Changes of Films with Anthocyanin as an Indicator of Chicken Nugget Deterioration during Storage

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***Abstract*— An indicator can be defined as a substance which indicates the presence or absence of another substance or the degree of a certain reaction through characteristic changes. Therefore, the aim of this research is to evaluate the changes of a films with anthocyanin as an indicator of chicken nugget deterioration during storage. A film made of cassava starch, glycerol, and anthocyanin was prepared using the casting technique. Chicken nugget samples were put in packaging containing an anthocyanin film and stored at 25°C. The lightness (L*), redness (a*) and yellowness (b*) of films were analyzed for a 28 day- period. Colour changes were also identified in film. Chicken nuggets samples were analyzed of moisture content, pH, and water activity (aw). Changes in moisture content, pH, and aw of samples was observed over the storage period as result of chicken nugget deterioration. However, the storage period was it possible to establish a correlation between change of colour, pH and aw with chicken nugget deterioration.**

Keywords— **Films, indicator, anthocyanins, chicken nugget, deterioration**

I. INTRODUCTION

The development of packaging technology is smart packaging, which is currently being developed where packaging is able to monitor the condition of packaged food and provide information on the quality of the food in the container during transport and storage. The Smart packaging system is able of indicating inform about a change occurred in a product, such as temperature and pH by means of visual changes (Realini et al., 2014).

The study of smart packaging in the form of biodegradable film with a color indicator to identification of deterioration of product such as using grape and spinach extract (anthocyanin and chlorophyll) as the color indicator to detect deterioration of fish fillet during storage period (Hasnedi, 2009). Indicators are a subtances that indicate the presence, absence or concentration of another substance, or the degree of reaction between two or more substances by means of a characteristics change, especially in color (Hogan, et al., 2008).

The development of indicators in smart packaging using natural pigment from vegetable source, anthocyanins have great potential as indicators in smart packaging system. These flavonoids are widely spread in nature comprising the largest group of water-soluble plant pigments, and they have been isolated mainly from flowers and fruits (Silva, et al., 2012). Color of anthocyanin is strongly influenced by its structure, pH, co-pigmentation, temperature, UV radiation, and presence of oxygen providing different colors that range from salmon-pink through red and violet to nearly black. This color instability of anthocyanins makes these pigments especially useful to monitor food quality and therefore can be used as an indicator of food spoilage in intelligent packaging system (Golasz, et al., 2012).

Golasz, L.B, Silva, J. and Silva, S.B (2012) developed a biodegradable film as packaging material based on the anthocyanin extracted from grape skin incorporation into cassava starch matrixs as indicator of the deterioration of chilled pork. The aim of this study to evaluate the performance of a bio-based film made cassava starch, glycerol, and anthocyanin extract from purple sweet potato as indicator of deterioration of chicken nuggets during storage 25^{o}C. For 28 days, film and chicken nuggets deterioration was assessed by color change analysis, moisture content and pH value.

II. MATERIALS AND METHODS

2.1 Materials

Anthocyanin extracted from purple sweet potato, cassava starch and glycerol were used as raw materials to prepare the films. Chicken meat, flour, batter, breadcrumbs and spices were used as raw materials to prepare the nuggets used in this study.

2.2 Film preparation

Films were prepared from a filmogenic suspension of cassava starch, glycerol, and anthocyanin extracted from purple sweet potato (45:45:30) using the casting technique. The film formula was developed by Silva et al. (2011), Film-forming suspension was obtained under slow and constant stirring up to 75 °C for 30 min of starch gelatinization. Afterwards, the film was cast into glass plate were dried under vacuum oven at 50 °C for 9 hours, followed by storage at controlled conditions (22^{o}C ± 2^{o}C) for 48 hours.

2.3 Chicken nugget preparation

Food-grade flour and seasonings (garlic powder, salt and black pepper) were weighed and added to the formulations. They were hydrated with water and thoroughly mixed with ground chicken meat in a mixer equipped with a flat beater and operated at a low speed for 2 min. The chicken mixture was transferred to steam machine at 90°C for 30 min. The chicken nugget was weighed to provide individual nuggets pieces (25±1g per piece), shaped into discs about 1.5 cm thick, add batter and breadcrumbs.

2.4 Analysis.

2.4.1 Moisture content

The moisture content was determined according to standard procedures (AOAC, 2000).

2.4.2 pH

The pH analysis was performed using a pH meter with a penetration electrode meter (Delta OHM, Australia), which was inserted in the solution of samples.

2.4.3 Colour analysis

Lightness *L**, redness *a** and yellowness *b** (CIE, 1978) colours of film samples were evaluated on a *Spectophotometer ColorFlex EZ* (*HunterLab Inc.*: Reston, VA) was standardized with a white colour standard.

2.5 Statistical methods

Data obtained from all the analysis were analysed by using One-Way Analysis of Variance (ANOVA) and followed by Duncan Multiple range test of statistical package for social science version 15.0 (SPSS Inc., Chicago, Illinois, U.S.A). Statistical significance was indicated at 95% confidence level.

III. RESULTS AND DISCUSSIONS

The moisture content is one of the most important parameters in food as it relates to the quality and shelf life of products, the water content in food ingredients also determines the freshness of foods (Winarno, 2004). The moisture content plays a role in influencing the level of freshness, stability, durability, chemical reaction, enzyme activity and microbial growth (Kusnandar, 2010).

