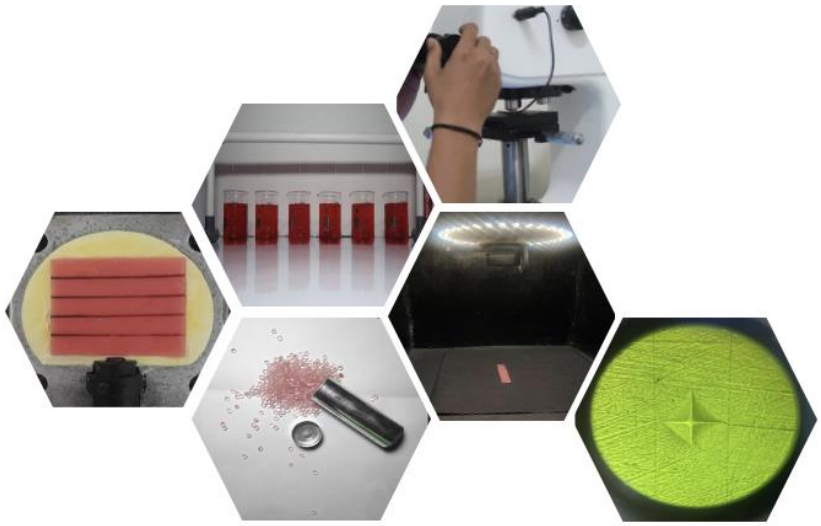
THE EFFECTS OF ENERGY DRINK ON COLOR STABILITY AND HARDNESS OF THERMOPLASTIC NYLON PLATE
(Laboratory Experimental Research)



MUHAMMAD DAFFA GHANIALGHIFFARY DAUD

J011211124

DENTAL EDUCATION

FACULTY OF DENTISTRY

HASANUDDIN UNIVERSITY

MAKASSAR

2024

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Thesis

As one of the requirement to achieve a bachelor's degree of Dentistry program

DEPARTMENT OF PROSTHODONTICS

FACULTY OF DENITSTRY

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Thesis,

Has been defended before the undergraduate Dental Education Examination Committee and declared to have fulfilled the graduation requirements on

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APPRECIATION REMARKS

The research that I conducted was successfully implemented and this thesis was completed thanks to the guidance and graciousness as well as mercifulness of Allah SWT as I could have the ability to complete this research and thesis and be in this state of condition.

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Writer,

Muhammad Daffa Ghanialghiffary Daud

ABSTRACT

EFFECT OF ENERGY DRINK ON COLOR STABILITY AND HARDNESS OF THERMOPLASTIC NYLON RESIN PLATE

Muhammad Daffa Ghanialghiffary Daud, Acing Habibie Mude

Background: Removable dentures function to replace teeth that are not in the mouth that can be removed or used by the wearer. These denture materials can be made from metal frames, acrylic resins, and thermoplastic nylon. Currently, the use of thermoplastic nylon is widely used in the field of dentistry. The color stability of resin plates is affected by factors such as exposure to coffee, tea, and energy drinks. **Objective:** This study aims to analyze the effect of energy drink as an immersion material on the color stability and surface hardness of thermoplastic nylon plates. **Methods:** In this study, four immersion groups were used consisting of: Aquades, Krating daeng, Kukubima Energ, and Extrajoss. Hardness and color stability checks were carried out before and after immersion for 12 days. The data was then analyzed using the Anova test and sampled Paired T test. **Results:** the hardness of thermoplastic nylon resin decreased significantly after immersion, with Aquades retaining the highest post-immersion hardness (4.96 HV) and energy drinks such as Kukubima Energ showing the most significant decrease to 4.36 HV. The study found that thermoplastic nylon resins underwent changes in color stability after immersion, with Krating Daeng showing the most significant changes, while Aquades had the highest Delta E L*A*B value (66.31) and Kukubima Energ had the lowest value (12.07). **Conclusion:** based on the results of the study, there were significant effects and differences on immersion in Energy Drinks: Krating Daeng, Kukubima Energ, Extrajoss on the hardness of thermoplastic nylon resin plates There were significant effects and differences of immersion on Energy Drinks: Krating Daeng, Kukubima Energ, Extrajoss on the color stability of the surface of thermoplastic nylon resin plates.

