The effect of cocoa (*Theobroma cacao* L) on the basic color stability of thermoplastic nylon resin dentures

Amiyatun Naini*)

***Department of Prosthodontics Faculty of Dentistry Universitas Jember, Jember**

ABSTRACT

Nylon thermoplastic resin is material of choice for the making of flexible. This denture do not use wire retention, but has the physical properties of water absorption. In the oral cavity, it will always be in contact with food and beverages consumed. One of the foods that are consumed by the public is chocolate. This study aimed to determine the effect of cocoa (*Theobroma cacao* L) on color stability of the thermoplastic nylon denture base. The study sample was thermoplastic nylon (valplast) with a size of 10x10x2 mm soaked in the chocolate solution for 7 and 14 days. As the control, the sample soaked with distilled water. The color testing stability used was densitometer. There were significant differences between the control group (distilled water) and the chocolate solution. This was due to dissolved components/tannin having a capillary flow diffusion into thermoplastic nylons that causing discoloration. The conclusion of this study, there was the effect of cocoa (*Theobroma cacao* L) against the color stability of the nylon thermoplastic denture base. The longer time of immersion of nylon thermoplastic the greater the change in color.

Key words: Chocolate solution, color stability, nylon thermoplastic

ABSTRAK

Resin nilon termoplastis merupakan bahan pilihan untuk pembuatan gigi tiruan fleksibel atau lentur. Gigi tiruan ini tidak menggunakan kawat retensi, tetapi mempunyai sifat fisik menyerap air. Dalam rongga mulut akan selalu berkontak dengan makanan dan minuman yang dikonsumsi. Salah satu bahan makanan yang sering dikonsumsi oleh masyarakat adalah coklat. Penelitian ini bertujuan untuk mengetahui pengaruh larutan coklat (Theobroma cacao L) terhadap stabilitas warna basis gigi tiruan nilon termoplastis. Sampel penelitian adalah nilon termoplastis (valplast) dengan ukuran 10x10x2 mm direndam dalam larutan coklat selama 7 dan 14 hari. Sebagai kontrol, sampel direndam dalam aquades. Pengujian stabilitas warna dilakukan dengan Densitometer. Hasil penelitian menunjukkan terdapat perbedaan yang bermakna antara kelompok kontrol (aquades) dan kelompok larutan coklat. Hal ini disebabkan komponen terlarut/tannin mengalami aliran kapiler secara difusi kedalam nilon termoplastis sehingga menyebabkan perubahan warna. Simpulan penelitian ini, terdapat pengaruh larutan coklat (Theobroma cacao L) terhadap stabilitas warna basis gigi tiruan nilon termoplastis. Semakin lama waktu perendaman nilon termoplastis semakin besar perubahan warnanya.

Kata kunci: *Larutan coklat, stabilitas warna, nilon termoplastis*

**)Correspondence author: Amiyatun Naini, Department of Prosthodontic Faculty of Dentistry Universitas Jember Jl. Kalimantan No. 37 Jember, Tel./Fax: (0331)333536, 08124918255, Email:amiyatunaini_drg@yahoo.co.id*

INTRODUCTION

Current needs of the community on oral and dental treatments are increasing. One of the needs is the making of denture due to the loss of teeth that function for aesthetic or masticatory function. Commonly used denture is made of acrylic resin material which color resembles gum color and the material is stiff. The retention of denture is obtained by using a wire that makes the aesthetic value reduced.[1]

With the development of materials, today's dentistry materials adjust the society's desire and interest in fulfilling the beauty/aesthetic value. In dental practice, many patients prefer a denture without wire because patients' aesthetic needs are very high. Thermoplastic nylon resin is a chosen material for making a flexible or pliable denture, it does not use wire retention which formula chemically owns 3 constituents, they are polyamide (valplast, Lucitone, flexite), polycarbonate (reigning, jet carbo resin) and polyethylene terepthalate (estheshot). Valplast is thinner and more transluscent thermoplastic nylon than regular denture. Valplast is very good in aesthetic, does not use wire retention but the attachment in oral cavity is very good so patients prefer Valplast due to the comfort in using it and the flexibility that makes it strong and unbreakable.[2] But this thermoplastic nylon denture basis has physical natures, they are shrinkage, dimension change, and water absorption. High water absorption is a major shortage of nylon. This is because thermoplastic nylon has a fiber that absorbs water. Thermoplastic nylon has also hydroscopic nature that is the ability of a substance in absorbing water molecule from its environment.

