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Physicochemical Analysis of Medicated Ointment Enriched with Ginger (*Zingiber officinale*) Oil

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Abstract. *Zingiber officinale* rhizome has been revered as a culinary and medicinal spice in many traditional cultures. The essential oil from this plant has been proven to cure diseases of fighting infections by decreasing cholesterol and enhancing weight loss. Therefore, the benefits of this plant must be fully utilised either using raw or ginger based-products. Thus, this study aims to formulate herbal ointments with different concentration of ginger oil as well as to investigate the effect of varying concentration of oil on the ointment properties. In this work, five different ointment formulations were evaluated with various ratios of ginger to virgin coconut oil. All formulated semi-solid ointments were tested for physicochemical properties including hardness, viscosity, pH and turbidity. In this study, the properties of the developed ointment were compared with the commercial product as a benchmark. The developed ointment showed a good result of pH values where all ointments are ranging from 6.03 to 6.19. The ratio of 5:95 of ginger to virgin coconut oil was the best formulation where the tested properties were almost similar to the commercial ointment. Accordingly, the developed ointment in this study can be considered as suitable to be used to the external human body such as chest and nose to heal and protect the respiratory problems.

1. Introduction

Zingeber officinale, or commonly known as ginger, has been widely used as natural additives and spice in cuisines, especially the rhizome part. The rhizome has also been applied as medicinal purposes by ancient China and Indian medicine due to the healing properties related to digestive problems such as indigestion, constipation, flatulence, and gastrointestinal illness. It is often considered as an effective treatment for nausea and motion sickness, that related to the discomfort feeling in the digestive tract [1]. Ginger has also been reported as an excellent herb in treating gastric ulcer; an illness occurred for those who have a weak stomach, resulting in ulcers formation from stomach acid juices [2]. Furthermore, it is effective in treating cold and cough because of the presence of the biochemical in ginger that controls the spread of rhinoviruses; a virus that responsible for spreading cold and cough [3]. Apart from that, ginger has been proven as an excellent antimicrobial agent. Gingerols is one of the compounds found in ginger which is responsible for inhibiting the growth of pathogens such as *Staphylococcus aureus* and *Listeria monocytogenes* [4].

Based on the previous study, a-zingiberene is a sesquiterpene; a dominant constituent of the oil of ginger. This compound contributes about 30% of the essential oil in ginger rhizome that gives the distinct flavour in ginger [5,6]. Gingerols is the main component found in ginger, which acts as antioxidants, and antimicrobial agent. Besides, this component also promotes healing the flatulence and gastrointestinal disease [2,7]. Meanwhile, curcumin is a terpene, which contributes anti-inflammatory and acts as a pain reliever agent, and the spicy scent and flavour from ginger are due to sabinene compound [6]. Ginger also contains the nutritional composition including carbohydrate and other minerals such as iron, calcium and potassium, [5].

An ointment has been used since the past decade by Sumerians, Egyptians and Greeks for religion and medical purposes especially respiratory problems [8]. Currently, homemade ointments are widely produced with the claim that the products are better than commercial one due to the use of natural ingredients without any chemicals added. However, most of the homemade ointments were mixed with various type of herbs without considering the adverse effect. They did not undergo proper analysis that may affect the skin, such as skin irritation, and rashes. Several aspects that need to be considered to develop an ointment product. The issues include the type of herbs used by identifying the benefits of those particular herbs based on the bioactive compound content, the exact amount of herbs needed to be added in ointment based on the ratio given, and the suitable viscosity and pH of the ointment. Therefore, this study is focusing on the formulation and physicochemical properties analysis of ointment product by adding ginger rhizome. Physicochemical properties such as pH, colour, and viscosity, are the main aspects that need to be considered to develop an ointment product.

2. Materials and Methods

2.1 Sample Preparation

Fresh ginger rhizome was purchased from Jeli market, Kelantan. The sample was washed thoroughly under running tap water and then wiped gently. After that, the ginger rhizome sample was cut into small pieces and dried using a drying oven, at 70 °C until becoming a constant weight. After that, the dried rhizome was ground into coarsely powdered form by using a mechanical grinder and preserved in a plastic bag to avoid contamination and surrounding moisture.

2.2 Preparation of Infused Oil

The dried powdered ginger rhizome was weighed and was placed in a beaker with the measured virgin coconut oil based on five different ratios of ginger to oil (5:95, 10:90, 15:85, 20:80, 25:75). Then, the beaker was covered with aluminium foil and was let infused by heating it in the drying oven, which set at 65 °C for 5 hours until the colour and scent of oil changes. After that, the mixture was allowed to cool and filtered using cheesecloth. The filtered oil (infused oil) was stored in an opaque glass bottle, in a cool and dark place for further use.

2.3 Formulation of Medicated Ointment

The ointments were prepared based on the five different ratios of ginger to virgin coconut oil with 1:4 ratio of wat to infused oil. Firstly, the infused oil was heated along with the beeswax at 70°C, until the beeswax was melted entirely. Then, the mixture was poured into ointment container and before allowing it to sit for 10 to 15 minutes. These procedures were repeated for all five different formulations. The formulated ointments with slightly different in colors are shown in Figure 1.

Figure 1. Five formulations of medicated ointment with different ratio of ginger to oil

2.4 Physicochemical Properties Evaluation

All formulated semi-solid ointments were tested for physicochemical properties including hardness, viscosity, pH and turbidity. In this study, the properties of the developed ointment were compared with the commercial product (Vicks VapoRub) as a benchmark.