Keywords: Removable dentures, Energy Drinks, thermoplastic Nylon Resin, color stability, hardness

ABSTRAK

PENGARUH MINUMAN ENERGI TERHADAP STABILITAS WARNA DAN KEKERASAN PLAT RESIN NILON TERMOPLASTIK

Muhammad Daffa Ghanialghiffary Daud, Acing Habibie Mude

Latar Belakang*: Gigi tiruan lepasan berfungsi untuk menggantikan gigi yang tidak ada di dalam mulut yang dapat di lepasa pasang oleh pemakainya. Bahan gigi tiruan ini dapat berupa kerangka logam, resin akrilik, dan nilon termoplastik. Saat ini penggunaan nilon termoplastik banyak digunakan dalam bidang kedokteran gigi. Stabilitas warna plat resin dipengaruhi oleh faktor-faktor seperti paparan kopi, teh, dan minuman berenergi.****Tujuan:*** *Penelitian ini bertujuan untuk menganalisis pengaruh Minuman energi sebagai bahan perendam terhadap stabilitas warna dan kekerasan permukaan plat nilon Termoplastik.* ***Metode:*** *Pada penelitian ini menggunakan empat kelompok perendaman yang terdiri dari: Aquades, Kratingdaeng, kukubima energi, dan extrajoss. Dilakukan pemeriksaan kekerasan dan juga stabilitas warna sebelum dan setelah perendaman sellama 12 hari. Data kemudian dianalisis dengan menggunakan uj Anova dan Sampled paired T test* ***Hasil:*** *kekerasan resin nilon termoplastik menurun secara signifikan setelah perendaman,dengan Aquades mempertahankan kekerasan pasca-perendaman tertinggi (4,96 HV) danminuman berenergi seperti Kukubima Energi menunjukkan penurunan paling signifikan hingga 4,36 HV. Penelitian ini menemukan bahwa resin nilon termoplastik mengalami perubahan stabilitas warna setelah perendaman, dengan Krating Daeng menunjukkan perubahan paling signifikan, sementara Aquades memiliki nilai Delta E L*A*B tertinggi (66,31) dan Kukubima Energi memiliki nilai terendah (12,07).* ***Kesimpulan:*** *berdasarkan hasil penelitian Terdapat pengaruh dan perbedaan yang bermakna pada perendaman dalam Minuman Energi: Krating Daeng, Kukubima Energi, Extrajoss terhadap kekerasan plat resin nilon termoplastikTerdapat pengaruh dan perbedaan yang bermakna pada perendam pada perendaman dalam Minuman Energi: Krating Daeng, Kukubima Energi, Extrajoss terhadap stabiitas warna permukaan plat resin nilon termoplastik.*

Kata kunci*: Gigi tiruan lepasan, minuman energi, resin nilon termoplastik, stabilitas warna, kekerasan*

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CHAPTER I
INTRODUCTION

1.1 Background

Dentures are special medical devices that is prescribed by a dentist and made by professional dental technicians to replace the hard and soft tissue structures in the oral cavity.[1] Dentures have two types, namely fixed dentures that cannot be removed and removable dentures that can be removed.[2] Removable dentures are devices that replace part of the missing dental arch and can be removed from the patient's mouth.[2] While fixed dentures are dentures that can be installed by cementing, screwing or attaching to the remaining natural teeth or roots. In addition, dentures have two types of dentures, namely full dentures or commonly called full dentures and partial dentures or commonly called partial dentures. Full dentures are devices used to replace all parts of the edentulous dental arch.[3] While partial dentures are devices that only replace part of the edentulous dental arch.

Dentures have two types, namely removable dentures and non-removable dentures or fixed dentures.[3] Removable dentures are devices that replace part of the missing dental arch and can be removed from the patient's mouth. While fixed dentures are dentures that can be installed by cementing, screwing or attaching to the remaining natural teeth or roots. Dentures can be classified by the type of denture base used, namely dentures that use metal frames and dentures using acrylic frames. However, dentures that use metal frames have disadvantages, namely the appearance of the grip that is less aesthetic and stiffer, making patients often complain of irritation in the tissue area of the grip, and the rate of fracture is higher due to poor support for the clasps and metal frames. (PMMA) Polymethylmethacrylate also has several disadvantages, namely having a high level of porosity, high water absorption.[4]

