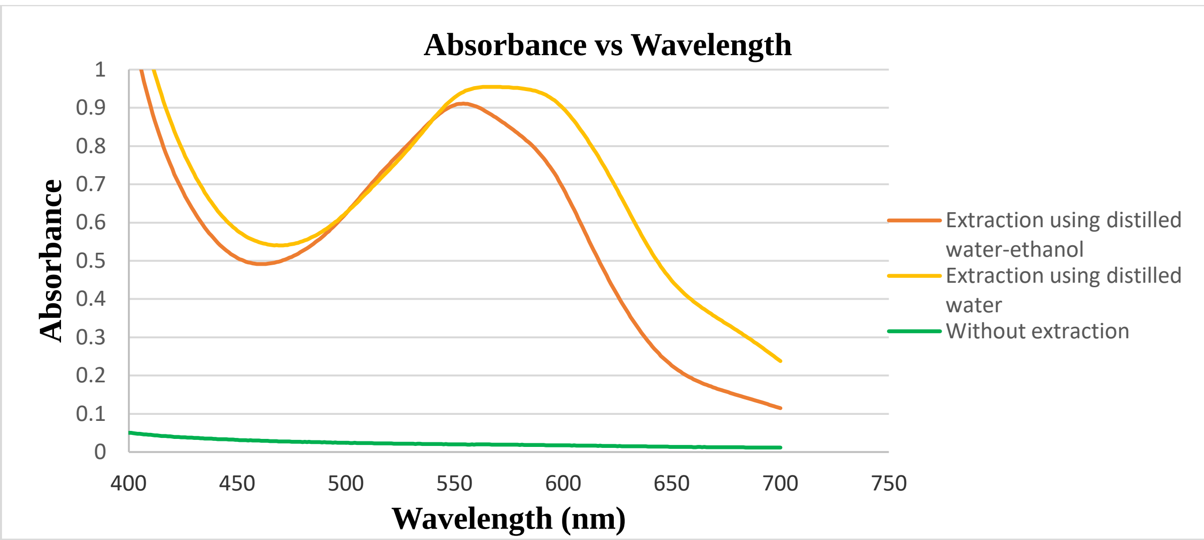


Fig. 2 UV-vis spectra of pH indicator films with and without purple cabbage extract

4 SUMMARY

Film with high light absorbance could be an excellent barrier to prevent light-induced lipid oxidation and it is useful to be applied in food technology [5]. Overall, plastic film with purple cabbage extract had a high potential which can be used in pH sensitive dye due to its sensitivity to color variations where the colour had change from purple to pink as a result of pH changes. From the UV-vis spectra above, we can see that pH indicator films which contain purple cabbage extract have a strong absorption peak in the UV-vis region. Whereas film without purple cabbage extract do not have absorption peaks in the UV-vis spectrum. This variation happened because of the presence of anthocyanin from those extractions. A conclusion can be made which is purple cabbage extract was incorporated into agar and starch films.

ACKNOWLEDGEMENT

Support for this research was provided by a grant(RAGS/1/2014/TK05/UITM/4) from the Ministry of Higher Education of Malaysia. The author would like to expresss her gratitude towards Universiti Teknologi MARA and to all who may contribute directly or indirectly towards making this research successful.

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