CHEMICAL ENGINEERING TRANSACTIONS
VOL. 83, 2021
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.cetjournal.it
Guest Editors: Jeng Shiun Lim, Nor Alafiza Yunus, Jiří Jaromír Klemeš

ISBN 978-88-95608-81-5; **ISSN** 2283-9216
DOI: 10.3303/CET2183009

Stability Analysis of Carrot-based Natural Moisturising Lip Balm

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Moisturising lip balm is an essential cosmetic product to enhance the lips appearance as well as to prevent inflammation or cracked lips. Lip balm with moisturising function formulated using all-natural ingredients is very significant because of the negative side effect awareness among people on using the unnatural or chemically derived ingredients of the lip balm. However, the stability analysis of this natural lip balm must be conducted to ensure the safety of the product as well as to predict the product shelf life. This study aims to evaluate the stability of carrot lip balm in two weeks under room temperature and refrigerator condition. Three lip balms with different concentration of virgin coconut oil (VCO) to carrot (35:65, 38:62, 43:57) were formulated and tested for their physicochemical properties (texture, colour, pH and spread ability) for two weeks. Lip balms with ratios of 35:65 and 38:62 were the best formulations as they presented good result in spread ability criteria in the stability test. From the observations, lip balms showed some changes at different temperature and time because of the degradation of natural ingredients. The product shelf life can be predicted from this stability test.

1. Introduction

Daucus carota L. commonly known as carrot, is a biennial type plant from Apiaceae family. Carrot is one of the most popular root vegetables in the world and one of the most important sources of carotenoids. Carotenoids contain five to six C in a ring, where they can be straight or branched chains (Sharma et al., 2012). The main carotenoids in carrot are ß-carotene (Søltoft et al., 2010). The presence of carotenoids has been proven to give various medicinal properties such as cleansing the intestines in human, antidiarrheal, anti-anaemic, neutralize the blood and also helps in maintaining good eyesight (Olalude et al., 2015). Besides, carotenoids are useful in maintaining a healthy skin due to potent antioxidant content and also prevent many diseases such as cancer, muscle degeneration in old age and also cataracts (Mustafa et al., 2012). ß-carotene is a pro-vitamin of vitamin A, and lack of this vitamin can cause xerophthalmia, blindness and premature death.

Cosmetic product including lip balm functions to assure personal hygiene and beautification (Marinoa et al., 2020). Nowadays, homemade lip balms have been widely sold without performing any physicochemical properties test to ensure the safety and stability of the product. Some of the lip balms use chemicals such as phenol (as an exfoliate of dead cells from the surface of the lips), salicylic acid (as an exfoliate of dead cells from the surface of the lips), and menthol (as a preservative that can stop some bacteria and fungi from growing) in the formulation which can lead to itchiness to lips and make lips drier (Piliang, 2014). Synthetic scent or flavours that purposely applied to attract the customer sometimes can cause irritation to the lips. Besides, lip balm in the current market commonly utilised petroleum jelly to function as a lip moisturiser in the formulation because it is inexpensive. The petroleum jelly contains a combination of paraffin and oil which only supplies moisture at the surface of the lips. However, this petroleum jelly does not allow the atmospheric humidity to be absorbed from the atmosphere into the skin, causing the skin to be unable to breathe. In the worst case, petroleum jelly supplied by non-reputable brand or not approved by the cosmetic-safety

Paper Received: 25/06/2020; Revised: 02/09/2020; Accepted: 06/09/2020
Please cite this article as: Mohammad Azmin S.N.H., Sulaiman N.S., Yosri N.A., Mat Nor M.S., Sannasi Abdullah P., 2021, Stability Analysis of Carrot-based Natural Moisturising Lip Balm, Chemical Engineering Transactions, 83, 49-54 DOI:10.3303/CET2183009