In addition to acrylic resin bases and metal denture bases, there is a thermoplastic nylon resin base known as "Flexi denture" which is an abbreviation of flexible denture. Flexi denture is another alternative to avoid complaints obtained in dentures that have metal framework materials and acrylic resin. Flexi denture is a denture made of thermoplastic nylon, in the market itself there are several thermoplastic nylon resin products available such as Valplast, Flexiplast, Flexite, Flexite plus, Sunflex, Leucitone FRS, Thermosens, Ultimate.[4] Thermoplastic nylon dentures themselves have several advantages for their users, namely more aesthetic because there are no metal hooks, more transparent and the color is more in harmony with the surrounding tissue, has a strong material and high flexibility where if bent it can have the ability to return to its original condition, has lower elasticity and

a softer and thinner surface than acrylic, is very easy to wear because the installation is right under the alveolar, does not irritate soft tissue because it is free from monomers and metals which are the biggest causes of allergies in denture materials.[5] As of the several other types of dentures, thermoplastic nylon dentures are the material that causes the least stains and discoloration compared to conventional resin types such as acrylic and polymethyllacrylate.[6]

Color stability is the main factor that indicates durability and aging or when the denture base resin is damaged during use at a certain time. There are two factors that can cause discoloration in thermoplastic nylon dentures, namely intrinsic factors and extrinsic factors. Intrinsic discoloration can be caused by physical reactions such as brushing with soap or abrasive chemicals and can increase the absorption of discoloration agents.[7] Extrinsic discoloration is a discoloration caused by plaque accumulation or coloring from a coloring agent such as coffee, tea, cigarettes, or carbonated drinks such as energy drinks. [8]

Energy drinks are a quite popular and rapidly growing drinks. Especially among adults, young people to athletes also consume energy drinks. This energy drink is very popular in Europe and the United States where the highest sales of energy drinks there reached 5.4 billion dollars in 2006 with growth of up to 47% in the same period.[9] Similarly, in Indonesia, carbonated drinks such as energy drinks are used as a drink supplement that is believed to support daily activities instantly.

Energy drinks like other carbonated drinks are made by injecting carbon dioxide into drinks that have been flavored, sweetened, flavored, or colored. This carbonation process produces the characteristic foam of energy drinks due to the dissolution of CO2 in a liquid under pressure.[10] Most energy drinks have a high dose of caffeine combined with other substances such as taurine, guarana and sugar. Energy drinks contain an average of 70-80 mg of caffeine per can or 3 times more than soda drinks such as cola.[11] Based on research conducted by Ogbeide UM et al., the pH of energy drinks ranges from 2.61 to 3.48 which is classified as acidic, far below the normal pH level of 7.[12] The bad habit of consuming energy drinks can cause damage to thermoplastic nylon resin dentures. This is because the nature of thermoplastic nylon can absorb water, although not as much as dentures with acrylic resin. It can slowly create absorption through molecular diffusion.[13] Based on the results of a survey and research by Talenta Data Indonesia, there are three energy drinks with the highest popularity in Indonesia. In the first rank for the most popular energy drinks is Krating Daeng, followed by Kukubima Ener-g in second place and in last and third place Extrajoss. Therefore, based on the description above, the researcher will conduct a

study on the effect of energy drinks on the color stability and hardness of thermoplastic nylon removable dentures.

1.2 Problem Formulation

Based on the background that has been described, the problems of this research are:

1. Is there an effect of the immersion time of the energy drink on the surface hardness of the thermoplastic nylon resin plate?
2. Is there an effect of the immersion time of the energy drink on the color stability of the surface of the thermoplastic nylon resin plate?

1.3 Research Objectives

1.3.1 General Objectives

This study aims to analyze the effect of energy drinks as a immersion solution on the color stability and surface hardness of thermoplastic nylon plates.

1.3.2 Special Objectives

1. To determine the difference in surface hardness of thermoplastic nylon plates before and after immersion, three types of energy drinks were used.
2. To find out the difference in the surface color of thermoplastic nylon plates before and after immersion using three types of energy drinks

1.4 Research Benefits

1.4.1 Scientific Field

To provide scientific information to dental students about the effect of energy drinks on the surface color stability and surface hardness of thermoplastic nylon bases.