Throughout the day, the denture in oral cavity will always be in contact with food and beverage consumed. One of the food materials that is often consumed by the people is chocolate from cacao beans.[3] According to Wijaya[4], the data from International Cacao Organization in year 2003, the level of cocoa consumption in Indonesia was 12 thousand tons per year. Generally, the things that underlie the consumers consume chocolate is the consumers' desire after seeing the interesting form or the way of presenting chocolate. Chocolate processed from cacao bean has some contents; 2.1% water, 54.1% fat, 2.2% nitrogen, 0.1% glucose, 6.1% starch, 4.1% pectin, 2.1% crude fiber, 1.9% cellulose, 1.2% pentose, 2.0% tannin (acid Tannates). Tannin content in chocolate can influence the color change in denture base.[5] This study aimed to determine the effect of chocolate solution (*Theobroma cacao* L) on thermoplastic nylon denture base.

METHODS

The type of the study was laboratory experimental study using research design: pretest posttest control group design in which measurement (observation) in control group and treatment group before and after treatment was carried out. This study was conducted at the Laboratory of Biological Pharmacy, Pharmacy Program of Universitas Jember in May-June 2011. The samples of the study were thermoplastic nylon (valplast) size 10x10x2 mm.[6] The samples criteria were: samples shape and size were adjusted to the size of the mold, samples were not porous, samples surface was smooth and flat, samples did not change in shape.[7] Division of sample group were control group: before 7 day immersion, after 7 day immersion, before 14 day immersion, after 14 day immersion and treatment group in chocolate solution: before 7 day immersion, after 7 day immersion, before 14 day immersion, after 14 day immersion. The number of samples of each group was 6.

The making of chocolate solution was by dissolving 5 gram of chocolate powder with 625 ml of boiling water. The solution was then precipitated and taken for 500 ml until it cools off. This research was performed by carrying out the immersion for 7 days. It was assumed that 7 days were identical to 2 year usage. For instance, someone who has a habit of consuming chocolate beverage once a day, once spends 15 minutes. 7 day immersion means 7 day x 60 minutes= 10080 minutes:15 minutes/day = 672 days identical to 2 year usage.

Treatment on thermoplastic nylon (valplast) samples immersed in chocolate solution at room temperature, the entire surface of valplast must be immersed in chocolate solution. Immersion was conducted for 7 and 14 days. The solution must been replaced every day. As a control, valplast was immersed in sterile distilled water for 7 and 14 days.

Test on color change was carried out after

the samples were cleaned using a soft tooth brush, rinsed with sterile distilled water and then dried, inserted, and placed in a measuring device. Measurement was performed using the ray coming from the UV-Vis, then the light beam formed was dropped on the samples and the measurement was carried out. Light intensity on the samples was measured using a Densitometer, Camag brand.[8]

The data obtained was tabulated based on each group. Then, Kolmogorov-Smirnov test and Levene's test were conducted to determine the distribution and homogeneity of the data. Furthermore, the data was analyzed using one way Anova, followed by LSD test to determine which group was significantly different using, 95% level of confidence ($\alpha = 0.05$).

RESULTS

The result obtained before and after the immersion of the samples thermoplastic nylon (valplast) in chocolate solution and sterile distilled water as a control, respectively for 7 and 14 days. Measurement is conducted to each sample using a densitometer and the result obtained is as follow:

The below table shows the average value of light intensity between control group (distilled water) and chocolate solution group that undergo an increase before and after immersion for 7 and 14 days. In chocolate solution group, light intensity increase is bigger than in control group immersed in distilled water. The biggest increase of light intensity average value occurs in chocolate solution group immersed for 14 days. The result of light intensity average value in control group and chocolate solution can be seen in the diagram below:

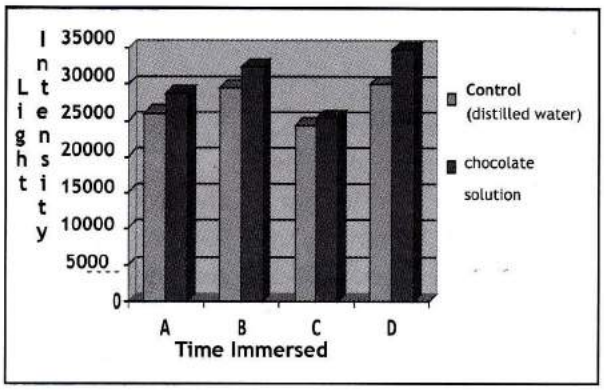

Diagram 1. The result of light intensity average value in control group and chocolate solution can be seen: A. Before 7 day; B. after 7 day; C: before 14 day; D: after 14 day.