organization might also contain polycyclic aromatic hydrocarbons. Polycyclic aromatic hydrocarbon is a chemical that was found in contaminated petrolatum. The European Union banned the use of petrolatum in any beauty product and categorize it as a carcinogen (Megan, 2015).
Lip balms with strawberry, lemon, and orange flavours are the most home crafted, while carrot has not been listed and commercialized as lip balm flavour. This study used carrot as flavour and pigment in the lip balm formulation. Carrot is one of the primary sources of β-carotene which is rich in antioxidant (Gul et al., 2015). Antioxidant that presence in the β-carotene can increase the immune system function, inhibit the growth of the specific type of cancer such as lung cancer and also protection against sunburn (V et al., 2013). Lip balm formulation in this research used all-natural ingredients including carrot, virgin coconut oil (VCO) and beeswax. VCO contains vitamin E that acts as an antioxidant, moisturiser and helps to increase the shelf life of oil-based products (Rizvi et al., 2014) while beeswax has a high melting point and more stable (Kadu et al., 2015) as compared to another base like cocoa butter. The formulated lip balms were analysed in the stability test at two different temperatures. Critical physicochemical properties like texture, colour, pH and spread ability that affect the performance of lip balm to the lips were also evaluated. A cosmetic product that undergoes physicochemical analysis increases the confidence level of buyers to try the lip balm and make the product becomes more trusted.

2. Materials and methods

2.1 Plant material

Carrot sample was purchased from a local market located at Jeli, Kelantan Malaysia. Carrot sample was washed under running tap water to remove all residues and impurities. The clean sample was dried using cloth paper for further use.

2.2 Infused oil preparation

The preparation of carrot infused oil is illustrated in Figure 1. At first, the carrot skin was peeled off using potato peeler before it was grated into small pieces for extraction purpose. The extraction of carrot was carried out using a maceration process by applying a conventional heating method at the temperature of 90 ºC (Coelho et al., 2019). Next, the carrot was mixed with the virgin coconut oil, VCO and heated for 2 min at a temperature of 40°C until the VCO liquid became light orange. The mixture of VCO and grated carrot was strained using a muslin cloth to separate the grated of carrot from the infused oil. Then, the carrot infused oil was ready to be used in the lip balm formulation. In this study, three different ratios (VCO to the carrot) of infused oils which are 35:65, 38:62 and 43:57 were prepared. These ratios were set after the trial, and error method was applied to find the best ratio range.

Figure 1: Infused oil preparation

2.3 Lip balm formulation

In the lip balm formulation, beeswax and infused oil were mixed. The ratio of beeswax to infused oil was set at constant, which is 1:2. Initially, the beeswax was heated using the double boiling method on a hotplate until the beeswax was melted entirely (Khamdaeng et al., 2016). After the beeswax melted, the infused oil was added into the beeswax and heated at 60 °C. This mixture was continuously stirred to ensure there was no solid form in the mix. In the meantime, two drops of roses essential oil were added to each formulation to give a delightful odour to the lip balm. The heat was finally removed before pouring the mixture into a lip balm container, as shown in Figure 2. In this study, 20 g of lip balm formulations were prepared for each ratio of VCO to the carrot. The mixture was left about 15 min to cool and harden at room temperature for further

evaluation. The formulated lip balms in this study were labelled as A, B, C according to the ratios, as stated in Table 1.

Figure 2: Carrot lip balm container

Table 1: Formulation of lip balm

Formulated lip balm	Ratio of beeswax: Infused oil	Ratio of VCO: Carrot
A	1:2	35: 65
B	1:2	38: 62
C	1:2	43: 57

2.4 Stability test

The stability test was conducted for A, B and C carrot lip balm formulations at two different conditions which are room temperature (25 °C) and refrigerator condition (4 °C). The selected storage temperatures for evaluation depending on the conditions to which the final product may be sold (Fernandes et al., 2013). The characteristics of each formulation must be performed. In this stability test, texture, colour, pH and spread ability were evaluated for 1, 7 and 14 d at the stated conditions. The analysis of lip balm samples on day one was used as an indicator for any changes to the lip balms in the following days. The stability test was conducted to predict the possible changes that may occur on the lip balms (Fernandes et al., 2013).