1.4.2 Clinical Field of Dentistry

The results of this study are expected to be useful for dentists as a consideration in providing instructions to patients in maintaining dentures based on thermoplastic nylon and educating patients about the effect of energy drinks on the base of their dentures.

1.4.3 Benefits for the Community

The results of this study are expected to provide additional knowledge to the public about the influence of energy drinks which are increasingly popular and have become a trend in society, namely as one of the drinks that are believed to be a supplement and support daily activities for the base of thermoplastic nylon dentures.

1.4.4 Benefits for Researchers

Researchers can apply the knowledge learned during education in conducting this research. In addition, researchers can also add insight in analyzing the effect of energy drinks on the color stability and hardness of thermoplastic nylon resin dentures.

CHAPTER II
RESEARCH METHODS

2.1 Type of Research

The type of research used is *quasi-experimental* research with *a pre and post-test research design with control group design***.**

2.2 Time and Location of Research

2.2.1 Research Time

The research was conducted in December 2023 -July 2024

2.2.2 Research Location

1. Corona Dental Laboratory for Thermoplastic Nylon Resin Plate Manufacturing Laboratory
2. Physical Metallurgy, Faculty of Engineering, Hasanuddin University to conduct a plate hardness test using the Indenter Vickers on the surface of the plate.

2.3 Research Variables

2.3.1 Independent Variable

Independent variable: is a variable that determines a certain direction in the bound variable, whereas the independent variable is in another position not affected by the dependent variable. The independent variable in this study was the duration immersion of thermoplastic nylon resin in energy drinks: Energy drinks from several brands: Krating Daeng, Kukubima ener-g, Extrajoss (12 days).

2.3.2 Dependent Variable

Dependent variable: is a variable that is influenced by an independent variable. The bound variables in this study are: Surface color of thermoplastic nylon resin plate, Surface hardness of thermoplastic nylon resin plate

2.3.3 Controlled Variables

Control Variable: is a variable that is deliberately controlled or made constant by the researcher as an effort to minimize or even eliminate other influences other than the independent variable that may affect the results of the bound variable. The controlled variable in this study was: Energy drink volume, Thermoplastic nylon resin plate immersion method, Types of thermoplastic nylon resin plates, shape, and size of thermoplastic nylon resin plates

2.4 Operational Definition

2.4.1 Color Stability Resin Plate [14]

Color stability is the ability of a dental material to maintain its original color. Color stability is an important physical factor, especially in denture bases because it can show signs of damage or ease of repair in denture base resin in a certain period.

2.4.2 Surface Hardness Resin Plate[15]

Surface hardness is one of the main properties of dentures. Hardness can be interpreted as the ability of a material to withstand loads, namely occlusal loads and provide resistance so that it can withstand scratches, abrasions, and fractures on the surface of resin materials.

2.4.3 Shape and Size of resin Plate[16]

The shape and size of thermoplastic nylon resin plates is a guide to the shape and size of thermoplastic nylon resin plates thermoplastic nylon is length, width and height according to ISO 1567:2005 standards.

2.4.4 Method of Manufacturing Resin Plate[17]

The Manufacturing Method is a technique for making resin plates and the type of technique that will be used to activate until the resin can turn into a base. For thermoplastic nylon resin dentures with Thermosens using injection molding manufacturing techniques and methods using chemical polymerization to activate the resin.

2.5 Research Sample

All resin samples used in this study are square-shaped thermoplastic nylon resin plates with a size of 64 x 10 x 2.5 mm according to ISO 1567:20 standard

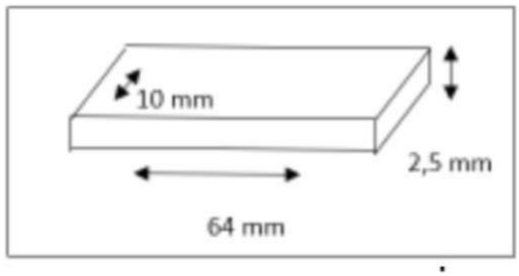

Figure 3.1 Sample Size (Source: Primary data, 2022)

The research sample is divided into 2 groups as follows:

1. Group 1 : Thermoplastic nylon resin plates soaked in aquades liquid
2. Group 2 : Immersion thermoplastic nylon resin plate Energy drink Krating Daeng