From the result study, Kolmogorof Smirnov normality test was then conducted in order to determine the normal data distribution, the obtained value was 0.662. This indicated that the significance level was >0.05 meant that the data was normally distributed. Next, homogeneity test was performed, resulting the value of 0.331. This indicated that the significance level was >0.05 means that the data was homogenous. The data obtained were then tested using one way anova to determine the effect of the immersion of denture basis made of thermoplastic nylon in chocolate solution on the light intensity value. The value obtained was 0.016 means that the significance value is <0.05. This indicates that there was a significant difference between the control group (distilled water) and the chocolate solution group. In ordered to determine the difference of light intensity average value between the control group (distilled water) and the chocolate solution group, LSD test was then performed.

Based on the table, compared to the ther-

Table 1. The mean and standard deviation of light intensity measurement on thermoplastic nylon in the control group (distilled water) and chocolate solution

Group		N	Mean	SD
Control (distilled water)	Before 7 days	6	25966.07	1123.24
	After 7 days	6	29551.99	1301.58
	Before 14 days	6	24391.80	1908.46
	After 14 days	6	30155.77	2833.90
Chocolate solution	Before the immersion 7 days	6	28777.20	4684.52
	After the immersion 7 days	6	32411.76	3326.85
	Before the immersion 14 days	6	25375.81	2329.89
	After the immersion 14 days	6	34735.01	3086.98

moplastic nylon immersed in chocolate solution for 7 days, the thermoplastic nylon immersed in distilled water for 7 days as the control group has no significant difference. Which was significantly different was between the thermoplastic nylon immersed in distilled water for 7 days and the thermoplastic nylon immersed in chocolate solution for 14 days; and the thermoplastic nylon immersed in distilled water for 14 days and the thermoplastic nylon immersed in chocolate solution for 14 days.

DISCUSSION

In dental practice, many patients prefer a denture without wire because patients' aesthetic needs were very high. Thermoplastic nylon resin is a chosen material for making a flexible or pliable denture, it does not use wire retention, thinner and more translucent than other dentures.[2] But this thermoplastic nylon denture basis has physical natures; they are shrinkage, dimension change, and water absorption. High water absorption is a major shortage of nylon. This is because thermoplastic nylon has a fiber that absorbs water. Thermoplastic nylon has also hydroscopic nature that is the ability of a substance in absorbing water molecule from its environment.

This study performed the immersion of thermoplastic nylon denture basis in sterile distilled water as the control group and in chocolate solution as the treatment group for 7 and 14 days. In Table 1, the data result in light intensity measurement after larger immersion than before immersion both immersed in distilled water and chocolate solution. This indicated that the liquid will be absorbed by thermoplastic nylon so that it affects light intensity value. In line with Phillip that thermoplastic nylon which is in contact with liquid will generally undergo liquid absorption or diffusion (migration of a substance through a cavity)[9] and according to Takabayashi[10], water absorption phenomena occurs in thermoplastic resin is caused by the high hydrophilic nature as the result of the formation of amide that forms the main chain of polyamide resin. Thus, the high water absorption is in the same direction as the concentration of amide chain in resin.

One way to observe the color change occurred is by using a densitometer which able to measure the magnitude of light intensity absorbed by an object. The unit absorbance value in the densitometer will decrease if the light reflected is more than the transmitted light. This means the color becomes lighter or getting white. In other words, more spectrums are reflected than the transmitted ones. Thus, the unit absorbance value decreases.[11]

Light intensity value in this study occurs after the samples are immersed in chocolate solution for 7 and 14 days and the light intensity value in thermoplastic nylon increases. The samples immersed in chocolate solution for 7 days have light intensity average value of 32411.76 while the samples immersed in chocolate solution for 14 days have light intensity average value of 34735.01. The measurement result of light intensity of the samples immersed in chocolate solution for 7 days indicates that within 7 days there is an increase in light intensity in thermoplastic nylon, and it can be concluded that the immersion of thermoplastic nylon into chocolate solution for 7 days is able to create color change. This is due to the dissolved components/tannin experience diffusion capillary flow into thermoplastic nylon. Also supported by Takabayashi[10] that there is color change in thermoplastic resin after contact with some beverages. Color change occurs due to physical penetration of pigment such as molecules or pigment absorption in thermoplastic nylon resin.[10]

Table 2. The LSD test result of light intensity value of thermoplastic nylon in control group (distilled water) and chocolate solution for 7 and 14 days

	Control (distilled water) for 7 days	Chocolate solution for 7 days	Control (distilled water) for 14 days	Chocolate solution for 14 days
Control (distilled water) for 7 days	-	0.087	0.708	0.004 (B)
Chocolate solution for 7 days	0.087	-	0.171	0.159
Control (distilled water) for 14 days	0.708	0.171	-	0.009 (B)
Chocolate solution for 14 days	0.004 (B)	0.159	0.009 (B)	-

