Research Article

Formulation of Toothpaste Activated Charcoal from Palm Shell (*Elaeis guineensis* Jacg) as Teeth Whitening for Nicotine Addicts

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ABSTRACT

Smoking is notably one of the most serious factors causing various periodontal problems, including bacteria in plaque build up and yellow teeth. Based on our study revealed that an activated charcoal from palm shells has been proven as a teeth whitening with an absorption ability of two times higher than other commercially active charcoals. This study aims to determine four formulas of toothpaste which are useful as teeth whitening. The results showed that all of the four formulas were proven effective as teeth whitening with the VITAPAN level of C1 (greyish shades) - all of which are similar to the positive control. The second formula was verified as the best physical property compared with the other formulas, with the quality standard at the concentration of carbomer 940 of 1% and tween 80 of 1.5%.

Keywords: Activated charcoal, palm shells, toothpaste, carbomer 940, tween 80.

INTRODUCTION

Smoking habits usually make yellow teeth and plaque that triggers formation of caries then caused cavities. The prevalence of dental caries continues to enhance as the intensity of smoking increases. Inhaling tobacco causes blood flow to the gums disturbed, making the gums lack of nutrition, oxygen and thus accelerating the disease[1]. Nowadays, widely used Palm Shell accounts for the increase of activate charcoal that can be used as an alternative substance to prevent tooth decay which is effective as teeth whitening. It forms porosity with a diameter of 3.2 nm enabling it to bind dirt that sticks to the surface of the tooth. The surface area and porosity of the palm shell could be increased when it is processed into activated charcoal so that it has an absorption capacity two times higher than a commercial activated charcoal [2].

This study aims to determine four formulas of toothpaste which are useful as teeth whitening. In a preliminary test about ability of activated charcoal of palm shell and commercial activated charcoal, it showed that palm shell activated charcoal was two times higher than commercial activated charcoal and thus it is potentially used as a toothpaste preparation. The activated charcoal toothpaste contains various minerals which afford to absorb yellowish substances in the teeth, increases roughness of the enamel surface, cleans up plaque and food scraps on the teeth, although the color is black but it is able to whiten smokers teeth [3]. Toothpaste gel preparations required gelling agent such as carbomer 940 with a concentration of 0.5-2% as a gel base and surfactant such as tween 80 with a concentration of 1-15% to stabilize the oil phase and water phase in the toothpaste gel preparation[4]. The use of carbomers 940 and tween 80 in the toothpaste gel base as a complement has been proven to be good physical properties and stability. Thus when using a carbomer 940 without tween 80 as a surfactant led to be no foam formation and resulting in un-soft toothpaste due to the nature of tween 80 as a foam-forming surfactant and cleanser which is good in toothpaste gel [5].

MATERIALS AND METHODS

The materials used in this study were Palm kernel activated charcoal (obtained from PT Sumber Tama Nusa Pertiwi), carbomer 940, tween 80, glycerin, sodium benzoate, triethanolamine, *Oleum menthae piperitiae*, methylene blue, iodine, KI, sodium thiosulfate (obtained from Brataco), charcoal formula toothpaste (produced by PT. Orang Tua), acrylic material dentures (obtained from Indo Trading) and artificial saliva solutions (obtained from Mathematics and sciences laboratory of Gadjah Mada University). Apparatus used in this study included Furnace, 200 mesh sieve, pH meter, broochfield viscometer, VITAPAN Shade Guide and laboratory glassware.

Evaluation of physical properties of the toothpaste gel

Taken out eight grams from the substance, each formulas were stored at 4°C for 24 hours then transferred to the oven at 40°C for 24 hours and this treatment was carried out in one cycle. Evaluation was undertaken in six cycles (12 days). Physical changes observed include [6].

a. Organoleptics were including examination of the color, texture, shape and smell of each toothpaste gel formula.

b. Homogeneity by means of toothpaste gel applied to the object glass and covered with a glass cover. Good homogeneous preparations must show no air bubbles, separate clots and particles and the absence of foreign objects.

c. Degree of sedimentation test encompassed the toothpaste bases were inserted into the test tube given a boundary mark and then observed the initial volume stored at different temperature for 4 weeks and observed the final volume whether or not separation occurred.

d. pH test were conducted through the toothpaste bases stored at different temperature for 4 weeks were dipped in electrodes from the pH meter in each formula, and wait until the screen shows a stable number.

Tabel 1: Formulation of toothpaste gel selected.

