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# Identification of Beef Freshness Using Smart Labels Based On Anthocyanin Extract of Purple Cabbage (*Brassica Oleracea Var. Capitata* L.)

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***Abstract*— Technological developments ensure food quality and food safety when the Covid-19 pandemic in innovation and application develop rapidly. This is related to food safety which prioritizes body health. Beef is a source of animal protein that is needed to complete nutritional needs to maintain body health and immunity. Beef is a food material that is susceptible to damage due to microbiological and chemical activities. In general, people can only assess the quality and freshness of beef by conducting a sensory evaluation, namely the visual, smell, and texture processes. Sensory evaluations tend to be subjective in nature which is accepted by human reason. It is very ineffective to be used as the same parameter by everyone. Moreover, in support of new habit patterns, there must be renewable technology that can help to reduce direct contact between people being marketed. So we need indicators that can answer the freshness of local beef which is more practical and can facilitate all levels of society. The smart label based on purple cabbage anthocyanin can be a product that helps people see the freshness of beef very easily. Several previous studies have stated that anthocyanins in fruits and vegetables can be a natural indicator that can harm the volatile gases present in meat during the storage process. Purple cabbage (*Brassica oleracea var. capitata* L.) is known to have a very high anthocyanin content. Besides that, the color density produced by purple cabbage makes it possible to support smart labels. In this study, the extraction of purple cabbage anthocyanin by maceration method used two different types of solvents, namely 96% methanol acidified with 1% HCl and 95% ethanol which was acidified with 3% Citric Acid so that the best total content of purple cabbage anthocyanin was 87,324 mg / 100g with a pH of 5.4. Smart labels are made into edible films with a mixture of chitosan, polyvinyl alcohol, and CMC. The parameters of the freshness level of the meat are based on the pH and Total Microbial tests on beef. From these parameters, changes in smart labels are avoided so that it can change changes in the quality of meat in packaging. Fresh beef has a pH ranging from 6.7 - 7.2 then will experience a decrease in pH to 5.4 - 5.5 (ultimate pH of beef) and then beef tends to increase in pH (spoilage process). In this pH range, it can be divided into three types of groups of smart label indicator color change which results in grouping data on meat products, namely fresh, still fresh, and not fresh.**

***Keywords—Freshness, Beef, Purple Cabbage, Anthocyanin, Smart labels.***

## I. INTRODUCTION

Technology in ensuring food quality and food safety is developing rapidly and rapidly. This is related to the demands of an increasingly advanced era. Previously, many cases occurred in the world related to food safety such as poisoning with infected meat and other food poisoning cases [1]. After that, great attention was paid to the issue of food safety around the world, because every year many people suffer from food poisoning [2]. Meat consists of very complex chemical compounds which mainly consist of water, protein, and fat (Nychas, et al, 2008). Beef is one of the livestock commodities which is a mainstay of animal protein sources and is very supportive of meeting the basic needs of foodstuffs in Indonesia. This demand-side dynamics causes national food demand to increase rapidly, both in quantity, quality, and diversity [3].

In general, people in determining the quality of beef circulating in the market tend to use sensory evaluation, namely visual identification through color changes, smell, and texture. This results in subjective assessments so that there are no specific measurable reference parameters in determining the quality of beef [4]. Quality degradation is closely related to microorganisms and chemical activity. The activity of microorganisms in beef produces volatile amine components which make the pH of beef change. The pH of fresh beef after 1 hour of slaughter ranges from 6.7 - 7.2 then the pH will decrease to 5.4 - 5.5 and after the glycogen reserves run out, the pH of the meat tends to increase again with the length of storage of beef. This phase of increasing the pH of beef is what causes the quality of beef to become poor so that it is not suitable for consumption [5]. Also, chemical activity in the form of meat protein decomposition results in changes in the chemical composition of meat such as the presence of volatile amines, formaldehyde, and others [6]. Determination of the quality of beef can be measured in determining specific parameters of meat quality by paying attention to the damage process that occurs, the activities that occur can be controlled by using an indicator that can provide a result of changes during the meat storage process.

The packaging of meat plays an important role in preventing or reducing damage by microorganisms, maintaining meat quality and physical disturbances, and extending the shelf life of beef. Along with the development of packaging technology, the freshness of the quality of food ingredients can be done with intelligent packaging. Smart packaging is packaging that can regularly monitor food conditions, detect and communicate the state and quality of a product [7].