3. Group 3 : Thermoplastic nylon resin plate soaked in Kukubima energy drink Energ
4. Group 4 : Thermoplastic nylon resin plate-soaked Extra Joss energy drink

2.5.1 Sample Size

The determination of the sample size is carried out with the following Federer formula:

$$(T-1)\ (R-1) > 15$$

Description: n: Cluster size: number of samples per treatment

Based on the formula listed above, the number of sample groups used in each treatment can be calculated, for this research using t=4 sample groups.

$$(T-1)\ (R-1) > 15$$

$$(4-1)\ (R-1) > 15$$

$$(3)\ (r-1) > 15 r-1 > 15\ /3 = r-1 > 5$$

$$r > 5+1 \text{ or } r = 5+1\ r>6\ /\ r= 6$$

From the results of the calculation obtained from the sample above, the number of samples to be used in this study is greater than 6 samples or equal to 6 samples. Because there are 4 treatment groups, the total number of samples is 6x4, which is 24 samples of thermoplastic nylon resin plates.[18]

2.5.2 Sample Group Segmentation

The research sample is divided into four groups as follows:

- Group 1 : Thermoplastic nylon resin plates soaked in aquades solution
- Group 2 : Thermoplastic nylon resin plate soaked in Krating Daeng energy drink
- Group 3 : Thermoplastic nylon resin plates soaked in Kukubima Ener-G energy drink
- Group 4 : Thermoplastic nylon resin plate soaked in Extra Joss energy drink

2.6 Sample Criteria

2.6.1 Inclusion Criteria

- There is no real shaft on the surface of the thermoplastic nylon resin plate
- Sample of the thermoplastic nylon resin plate, has a square shape with the size 64 x 10 x 2.5 mm

2.6.2 Exclusion Criteria

Samples of thermoplastic nylon plates are broken or have been contaminated with other materials.

2.7 Research Instruments

2.7.1 Research Tools

1. Cuvette
2. Screw
3. Bagel press (cuvette)
4. Hydraulic press
5. plugger
6. Rope
7. Pot
8. Bur polish
9. Micromotor (Guangzhou Skyrann Electronic Tech Co., Ltd)
10. *Handpiece* (Nsk Pana-air FX Push Type Handpiece B2)
11. Analytical balance/digital balance sheet
12. *Stopwatch*
13. Scissors
14. Night knife
15. Cast blade
16. *Rubber bowl*
17. Spatula
18. Ruler
19. Measuring cup
20. Stove
21. Thermometer
22. Glass beaker for immersion
23. Markers
24. Digital display Vickers microhardness tester
25. Camera (Canon G7X)
26. Light box
27. Laptop (MacBook pro-2021)
28. Adobe photoshop (2023 version)

2.7.2 Materials

1. Wood (plywood)
2. Thermoplastic nylon (Thermosens)
3. Energy Drinks (Krating Daeng, kukubima energy, Extrajoss)
4. Aquades
5. Vaseline (petroleum jelly)
6. White cast (plaster of Paris)

2.8 Data Analysis

Data Type : Primary data

Data Processing : Using SPSS

Data Analysis : This study analyzed the normality test data with the Shapiro walk data test, the data was divided into normal when a significance value of more than 0.05 (p-value>0.05) was obtained.

To see the comparison of the average value of color stability calculation and hardness paired t- test was carried out to measure the difference in the average value of color stability calculation and hardness of thermoplastic nylon resin plate before and after immersion with energy drink using paired-t test. To see a comparison of the average value of the calculation of surface color and hardness of thermoplastic nylon plates after immersion in energy drinks Krating Daeng, Kukubima ener-g, and Extrajoss. These two tests have a *confidence interval* of 95% (p-value <0.05). [19]

Data Presentation : in the form of tables, graphs and narratives.

2.9 Research Ethics

This research is done according to the ethical procedure and requirement and has followed the ethical regulations. This research is done to a non-living object however it still needs an ethical letter in order to produce an accurate and a great result of the research.

The ethical submission for this research will be carried out at Kandea Dental and Oral Hospital Hasanuddin University's. Kandea No. 5, Baraya Street. Subdistrict, Bontoala, Makassar city, South Sulawesi

2.10 Research Data

The data of this study was obtained from the results of questionnaires filled out by the subjects in the study. After that, the data is then tabulated, then processed and analyzed and systematically described through the results of the research and distributed in the form of tables and diagrams.