Ingredients	Formula, Quantity used (%)				
	FI	FII	FIII	FIV	Property
Activated Charcoal	12	12	12	12	Active Substance
Carbomer 940	0.5	1	1.5	2	*Gelling Agent*
Tween 80	2	1.5	1	0.5	Surfactant
Glycerin	1	1	1	1	Humectant
Sodium Benzoate	1	1	1	1	Preservative
Triethanolamine	1	1	1	1	Surfactant
Candy Oil	0.75	0.75	0.75	0.75	Sweetener
Aquadest add 100 ml	81.75	81.75	81.75	81.75	Solvent

Stability test during storage

The second formula (the best formula) was stored at the temperatures of 0°C, 4°C, 8°C, 12°C, 25°C, 40°C, 50°C, 60°C respectively. This was done in order to determine the effect of temperature at a different pH. For further testing of storage stability then the bases were stored at 4°C, 25°C and 40°C and this was observed for physical changes for 1 week and 4 weeks starting from organoleptic observation, homogeneity, sedimentation rate, pH, viscosity, properties flow, spread ability, foam height [7].

Teeth Whitening efficacy test

Efficacy test was carried out to observe the changes of teeth color after brushing by toothpaste gel towards teeth which was exposed to cigarette smoke treatment. Toothpaste bases were brushed into the teeth every day for 4 consecutive weeks by brushing twice a day in the morning and night time. The teeth was observed every day and was pictured for a week to check the color changes and the results were compared with a positive control *i.e. formula charcoal* and controled negative base of toothpaste without activated charcoal and water. Furthermore, each observation on the level of dental whiteness was determined based on the VITAPAN shade guide level which consisted of A1-A4 (reddish-brownish), B1-B4 (reddish-yellowish), C1-C4 (greyish) and D1-D4 (reddish-gray). The order of color scores from the brightest to the darkest is B1, A1, B2, D2, A2, C1, C2, D4, A3, D3, B3, A3.5, B4, C3, A4, and C4 [8].

RESULTS AND DISCUSSION

The evaluation of physical properties towards four types of active charcoal toothpaste based on organoleptic tests during four weeks storage at different temperatures of 4°C, 25°C and 40°C, the first formula was liquid because it contains Carbomer 940 with a concentration of 0.5% so the base became slightly runny. Carbomer as a gelling agent forms a smooth and transparent gel when its concentration was above 0.5% [4]. At the same time, the second formula did not have a change in color, aroma and shape. Then at the third and fourth formula there were grows of microorganisms observed. This was due to enhanced carbomer and reduced tween 80 concentration which led to the increase of fungal activity.

The homogeneity test with varying temperatures showed all homogeneous formulas. There were no small lumps, coarse particles, air bubbles and no separation between each formula. Then the degree of sedimentation showed that all formulas were stable and did not undergo separation at value of F = 1 where a good toothpaste base was found when the separation ratio or value (F) = 1 [9]. Furthermore, in the pH test it turned out that the addition of carbomer had a decrease in pH due to different carbomer concentrations and all formulas were still in the similar pH range condition with oral salivary pH of 6.2-7.6 and this is also in accordance with SNI 12-3524 (Indonesian National Standard) in Table 2.

With regard to viscosity test and flow properties, it was figured out that all formulas had a viscosity of 4715-9735 cps with plastic flow properties. This was because these bases were included to non-Newtonian liquids. The ideal toothpaste viscosity range is 2,000-5,000 cps. The toothpaste gel viscosity is 7.100-83.144 cps [10]. When the temperature was increased, the viscosity of the base got lower. The curve could be seen in Fig. 1. Then in the scattering test, it showed that FII, FIII and FIV formula have spread with a range of 3.41-3.71 cm, according to the scattered power parameters in the range of 3-5 cm, but FI formula did not meet the requirements due to the spread exceeded the standard (5.34 cm). This caused the viscosity more watery so that the spread was greater. The

toothpaste is in the maximum spread of 8.5 cm according to the BIS (Bureau of Indian Standards) standard. In the high foam test, it turns out that all formulas had foam height with a range of 2.33 - 3 cm.

Table 2: Evaluation of physical properties of toothpaste Bases

Category	FI	FII	FIII	FIV	Standard
pH					pH 6,2-7,6
4°C	7,40	7,03	6,52	6,11	
25°C	7,48	7,32	6,90	6,30	
40°C	7,53	7,52	7,17	6,43	
Viscosity	4715	5962	6831	9735	7.100-83.144
Scatability (cm)	5,34	3,41	3,50	3,71	3-5
Foam height (cm)	2,33	2,83	3	2,33	2 – 3.5