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Intelligent packaging can be implemented with a smart label indicator which functions to provide information through visual changes (color) based on pH. PH indicators are widely used to monitor and indicate the freshness of food in storage because the spoilage process is usually marked by a change in pH. The use of natural dyes as indicators sensitive to changes in pH is currently being developed. Anthocyanins are natural dyes that are organic in nature so they can experience a color change from red (acidic atmosphere) to blue (alkaline atmosphere). At high pH, anthocyanins tend to be unstable and produce a blue or colorless color because the hydroxy (OH-) group is more dominant than the methoxy (H +) group in the anthocyanidin structure, while at low pH anthocyanins tend to be stable and produce a red color due to the methoxy (H +) group. , is more dominant than the hydroxy groups in the anthocyanidin (OH-) structure [8]. One of the plants containing anthocyanins is purple cabbage with the largest anthocyanin content compared to other food ingredients, namely 1111-1780 mg / 100 g dry matter and 109-185 mg / 100 g fresh ingredients [9]. Purple cabbage anthocyanin compounds can change color along with changes in pH so they are suitable for use as pH indicators on smart labels. Some of the reasons for using purple cabbage as a pH indicator to ensure consumer food safety because it comes from natural ingredients, affordable prices, easy to find, and easy extraction techniques. Therefore, a simple, inexpensive, highly efficient, and effective method is needed to evaluate the quality of meat, especially in field applications, such as home, supermarket, and shop settings. Where consumers can directly detect the freshness of the meat. An alternative method to meet this need is the development of smart packaging

## II. METHOD

This research has been running for 3 months starting in January 2020 until now with the required tools and materials, namely knives, scissors, cutting boards, basins, blenders, aluminum foil, 41 Whatman paper, 500 ml measuring cups, green pumps, 5 ml volume pipettes. and 10 ml, micropipette, beaker glass, Erlenmeyer 250 ml, test tube, test tube rack, petri dish, analytical balance, spectrophotometer, hotplate, and stirrer, colony counter, ATC brand hand pH meter, autoclave, incubator, oven, laminator, polytron brand showcase, Blue Tip pipette, Conway cup, printer, Image J software, and Research Material Storage Container Box, premium beef tenderloin / has in / deep scrub (100 grams/pack) purchased at "RPH Kaliwates Jember, purple cabbage, sterile distilled water, 95% ethanol, boric acid, acetylacetone, glacial acetic acid, formalin, methyl red, methyl blue, bromocresol purple, 96% methanol, 1% HCl, NaCl, Buffer solution, agar medium ( PCA / Plate Count Agar brand), paper filter, Whatman paper no. 1, Styrofoam, aluminum foil, tissue, label paper, PP testing plastic boxes, and plastic wrap as intelligent packaging for beef.

### A. Purple Cabbage Anthocyanin Extract

a. pH test

PH measurements are measured using a hand pH meter. Before using the hand pH meter, it was calibrated with buffer solutions 4 and 7. 10 ml of samples were taken and then put into a 50 ml beaker glass, then dipped the hand pH meter and made observations [10].

b. Total Anthocyanin Level Test

Measurement of total anthocyanin levels from natural dyes in liquid form was carried out using the pH differential method. Two test tubes were prepared, the first test tube was inserted with 2 mL of pH 1 potassium chloride buffer, then the second test tube was added with 2 mL of sodium acetate buffer pH 4.5. Each test tube was added with a sample to determine the anthocyanin level of 0.5 mL and let stand for 15 minutes. The absorbance measurements of the two pH treatments were measured using a spectrophotometer at wavelengths of 520 and 700 nm [11]. The absorbance value is calculated by the following equation:

$$A = [(A520 - A700)pH1 - (A520 - A700)pH4{,}5]$$

Total Anthocyanin Level = ((A x BM x FP x 1000))/(ε x1)

Information:
A : Absorbance
Mr : Molaritas (449,2)
FP : The dilution factor
$\varepsilon$ : Molar extension (26900 Lcm-1)

### B. Testing of Beef Freshness Parameters

a. Beef pH test

The pH test is measured using a hand pH meter. Before using the hand pH meter, it was calibrated with buffer solutions 4 and 7. The crushed beef sample was taken as much as 1 gram, put in 10 mL of distilled water in the test tube then homogenized with vortex, then transfer the sample into a 50 ml beaker glass and dip the hand pH meter. then make observations [12].