2.4.1 Texture test

The formulated lip balm sample was placed on the base of the AMETEK Brookfield CT-3 Texture Analyzer as shown in Figure 3. Cylinder probe (TA39) was attached to the load cell since it is the most suitable probe for cosmetic products. In this texture test, hardness was measured as it is vital to ensure that the formulated lip balms are not too hard nor too soft. The hardness and softness of the formulated lip balms were determined by comparing the hardness value of the commercial lip balm with the prepared lip balm in this study. The penetration depth of the cylinder probe into the lip balm sample indicates the hardness value of the lip balm. This test was conducted for all samples in two different temperatures (refrigerator, 4 ºC and room temperature, 25 °C) and days (1, 7 and 14).

Figure 3: The hardness of lip balm was analysed using Ametek Brookfield CT-3 Texture Analyzer

2.4.2 Colour test

The colour of the carrot lip balm was analysed using Konica Minolta CR-400 chroma meter. This chroma meter has three indicators which contributing to lightness (L*), redness (a*) and yellowness (b*) of the tested sample. Based on these three indicators, all formulated carrot lip balms are more favor on yellowness which is b* value.

2.4.3 pH test

The pH of the lip balms was determined using Hanna H12211 bench pH meter. Lip balm was melted on the hotplate before dipping the pH meter into the liquid lip balm to measure the pH value.

2.4.4 Spread ability test

The spread ability test was conducted by spreading the lip balm on the top of the glass slide, and any deformation or breakdown that happened was evaluated using naked eyes as examined by Kadu et al. (2015). This test is important to determine the level of moisturising effect on the user. If the spread ability test gives a bad result (deformation or breakdown that occurred during the test), it means that the lip balm is not able to moisturise the lips anymore. The deformation or break down of the lip balm sample can be observed with the sensory (naked eyes) as shown in Figure 4. The criteria for the status of lip balm sample is presented in Table 2.

Figure 4: Spread ability test on the glass slide

Table 2: Spread ability status of lip balm samples (Ribeiro Fernandes et al., 2013)

Status of Lip Balm Samples	Criteria
Good	Uniform, does not leave fragments, perfect application, without deformation of the lip balm samples.
Intermediate	Uniform, leaves few fragments, appropriate application, little deformation of lip balm samples.
Bad	Not uniform, leaves no fragments, difficult or inappropriate application, intense deformation of lip balm samples.

3. Results and discussion

Table 3 exhibits the result of a stability test by assessing four parameters, including texture (hardness), pH, colour and spread ability. Hardness, pH and colour parameters showed a numerical value as stated for day one while spread ability was observed with naked eyes.

The hardness (texture) of the lip balms in week 1 (7 d) were in normal (N) for room temperature storage condition while modified (M) in chiller condition. The texture of the lip balm turned to modified (M) and intensively modified (IM) in chiller condition in week 2 (14 d) due to the degradation of beeswax and VCO compositions in the lip balm. These are a regular phenomenon as the storage time increases; the degradation of natural ingredients also rises.

In this study, the fat bloom was also detected on the surface of formulated lip balm since day 14 (lip balm A) in room temperature and day 7 (all formulated lip balm) for chiller condition. The fat bloom occurrence composes of the formation of fat crystals on the surface of lip balm, which appears as whitish spots. The phenomenon can be related to the crystalline forms of fat (beeswax) and phase separation of the triglycerides within the crystalline structure of the beeswax. The fat bloom is a result of the migration of the liquid fraction of fat within

the product formulation and its continuous uncontrolled recrystallization on the product surface (Foubert et al., 2001). Modified, M sign indicates the presence of a small area of fat bloom while intensely modified, IM specifies for the more significant area of the lip balm surface was attacked by fat bloom. The formed fat bloom is more favourable in low temperature as shown in Table 3.