2.11 Data Collection Procedure

2.11.1 Manufacture of Thermoplastic Nylon Resin Plates

a. Making a Master Model /Mold Model

1. Plywood is used to make master models, Plywood wood later formed with a size of 64 x 10 x 2.5 mm, as a guide for mold model.
2. The cuvette is prepared and applied first using Vaseline or other *petroleum jelly*, then the bottom cuvette is filled with a cast using The manufacturer's instructions are a powder ratio of 2:1.
3. Place the master model in a cuvette that has been filled with cast dough with flat position.
4. Applying the upper surface of the cast and the upper side of the master model with a Vaseline so that it does not stick.
5. Fill the top cuvette that has been smeared with Vaseline and fill it with cast dough and vibrate to remove air bubbles.
6. Close and apply pressure to the cuvette using a begel press until the *setting* time is about +30 minutes.

b. Thermoplastic Nylon Plate Sample Making (Thermosens)

1. Clean the mold space then smear the separation material and wait until it dries
2. Thermoplastic nylon has different properties from acrylic, because Nylon cannot be dissolved so it cannot be made into a kind of dough shape or commonly called a dough stage to fill the mold using conventional techniques, but it must be done by melting and then injecting into the cuvette under pressure, this process is called as: (injection- molding)
3. Pour thermoplastic nylon in a cartridge which is then melted at a temperature of around 274 degrees Celsius to 293 degrees Celsius using a furnace or other heater.
4. After melting, the nylon dough is injected into the cuvette by a tool that is a plugger under pressure using a hydraulic press or manually.
5. Wait for the cuvette to cool to room temperature 30 minutes before opening the cuvette.
6. Open the cuvette and then pick up the base of the already formed thermoplastic nylon slab.
7. Clean the residue of roughness and excess using a finishing bur and

polish it using polishing bur.

2.11.2 Immersion of Thermoplastic Nylon Plates[20]

Samples are soaked using the 1-stage cycle method using an immersion time of 12 days = 1 year, with the following stages:

1. Hardness pre-test checks are carried out using a digital display vickers micro hardness test tool
2. The pre-test of the color stability of the plate surface is also carried out by taking a sample photo using a camera and analyzing the photo using Adobe photoshop to display the color results of L*A*B
3. Thermoplastic nylon resin plates are associated with threads on the immersion pipe so that all results and immersion time obtained on all samples are the same and no bias occurs.
4. Thermoplastic plastic plates are put into glasses filled with energy drinks simultaneously for 12 days.
5. After 12 days the thermoplastic nylon resin plate is lifted simultaneously using an immersion pipe.
6. The post test of hardness measurement was carried out again using the Vickers method digital display and the color stability post-test measurement using a camera and Adobe photoshop application.

2.11.3 Color Stability Test with L*A*B test[21]

The measurement was carried out twice, before and after immersion with energy drinks. The stability value of the sample was measured using a camera, laptop, and Adobe photoshop application using the *CIE* L*A*B* method: Here's how it was measured:

1. The sample is placed in a light box with a black background, in the shape of a box with 1 light source as lighting to minimize the possibility of bias of information and lighting during shooting.
2. Sample shooting is done at 40 from the camera direction to the sample
3. The photos are transferred to a laptop and uploaded to the Adobe Photoshop application
4. After the photo is uploaded, the plate area is divided into 3 areas per sample. Area 1 on the right side of the sample, area 2 median/middle of the sample, area 3 on the left side of the sample.
5. Determine the color stability through the color picker tool that generates a color value of L*A*B*.
6. The color measurement stage is repeated for 3 times in 3 parts of the divided area and calculates the average value to obtain the color stability result of the sample.

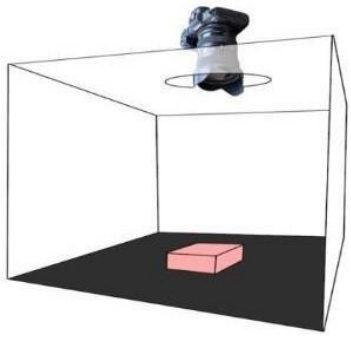

Image 3.2 Illustration of sample color Documentation