b. Total Plate Count Test / Total microbial test (TPC)

The equipment to be used in the total microbial analysis (tpc) must be sterile. the initial step is to prepare the sample, namely by weighing 25 grams of beef then adding 225 ml of sterile 0.85% physiological salt solution in a 250 ml erlenmeyer then homogenizing it, this is a solution with a 10-1 dilution. then the test method is carried out by taking 1 ml of the 10-1 dilution suspension with a sterile micropipette into 9 ml of sterile 0.85% physiological saline solution to obtain a 10-2 dilution.

Then make 10-3, 10-4, 10-5, and so on in the same way as needed. Next, put 1 ml of the suspension from each dilution into the petri dish Duplo. Then add 15-20 ml of sterile PCA media to each cup containing the suspension. For the suspension and sterile PCA media to be evenly mixed, it is necessary to rotate the plate back and forth or form a figure eight and leave it until it solidifies. After solidifying, incubate it in an incubator with a temperature of 34ºC - 36ºC for 24 hours by placing the plate in an upside-down position. After incubation, the calculation of the number of colonies is carried out with equation as follows National Standardization Agency (SNI 2897: 2008) [13]:

$$TPC = \text{Total Colony in cup } x1/(\text{The dilution Factor})$$

C. *Smart Label Feasibility Testing*

a. Smart Label Color Intensity Test

The color intensity of the smart label color of the purple cabbage anthocyanin extract from the freshness of the beef was measured using Image J software to determine the mean RGB (Red, Green, Blue) value. Image capture is done by scanning using a printer scanner, then the scan results are applied to Image J software and the mean RGB value is determined.

b. Smart Label Paper Durability Test

The smart label paper used is Whatman cellulose paper no.1 because it is made of cellulose so that it has very tight pores and the filtering speed is slow. The slow filtering speed is due to the Whatman No. paper. 1 can hold fine particles. Filtering speed will affect the paper thickness and paper durability [14].The endurance test of smart label paper is carried out by immersing the smart label in distilled water for 0 hours, 12 hours, 24 hours, 36 hours, and 48 hours. After soaking, then drying using the oven for 30 minutes at a temperature of 105ºC. After that, the weight loss is calculated on the smart label.

$$\text{Weight Loss} = (\text{initial weights - paper weight to-n})/(\text{initial paper weight}) \times 100\%$$

D. *Data Analysis*

Data Analysis using descriptive method research. Observation data are in the form of tables and graphs to facilitate data interpretation. Observations at room temperature (27ºC ± 3ºC) of beef were observed from the 0th hour then every 2 hours to the 12th and then every 4 hours from the 12th hour to the 24th hour. Observation at cold temperature (5ºC ± 3ºC) beef was observed every day until the 6th day. The data resulting from changes to the smart label are then taken and analyzed using Image J to obtain the mean RGB value. Data resulting from changes in beef freshness were observed and measured to obtain the mean / average value that was accessible. The resulting data will then be grouped into 3 categories, namely: fresh, still fresh, and not fresh. After obtaining the data, the calculation of the standard deviation (SD) of the observed data is then calculated. Standard deviation serves to measure all data deviations resulting from the average value [14]. The standard deviation can be calculated by the following formula:

$$SD = \sqrt{((\Sigma |Xd-\bar{X}d|)\text{^}2/(n-1))}$$

Information:
SD : standard deviation
X : average count
N : the amount of data

## III. RESULT

A. pH and Levels of Purple Cabbage Anthocyanins

In testing the anthocyanin extract of purple cabbage, testing was carried out based on the value of the degree of acidity and anthocyanin levels. The value of the degree of acidity or pH was carried out using a Hand pH meter and anthocyanin levels of purple cabbage using absorbance value detection with a spectrophotometer.

