Jurnal
Teknologi

Full Paper

Development of Purple Sweet Potato Starch Base Biodegradable Film

Article history
Received
3 December 2014
Received in revised form
19 October 2015
Accepted
19 October 2015

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Abstract

An antioxidant edible film based on purple sweet potato (PSP) starch plasticized with glycerol and incorporated with antioxidant sources (anthocyanin and Butylated Hydroxy anisole (BHA) has been developed. PSP consists of high anthocyanin content due to its bright purple color. The anthocyanin believes to become a carrier for antioxidant agent and also act as a natural colorant in food meanwhile BHA were a synthetic antioxidant additives which mainly used in food. PSP film was prepared by casting method. PSP starch blending with anthocyanin extract (89.04 ± 1.70 %) shows higher DPPH scavenging activity compared to sweet potato (SP) starch blending with BHA solution (74.83 ± 1.73 %). PSP with anthocyanin extract is more effective as antioxidant edible film due to higher antioxidant activity compare to mixture of SP with BHA.

Keywords: Biodegradable film, Purple sweet potato, Antioxidant, Anthocyanin, BHA, pH indicator

Abstrak

Sejenis filem antioksidan yang boleh dimakan telah terhasil menggunakan kanji ubi keledek ungu (PSP) yang digabungkan bersama gliserol sebagai bahan pemplastik. Larutan tersebut turut dicampurkan bersama sumber antioksidan yang berlainan iaitu antosianin dan Butylated Hydroxy anisol (BHA). Warna keungu-unguan PSP telah menyimpan kandungan antosianin yang tinggi. Antosianin dipercayai menjadi agen pembawa antioksidan dan juga bertindak sebagai bahan pewarna asli di dalam makanan manakala BHA merupakan bahan antiosidan sintetik yang sering digunakan di dalam makanan. Filem PSP telah dihasilkan menggunakan kaedah pengeringan piring petri. Campuran PSP bersama ekstrak antosianin (89.04 ± 1.70%) menunjukkan aktiviti memerangkap DPPH yang lebih tinggi berbanding kanji ubi keledek (SP) yang dicampur bersama BHA (74.83 ± 1.73%). PSP dengan ekstrak antosianin terbukti lebih efektif sebagai filem yang mempunyai aktiviti antioksidan yang lebih tinggi berbanding dengan campuran SP bersama BHA.

Kata kunci: Filem Bio-degradasi, Ubi keledek ungu, Antioksidan, Antosianin, BHA, indicator pH

1.0 INTRODUCTION

In the last few years, the new materials for biodegradable polymers in films and plastic industries have been developed as the alternatives and solutions due to environmental concern and problem posed by non-degradable synthetic polymers [1]. Biofilms such as starch film can decrease the environmental pollution and enhance properties to the packaged food industry. Starch film has a great potential to reduce waste, package complexity and cost of packaging [16]. In additions to the biodegradability, the films can be consumed along with food, provides additional nutrients, enhanced sensory characteristics and may include antioxidants properties [2]. Purple sweet potato (PSP) starch has been shown to have the ability to form edible or biodegradable films [3]. Purple sweet potato is unique from other type of tubers since it consists of high anthocyanin content and bright purple in colour for useful marker or indicator.

Anthocyanins are water-soluble vacuoles that may appear red, blue or purple depends on its pH [4] as shown in Figure 1. With the natural purple colour properties, it can be used as colorants in food, cosmetics, medicals, drinks and packaging. Hence, we can reduce the usage of synthetic colorants in food industry to have safer consumption and plus, intake of nutrition as well. In addition, several studies prove that anthocyanin is the source of antioxidant agent [2][5].

Figure 1 Color changes of purple sweet potato anthocyanin at different pH values [14]

Nowadays, food industry were using Butylated Hydroxyanisole (BHA) as an additive to add antioxidant agent into their food such as butter, meat, baked goods and beer to prevent or slowing the oxidative rancidity. Instead of foods, BHA was also included into film for antioxidant purposes [6]. The presence of BHA or mixture of 2-*tert*-Butyl-4-hydroxyanisole and 3-*tert*-butyl-4-hydroxyanisole in food industries for antioxidant replacement gives competition to natural antioxidant sources in the market. Even though BHA has undergone the additive application required by the US Food and Drug Administration, the production of BHA which uses various chemicals may implicate in health such as tumorigenicity or carcinogenicity [17]. Therefore, the function of anthocyanin extract as the source of antioxidant agent in foods may reduce the bad implication brought by synthetic antioxidants.