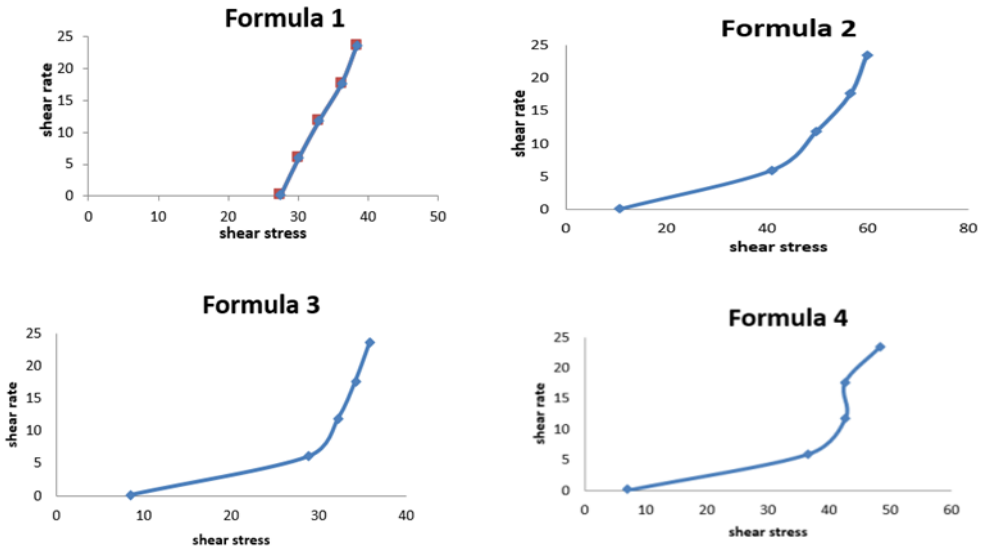

Figure 1: Properties of plastic flow

The toothpaste is in the maximum spread of 8.5 cm according to the BIS (Bureau of Indian Standards). In the high foam test, it turns out that all formulas had foam height with a range of 2.33 - 3 cm. The higher the foam, the better function and quality of the detergent. But there is no ideal maximum foam requirement for a toothpaste product, this is associated with the aesthetic value that consumers like [11]. The second formula proved to have physical properties in accordance with toothpaste quality standards as to determine the level of stability with respect to pH at a different temperature ranges 0°C to 60°C. A one-way ANOVA test was conducted and the results at 0-12°C were not different significantly, at 25°C and 40-60°C not significantly different as shown in Table 3.

Furthermore, the stability of physical properties during storage of four weeks at cold temperature, room temperature and heat temperature were evaluated, 4°C, 25°C, and 40°C respectively. As it is mentioned, the above data showed that the FII formula was stable and unchanged during four weeks of storage from all physical evaluation tests. But the pH test did not show significant differences and the higher the viscosity test the lower the viscosity and vice versa – also the higher the temperature, the higher the scattering power.

Table 3: Stability data of the FII formula at a range of pH

Temp	*pH*	
	1st Week (Ave+SEM)	4th Week (Ave+SEM)
0°C	7,44+0,011	7,55+0,020
4°C	7,06+0,055	7,12+0,038
8°C	7,37+0,020	7,59+0,005
12°C	7,45+0,015	7,68+0,025
25°C	7,28+0,080	7,32+0,101
40°C	7,53+0,015	7,59+0,032
50°C	7,56+0,025	7,77+0,055
60°C	7,62+0,032	7,83+0,017

Note: SEM, Standard Error of Mean superscript with different small letters on the same line showed significant differences ($p < 0.05$).

Effectiveness of Preparation toothpaste gel was tested using positive controls: charcoal formula. The negative control was the basis of toothpaste without palm shell active charcoal. The test results data are shown in Table 4.

Table 4: Efficacy of FII formula for four weeks

Formulas	Before	After	1st Week	4th Week
F1	A1	B4	C2	C1
F2	A1	B4	C2	C1
F3	A1	B4	C2	C1
F4	A1	B4	C2	C1
K+	A1	B4	C1	C1
K-	A1	B4	A4	A4

Note: K+(positive control), K-(negative control), A1-A4 (reddish-brownish), B4 (reddish yellowish), C1-C4 (greyish shades), C2 (greyish shades)

The results of yellow teeth brushing for two consecutive weeks by utilizing the four active charcoal toothpaste formulas during the four-week treatment, could be seen in Fig. 2.

Figure 2: After brushing four weeks with toothpaste

Based on Fig. 2 evidently that the four formulas proved to be as effective as positive control as teeth whitening, where the level of teeth whitening was at the C1 Vitapan Shade Guide level. In the previous study, it was known that the mechanism action of palm shell activated charcoal toothpaste gel as tooth whitener through porosity formed during activation process which caused the absorption process enhanced, thus the binding and cleaning dirt by entering through intermediate enamel to the dentinal tubules and oxidizes pigments to dentine, therefore color of teeth became younger[12].

CONCLUSION

The FII formula toothpaste of Palm shell activated charcoal (*Elaeis Guineensis Jacg*), found out effective as a tooth whitener in nicotine addicts which have physical properties fulfilled ideal requirements with a concentration of carbomer 940 of 1% and tween 80 of 1.5% then stable during storage four weeks at 4°C, 25°C and 40°C. Its stability unchanged in a different ranges of pH.

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