| No | Treatment | Type Repeat | pH | Anthocyanin Levels (mg / 100 gr) |
|---|---|---|---|---|
| 1 | P1 (A1 = Etanol 95% + 3% Asam Sitrat, B1 = Suhu Tinggi (±45˚C)) | 1 | 5.2 | 73,109 |
| | | 2 | 5.5 | 72,563 |
| 2 | P2 (A2 = 96% methanol + 1% HCl, B1 = High temperature (± 45˚C)) | 1 | 5.7 | 71,821 |
| | | 2 | 5.2 | 70,556 |
| 3 | P3 (A1 = 95% Ethanol + 3% Citric Acid, B2 = Room Temperature (± 27˚C)) | 1 | 4.8 | 65,036 |
| | | 2 | 5.1 | 66,203 |
| 4 | P4 (A2 = 96% methanol + HCl1%, B2 = room temperature (± 27˚C)) | 1 | 5.5 | 63,702 |
| | | 2 | 5.6 | 64,272 |

Based on the results of these data, the best comparison has been obtained in the extraction process, namely using ethanol at high temperatures. This shows that the solvent is crucial in the extraction process to get the expected anthocyanin levels. According to Phaza [16], the higher the ethanol concentration, the lower the polarity of the solvent used, which in turn can increase the ability of the solvent to extract the pigments expected in purple cabbage.

B. Test RGB Value

Detection of RGB values is done by scanning and then reading the mean red, green, and blue data on smart labels that have been immobilized by the best purple cabbage anthocyanins. The reading is done using Image J software.

| Type Repeat | Mean RGB | | | Picture |
|---|---|---|---|---|
| | *Mean Red* | *Mean Green* | *Mean Blue* | |
| 1 | 127,305 | 101,589 | 125,318 |  |
| 2 | 158,924 | 124,630 | 144,153 |  |
| Average | 143,114 | 113,109 | 134,735 | |

Based on the table above, it can be identified that the mean read value is the highest in the three categories in RGB. The higher the mean value, the more dominant the level of concentration in an image identified by Image J Software. This, too, is supported by Kusumah [17] that the colors that appear in the RGB color model are produced from mixing the three components of the primary color of light, namely red, green and blue where the result of each value will affect the colors that appear.

C. *Smart Label Sensitivity to pH*

The smart label sensitivity test to various pH conditions is carried out by testing the smart label with a pH solution. This is done to know the significance of the color change process that occurs on the smart label for various pH conditions.

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Figure 1. Smart label sensitivity test

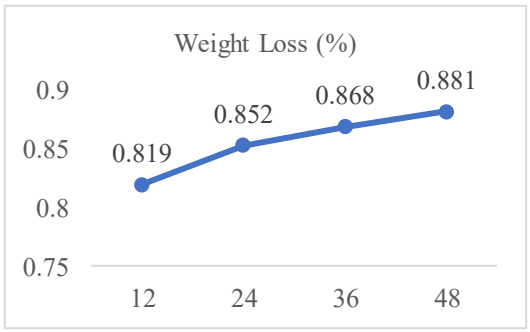
Based on the picture above, it can be identified that the color change on the label when treated in a pH atmosphere shows a variety of colors. This shows that smart labels contain anthocyanins which are relatively easy to detect pH by bringing up different pH colors.

D. *Smart Label Durability Test*

The smart label durability test is carried out to determine the data on the results of a long time that the smart label lasts until it breaks. Whatman paper no.1 is the material used to make smart labels. This smart label paper strength parameter can be seen from the paperweight loss value.

| Treatment | 0-hour | 12th hour | 24th hour | 36th-hour | 48th hour |
|---|---|---|---|---|---|
| Weight Loss 1 (%) | 0,786 | 0,813 | 0, 838 | 0,852 | 0,870 |
| Weight Loss 2 (%) | 0,791 | 0,826 | 0, 867 | 0,884 | 0,892 |

The treatment process in testing the durability of smart labels is carried out by soaking the smart labels based on the length of soaking time, then the labels are dried using an oven at a temperature of $105^0$ C. So that the average weight loss results are obtained in the graph below




Based on the graphic image of the weight loss data above, the smart label is immersed in aqua dest for 12 hours to produce a weight loss value of 0.819%, at 24 hours it produces a weight loss of 0.852%, at 36 hours produces a weight loss of 0.868% and at 48 hours produces a weight loss value of 0.868%. 0.881%. This shows that the longer the immersion is carried out, the weight loss value increases. This is by following Hurriyah's [18] statement that weight loss will increase along with storage. The high weight loss can be indicated due to the loss of water content in the smart label which can cause the smart label paper to have poor resistance.