In this study, a biodegradable film with glycerol and anthocyanin or BHA, as sources of antioxidant, incorporated into a purple sweet potato starch and sweet potato starch matrix respectively. The comparison, formulation and antioxidant activity of the films were evaluated.

2.0 EXPERIMENTAL

2.1 Materials

Purple sweet potato (Vietnamese culture) and sweet potato (Japanese culture) flour was purchased from local store at Taman Universiti, Johor, food grade glycerol purchased from Merck KGaA, Darmstadt, Germany and butylated hydroxyanisole (BHA) donated by CEPP, Universiti Teknologi Malaysia were used as raw materials in this study.

2.2 Starch Extraction Preparation

Original starches from purple sweet potato were extracted using 1:1 w/v upon distilled water [7]. The solution was then filtered using muslin cloth and the filtrate were centrifuged. Decant solvent while whitish sediments were obtained and left to dry in oven at 45°C overnight. Commercial sweet potato starch from Japanese culture (white flesh) were mixed with ratio 1:1 w/v to 10 mg/L butylated hydroxyanisole (BHA) solution and left to dry in oven at 45°C overnight. Both the dried starches were stored at 4°C before used.

2.3 Film Preparation

The biodegradable film base suspension (100 ml) was prepared with 7.0 g of purple sweet potato starch and 3.8 ml glycerol. The formulation were stirred constantly using magnetic stirrer. The starch were let to gelatinize in distilled water at approximately 70°C, followed by addition of glycerol and continuously stirred for 5-10 min to reach 80°C. The films were cast thoroughly onto a 25 cm x 25 cm plate and let cool at room temperature before dry in convection oven at 60°C overnight. The dried film were manually peeled off and stored in airtight container at room temperature. Sweet potato starch incorporated with BHA also using the same method for film preparation as PSP starch.

2.4 Antioxidant Activity of Film

Antioxidant activity were done using 2,2-diphenyl-1-picrylhydrazyl DPPH colorimetric analysis method based on Brand-Williams *et al*., (1995) [13] with slight modification. The film (10 mg) was dissolved and diluted in 10 ml absolute ethanol. 1 ml from the diluted solution was eluted and transfered to another tube with 5 ml of DPPH in 0.004% ethanol. The concentration of anthocyanin present in the sample considered as 1.0 mg/ml. The sample was left incubate in dark for 30 min at room temperature. The samples were measured at 517 nm using UV-Vis spectrophotometer (Lambda 25, Perkin Elmer, USA) using ethanol as a blank control. Daniele *et al*., (2012)[8] stated the calculation for antioxidant content using UV-Vis measurements in eq (3).

$$\text{Percentage of Antioxidant: } (A_0 - A_s) / (A_0 - A_i) \qquad (3)$$

where A_0 is the absorbance at 517 nm of the DPPH solution without antioxidant, A_s is the absorbance of the sample and A_i is the absorbance of the solution when 100% of DPPH is reduced. The test was being done triplicate for each batch (n = 3).

2.5 Analysis

The means which statistically different from each other from triplicate sample for antioxidant activity test were compared using Duncan's comparison tests at 5% confidence level of $p < 0.05$. SPSS (version 16.0) software was used to perform the statistically analyses.

3.0 RESULTS AND DISCUSSION

The resultant for PSP starch extraction were 11.8% from total weight of PSP. According to Braet *et al*, [15] the total starch from purple sweet potato were in the range of 11.1 to 33.5%. The film produced from both PSP starch and SP starches were homogeneous, smooth and translucent as shown in Figure 2. The films were compared based on their antioxidant activity in the film.