From the result of one way ANOVA test, there was a difference between the control group (distilled water) and treatment (chocolate solution) to the value of thermoplastic nylon light intensity with the significance value of 0.016 ($p<0.05$). There was a significance value of light intensity between the control group (distilled water) and treatment (chocolate solution) based on the assumption of the existence of tannin component from chocolate solution with double bond conjugated in polyphenol that functions as a chromophor (color bearer) and the group (OH) in tannin that functions as auxochrome (color binder). The existence of chromophor and auxochrom in tannin can cause brown color.[4] Supported by Craig et al.[12] the natural absorbed by resin resulted color change so the test result was significantly different.

In Table 2, an LSD test was conducted and the significant value difference is between the immersed thermoplastic nylon in aqua for 7 days and the thermoplastic nylon immersed in chocolate solution for 14 days, the thermoplastic nylon immersed in aqua for 14 days and thermoplastic nylon immersed in chocolate solution for 14 days. This indicated that the longer the immersion of thermoplastic nylon in chocolate solution, the light intensity will be higher, creating a significant difference compared to the control group (distilled water) showed by the intense color change. Tannin pigment accumulation may happen on thermoplastic nylon surface and color absorbance is more than that reflected so the thermoplastic nylon is darker.

This study used the immersion period for 7 and 14 days. The longer the immersion of thermoplastic nylon in chocolate solution, the higher color change occurs. In accordance with the assumption that 7 day treatment on the samples is identical to the use of thermoplastic nylon for 2 years; the thermoplastic nylon basis has already changed in color into darker color. In line with Phillip, the absorbance of liquid color substance can occur gradually within a certain period with water diffusion mechanism.[9]

Color change in thermoplastic nylon denture basis is not always permanent as it can reduce after the cleansing using soft tooth brush. This assumption was in accordance with Rohatiningrum that the possibility of the liquid or particles will disappear during brushing up or re-dying.[13]

CONCLUSION

There was an effect of chocolate solution (*Theobroma cacao* L) against the thermoplastic nylon denture base and the longer the immersion of thermoplastic nylon, the higher the color change will be.

REFERENCES

1. Combe EC. Notes on dental material. Jakarta: Balai Pustaka; 1992. P. 267-76.
2. Ditolla M. Valplast: flexible, aesthetic partial dentures. Chairside Perspective 2005 April; 5(1).295-99.
3. Triatmojo. Coklat. [cited 2006 Sep 6]. Available from: http://triatmojo.wordpress.com/2006/09/06/coklat.
4. Wijaya A. Pengaruh larutan coklat (*Theobroma cacao* L) terhadap perubahan warna pada anasir gigi tiruan resin akrilik. Minor thesis. Jember: Fakultas Kedokteran Gigi Universitas Jember; 2008.
5. Rianti DE, Munadziroh. Perubahan warna resin akrilik untuk basis gigi tiruan dan mahkota jaket akibat jus apel. J Kedokteran Gigi FKG UI 2000.
6. Sunarintyas SD, Irnawati. Karakteristik pelikel yang terabsorbsi pada permukaan resin akrilik. J Kedokteran Gigi FKG UI 2000.
7. Meizarini. Pengaruh perendaman basis gigi tiruan resin akrilik tipe cross-linked dalam glutaraldehyde terhadap pertumbuhan *C. albicans*. Majalah Kedokteran Gigi FKG Airlangga 2002;35.
8. Laode. Scanner 3 for densitometric evaluation of thin laper chromatograms. 2004. [cited 2007 May 18]. Available from:http://www.pascounhas.net/jurnal-pdf.
9. Phillips RW. Buku ajar ilmu kedokteran gigi. 10th ed. Jakarta: EGC; 2003.
10. Takabayashi. Characteristics of denture thermoplastic resins for non-metal clasp dentures. Dent Mater J Tsurumi 2010;29(4):353-61.
11. Dian HR, Verga P. Kit eksperimentasi pengukuran berbasis intensitas cahaya. [cited 2008

Nov 1]. Available from: http://www.Stei.itb.ac.id/d4-otomasi/images/stories/TA06-07/vergadian.

12. Craig RG, O'Brien, Power JM. Dental material, properties and manipulation. Toronto: Quintessence; 2000. p. 320
13. Rohatiningrum. Pengaruh larutan coklat (*Theobroma cacao* L) terhadap perubahan warna resin akrilik. Minor thesis. Jember: Faculty of Dentistry Gigi Universitas Jember; 2003.