## IV. CONCLUSION

Based on research, which is still ongoing, the data that have been obtained have reflected that anthocyanins are very likely to be used as a detection indicator based on a pH atmosphere. This allows success in detecting the freshness of the beef. Based on the data parameters, the smart label feasibility has a fairly good resistance due to the high weight loss.

## REFERENCES

[1] Wang, L. X., Li, Q. W., Liu, J. F., & Yang, X. K. "Application of risk analysis in management of agro-product quality safety". Chinese Agricultural Science Bulletin. 22 (1) 85-87. 2006.

[2] Sonneveld, K. “What drives (food) packaging innovation? Packaging Technology and Science ”, 2000. 13 (1): 29-35

[3] Gunawan, Lia. "Comparative Analysis of the Physical Quality of Imported Beef and Local Beef". Journal of Hospitality and Service Management. 1 (1): 22-26. 2013.

[4] Merthayasa *et al*. Merthayasa, J. S., I. K. Suada, & K. K. Agustina. 2015. "Water binding capacity, pH, color, smell and texture of Bali beef and Wagyu beef". Indonesia Medicus Veterinus 4 (1): 16-24. 2015.

[5] Soeparno. Meat Science and Technology. Second edition. Yogyakarta. Gadjah Mada University Press, 2015.

[6] Wu, T.H & Bechtel, P.J. Salmon by-product storage and oil extraction. Food Chemistry, 111, 868-871. 2008.

[7] Primapack, 2011 Primapack. Smart Packaging (Active and Intelligent Packaging). Packaging Science & Applied Technique Packaging Bulletin. Primapack Company. 2011.

[8] Ananta R., Samuel B.W., Harjono. "Films Based on Purple Sweet Potato Anthocyanin Extract as Bioindicator of Damage to Chicken Meat". Indonesian Journal of Chemical Science 6 (1): 84 -90. 2017.

[9] Ahmadiani, N., Robbins, R.J., Collins, T.M., & Giusti, M. M. "Anthocyanins Contents, Profiles, and Color Characteristics of Red Cabbage Extracts from Different Cultivar and Maturity Stages". Journal of Agricultural and Food Chemistry 6 (2): 7524 –753, 2014

[10] Suradi, K. "The Effect of Storage Time at Room Temperature on Changes in pH, TVB and Total Bacteria of Buffalo Meat." Journal of Animal Science 12 (2): 9-1, 2012.

[11] AOAC. "Total Monomeric Anthocyanin Pigment Content of Fruit Juice, Beverages, Natural Colorants and Wines pH Differential Method". 2005.

[12] Kurniawan, N.P., Septinova, D., Adhianto, K. "Physical Quality of Beef from Slaughterhouses in Bandar Lampung." Integrated Animal Husbandry Scientific Journal 2 (3): 133 - 137.2014.

[13] National Standardization Agency (SNI 2897: 2008) Testing Methods for Microbial Contamination in Meat, Eggs and Milk, and Their Processed Products. National Standardization Agency. Accessed from: http://standarpangan.pom.go.id/dokumen/peraturan/2016/PerKa_BPOM_No_16_Tahun_2016_tentang_Kriteria_Mikrobiologi_dalam_Pangan_Olahan.pdf. 2008.

[14] Marliana, Herci. Optimization of Reagents (Schryver) to Become Indicator Paper for Formalin Identification in Food Samples. Faculty of Mathematics and Natural Sciences, University of Indonesia, Depok [Thesis], 2008.

[15] Budiarto, E. "Biostatistics for Medicine and Public Health." Jakarta: Medical Book Publisher Egc. 2001.

[16] Phaza, *et al*. Effect of Ethanol Concentration, Temperature and Number of Stage on Batch Extraction of Ginger (Zingiber Officinale Rose). Semarang: Final Project of Chemical Engineering UNDIP. 2010.

[17] Kusuma R.B., Enis K, Siti M., Anjang B.P., Kamaluddin M. Digital Image Analysis as a Color Characterization and Quantification Method in Ornamental Fish. Journal of Ris. Aquaculture 6 (3): 381-392, 2011.

[18] Hurriyah (2017) Hurriyah R.A.R.Z., Bambang K., Dwi K.P. Development of Bromphenol Blue and Bromtimol Blue on Smart Label Dragon Fruit Maturity Sensor. E-Journal of Health Literature 5 (3): 406 412, 2017.