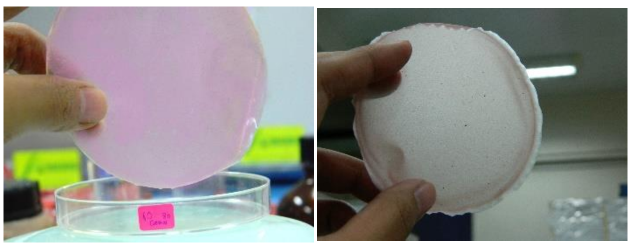

Figure 2 (a) Film from PSP and (b) Film from SP added with BHA

3.1 Antioxidant Activity of Film

The antioxidant of film determination using DPPH analysis were compared between the purple sweet potato film which incorporated with anthocyanin extract and Japanese sweet potato (white flesh) which incorporated with BHA. The antioxidant activities were calculated as total DPPH scavenging activity (%). Figure 3 shows white fleshed sweet potato incorporated with BHA had a slightly lower antioxidant activity with a value of 74.83 ± 1.73%.

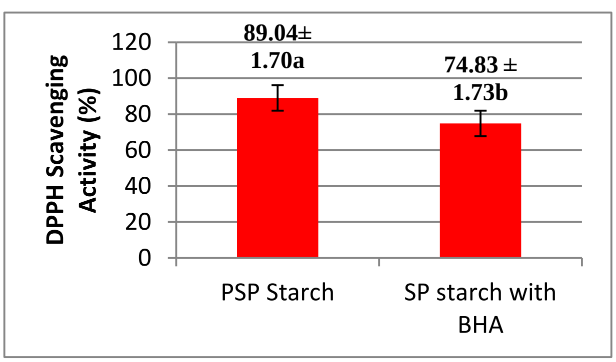

Figure 3 Comparison of DPPH Scavenging Activity between purple sweet potato incorporated with natural anthocyanin extract and white flesh sweet potato incorporated with BHA. Values are mean ± standard deviation (n=3) and a and b represent significant difference at 5% level of significance

Based on Figure 3, PSP starch incorporated with natural anthocyanin extract consist of higher antioxidant content (89.04 ± 1.70%) compare to white flesh sweet potato incorporated with BHA. Comparison between the same volume of solution (distilled water and BHA solution) which incorporated into different type of starch (purple sweet potato starch and white flesh sweet potato starch) shows different amount of antioxidant activity. The concentration of 1.0 mg/ml of anthocyanin in the film shows higher DPPH scavenging activity compare to 10 mg/L of BHA solution used in the film. BHA solution with 10 mg/L concentration usually been used as additives in food processing to prevent deterioration due to oxidation process [6]. However, the use of BHA in food can led to serious safety concerns [9].

Higher concentration of anthocyanin retained in the PSP flour shows higher in antioxidant percentage. According to Peng *et al*., (2013)[9], the DPPH radical scavenging activity of anthocyanin in purple sweet potato flour showed approximately 54.30% of antioxidant activity for 0.3 mg/ml. However, based on research by Cho *et al*., (2003)[10], 300 µg/ml concentration of PSP anthocyanin showed more than 90% DPPH radical scavenging activity. The DPPH reading are varies depending on different method of DPPH analysis where the results of antioxidant activity from PSP film shows a total of 89.04 ± 1.70 % from 1.0 mg/ml concentration of anthocyanin. Therefore, further research regarding purple sweet potato anthocyanin as antioxidant agent additives in food should be done due to its condition which cannot withstand environmental factors [12].

4.0 CONCLUSION

The PSP starch based films have shown the ability as an antioxidant film. The results indicated that natural anthocyanin (1.0 mg/ml) presents in purple sweet potato consists higher in antioxidant activity compare to BHA (10 mg/L) incorporated in white flesh sweet potato. Synthetic antioxidant agent may be reduced with the utilization of natural antioxidant in films. Further studies regarding the evaluation for type of product to be packed by the starch film materials should be researched.

Acknowledgement

This work was financially supported by Department Of Higher Education Ministry Of Education Malaysia by giving FRGS with vot number R.J130000.7809.4F343. The authors thank Universiti Teknologi Malaysia for supporting this research.

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