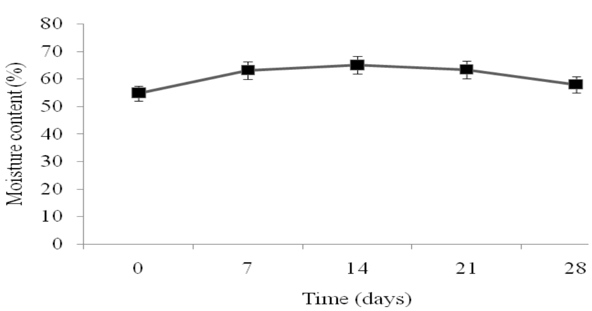

Figure 1. Moisture content of chicken nugget with film indicator

Moisture content chicken nuggets obtained during 28 days of storage in a variety of different storage period range between 54.76 - 65-01%. Figure 1 shows a comparison function of storage time on the water content of chicken nuggets. Damage caused to the product nuggets stored at freezing temperatures allegedly due to the risk of loss of product water (dehydration) and the occurrence of rancidity of the product due to fat oxidation reaction. Dehydration can be prevented by using the product packaging that has good ability in freezing temperatures with good protection properties against water vapor. At temperatures below 0°C, the water will freeze and form ice separate from the solution are similar in terms of water evaporated drying or a drop in temperature. Food products, chemical changes during freezing and cold storage can be kept to a minimum, then the quality of frozen foods can be maintained in the long term (Eddy, 1989). Therefore, nuggets in freezer temperatures have a good lasting power during storage and it is still suitable for consumption.

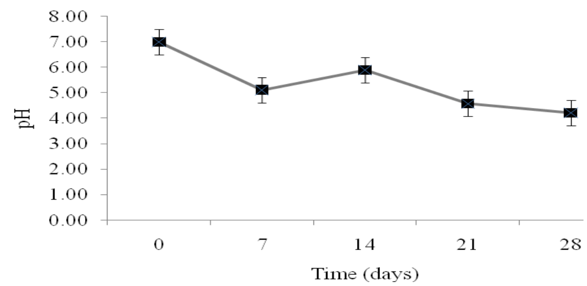

Figure 2. pH value of chicken nugget with film indicator

The pH used to monitor the shelf life of meat (Muela, E. 2010). The pH value of chicken nuggets is strongly influenced by the long treatment of storage time of the chicken nuggets. The results pH value of chicken nuggets was stored at freezer for 28 days ranged from 4.21-7.00.

From the analysis storage period factor give significant effect on the pH value. This is in accordance with the opinion of Lawrie (1995) which states that the pH of the meat can be affected by storage time. During storage, endogenous and microbial enzymes degrade protein meat and produce ammonia and amines, which increase the pH (Jay, 2000). Buckle et al., (1987) stated that the accumulation of lactic acid will stop after muscle glycogen reserves become depleted or after conditions are achieved, namely pH low enough to stop the enzymes - glycolytic enzymes in the process of anaerobic glycolysis. While the increase in pH is usually caused by a more open structure of the filament - filament miofibrilar causing a growing number of incoming water and it also supports an increase in water holding capacity (Soeparno, 1998).

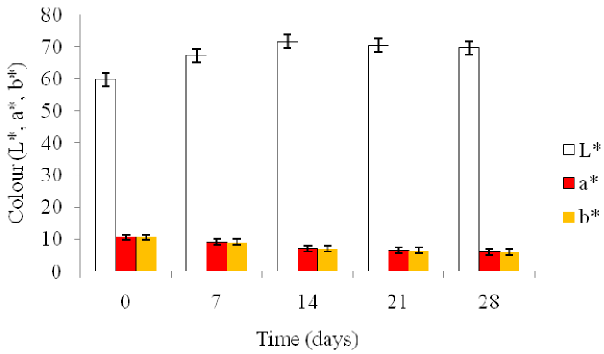

Figure 3. Color parameters (L*, a*, b*, h_{ab} , ΔE) of film indicator during storage at -5°C

Color plays an important role in the films as an indicator of chicken nuget deterioration where the color changes useful to monitor food quality and therefore can be used as an indicator of food spoilage during storage in smart packaging systems. The color analysis using a *HunterLab ColorFlex EZ Spectrophotometer*, there are 3 notation (L *, a * and b *) where the third notation is used to identify the signs of color changes that occur in the films during storage. L* indicates of lightness which has a value range from 0 to 100, where 0 indicates a dark color (black), while 100 indicates a light color (white), a* (+) is redness which ranged from 0 to 60, if a* (-) values indicate green color ranges from 0 to -60, and b* as a yellowness, if the value of b * positive value indicates color yellow that ranged from 0 to 60, if the value is negative b* indicates blue color that ranges from 0 to -60. °Hue is a term used for the classification of red, yellow, blue and others. Color analysis are shown in Figure 3.

Based on Figure 3, *L**, a*, b* changes during storage. In the beginning, the indicator film color was initially light red. After twenty eight days of frozen storage, it was observed visible change in the film indicator color. The films lost color intensity progressively and became Lightness (*L** increase), showing a more yellowish color. At day 28th, the higher value for parameter *L** was verified, indicating that at films tends to be lighter than other. The redness (a*) and yellowness (b*) values varied indicating that the films color changed significantly during storage. A higher value of the parameter a* at day zero indicates the color tendency to red, confirming that once applied in the films matrix the natural color changing pigment still keeps its property of becoming more pink during 28 days storage. Between day zero and 28th day, a significant increase in yellowness value (b*) was also observed.

IV. CONCLUSION

The developed film with anthocyanin extracted from purple sweet potato was able to detect changes in the chicken nugget during storage period through changes in the film color, moisture content and pH.

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