Table 3: Results of stability test of lip balm

Parameters	Lip balm	Storage condition (temperature) and duration (d)					
		Room temperature (25 ºC)			Chiller (4 ºC)		
		1	7	14	1	7	14
Hardness, g	A	101.67	N	M	N	M	IM
	B	239.67	N	N	N	M	IM
	C	388.33	N	N	N	M	IM
Colour, b* (light yellow)	A	51.80	N	N	N	M	M
	B	49.97	N	N	N	M	M
	C	45.35	N	N	N	M	M
pH	A	4.04 ± 0.21	4.04 ± 0.09	4.30 ± 0.34	4.62 ± 0.11	3.71 ± 0.14	3.21 ± 0.42
	B	4.00 ± 0.45	4.1 ± 0.01	4.12 ± 0.41	3.42 ± 0.09	4.66 ± 0.16	4.02 ± 0.48
	C	4.20 ± 0.36	4.04 ± 0.08	4.19 ± 0.26	4.51 ± 0.16	4.2 ± 0.45	4.3 ± 0.21
Spread ability	A	G	G	I	G	G	I
	B	G	G	I	G	I	I
	C	G	G	G	G	B	B

*All parameters were evaluated in triplicate
Hardness and Colour: N-Normal; M-Modified; IM-Intensely Modified;
Spread ability: G-Good; I-Intermediate; B-Bad

In term of colour, the uniformity of carrot lip balm can be observed as there was no spot or change in colour at room temperature. Slightly change in colour at chiller temperature was occurred which the lip balm turned into a dark yellow in the second week of evaluation. Azeredo et al. (2007) supported these results where they found that the degradation of ingredients in the formulation assists to colour changing.

All the formulated lip balms except for formulation B in chiller condition showed a pH of 4 on day one, where the lip balms are in the acidic range. However, these lip balms are suitable to apply on skin as the pH of the skin, including lips are in the range of 4 to 6 (Ali and Yosipovitch, 2013). All the tested lip balm showed the pH values are in the range of 4-6 after a week and above except for formulation A. The pH of lip balm in chiller condition for formulation A showed pH of 3 in week 1 and 2 which indicated that the lip balm is not suitable to be applied to the lips. As the pH is too acidic, it will cause inflammation to the lips (Kadu et al., 2015).

Table 3 shows the spread ability criteria labelled in Table 2 as good (G), intermediate (I) and bad (B). For this test, the lip balms were in good in spreading for day one under both conditions. However, the lip balm for formulations A and B under room temperature displayed a difficulty to be spread on the glass slide in week 2. On the other hand, the lip balm in chiller temperature for formulation C gave a lousy result when it was spread in week 1 and 2. This is due to the loss of moisture in chiller temperature, causing trouble to be spread.

It can be concluded that lip balms A and B can be considered as suitable to be used as a lip moisturiser as they do not show any bad result in spread ability as stated in Table 3. The lip balm formulations of A and B also appeared as normal and modified for hardness and colour while a bit changes only for pH values as increasing the storage time in both conditions. The properties evaluation for both lip balms only showed slightly different because of the ratios of VCO to carrot are not much different. Both formulations were stable within the stability test up to 14 d as compared to formulation C. Formulation C exhibited the hardest texture, the fade yellow colour (as the b* is the lowest value) and bad spread ability in particular storage condition result.

4. Conclusions

The stability test for carrot lip balms was successfully examined. From this study, all three lip balms presented excellent stability except for hardness (chiller condition), pH and spread ability. Formulations with more acidic

pH that is lower than pH 4 are not suitable to be utilised to the lips while formulation with good and intermediate spread ability is suited well to be applied as a lip moisturiser. This study demonstrated that the storage conditions of cosmetic product influence the physicochemical properties of the product. It is crucial to test the physicochemical properties of the cosmetic product to ensure the shelf life of the product. The product contains fat may form fat bloom within the storage time and conditions. This research found that fat bloom formation is more favorable in refrigerator conditions, making the lip balms stored at 4 °C became less stable. Besides, the degradation of active ingredients in the formulated product affects the product shelf life where it can be determined by measuring the specific physicochemical properties of the products.

Acknowledgments

This study was supported by Ministry of Education Malaysia, Fundamental Research Grant Scheme for Research Acculturation of Early Career Researchers (FRGS-RACER, R/FRGS/A0700/01552A/003/2019/00665) and Universiti Malaysia Kelantan. This support is gratefully acknowledged.

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