2.4.1 Hardness

The hardness of the ointments was determined using Ametek Brookfield CT-3 Texture Analyzer by using cylinder probe (2 mm diameter, 20 mm length). The ointment sample was poked by the cylinder probe twice each formulation. The reading was viewed at the monitor and recorded. The value of hardness was measured is in triplicate for each formulation to obtain the mean value.

2.4.2 Viscosity

The measurement of viscosity of ointments was carried out using Sine-wave Vibro Viscometer SV10/SV100. A 20 g of ointment sample was taken out and filled into the provided glass container and put on the stand. The value of each formulation was measured in triplicate and expressed in a mean.

2.4.3 pH

The determination of the pH value of the ointment was carried out using a digital pH meter. A 2.5 g of the sample was taken out into 100 mL beaker and added 50mL distilled water. The mixture was heated on a water bath with a maintained temperature at 65 °C in 10 mins. Then, the mixture was let cool and centrifuged at 3000 rpm for 10 minutes, at 25 °C. Decant the water extract by filling it into the beaker and measured using a digital pH meter by dipping the glass electrode into it. The pH value obtained was in triplicate to get the mean value.

2.4.4 Turbidity

The turbidity of each ointment formulation was analyzed using UV-VIS Spectrophotometer Spectroquant Pharo 300. A 0.5 g of sample was weighed and diluted with 20 mL of distilled water by heating on the hot plate until the sample completely melts. Then, the mixture was filled in a cuvette using the dropper, and the turbidity of the sample was analyzed. Each turbidity value of ointment sample was in triplicate, and be expressed in the mean value.

3 Result and Discussion

3.1 Hardness

Table 1 shows the hardness of five developed ointments in this study. The highest value of hardness is 152 g given by the 25:75 (ginger to oil) ratios, while 121 g is the lowest value of hardness, which is at the ratio of 5:95. These values showed that hardness depends on the number of active ingredients in ginger oil. The hardness values increase with the increase of the active ingredients in ginger oil, as presented in Table 1. The enormous amount of ginger used, the more significant active ingredients content has been extracted by oil. Kamaliroosta et al., [9] found that 100 g of dried *Zingiber officinale* contains about 30% of a-zingiberene, and 2.5% of shogaol, known as gingerols. Besides, the amount of

active ingredient has a difference between the ratio of 5:95 to 25:75 of ginger to virgin coconut oil slightly. This research found that, at the ratios of 5:95 and 25:75 (ginger: virgin coconut oil), 0.8 g and 5.33 g of active ingredient were respectively obtained.

Table 1. Physicochemical properties value for each formulation

Ratio (ginger:virgin coconut oil)	Hardness (g)	Viscosity (cP)	pH	Turbidity
5:95	121	18900	6.08	0.948
10:90	129	25900	6.02	0.734
15:85	130	28170	6.03	0.332
20:80	145	36730	6.15	0.490
25:75	152	41000	6.19	0.244
Commercial ointment	125	19900	6.09	0.953

3.2 Viscosity

The viscosity of the ointment can be defined as the ability of mixed materials to stick together. In other words, it can be known as the state of being thick, sticky, and semi-fluid inconsistency of the product and can be determined by applying forces to the product.

Frequently, the viscosity characteristic is correlated with the hardness of the ointment. Thus, the active ingredient contributes to the viscosity value of the ointment. The more concentrate the active ingredient (ginger) in the ointment, the more viscous the ointment is. This study proved that the viscosity value of ointment increases, as the number of ginger increases as presented in Table 1.

3.3 pH

The pH value can be expressed as a non-linear scale used to determine the solution is acid or base. The pH value of the ointment was influenced by the pH of the herb used and type of chosen carrier oil. The pH of raw ginger is 5.6 to 5.9, which is quite acidic due to the gingerol compound. Furthermore, virgin coconut oil used as carrier oil has 7 to 8 pH value, while beeswax is considered as neutral. The pH value of the ointment increases as the amount of active ingredient (ginger) increases, as stated in Table 1. It is because pH values become higher when the higher amount of active ingredient is utilized in the ointment formulation.

3.4 Turbidity

Turbidity refers to the measurement of light-transmitting the aqueous solution containing suspended and colloidal material. Turbidity is expressed in absorbance value, and the value obtained as a result of the amount of light absorbs the solution by a particle. The absorbance value mostly determined by using UV-VIS Spectrophotometer instrument. Table 1 shows the absorbance of different ratios of ginger to virgin coconut oil. There is a massive difference in the absorbance values as the active ingredients are increased. The ointment absorbance value decreases as the more considerable amount of active ingredient in ointment formulation is used.

The absorbance and concentration of the solution are closely related to Beer's Lambert law [10]. The absorbance value will decrease when the level of dissolves particle increases as stated by this law. This study supports the law, as indicated in Table 1. It is because, when the dissolved particles (ginger active ingredient) in ointment increases, the amount of light absorbs the solution by a particle become lesser.

This study used absorbance spectrum method, where the absorbance value is based on the wavelength. Spectrum is used to determine the type of radiation, which depends on the wavelength. The wavelength recorded were between 280 nm to 290 nm, which is type B ultraviolet radiation. The type B ultraviolet can be absorbed by proteins, RNA, and DNA [9].

4 Conclusion

In this study, the ointment products have been formulated successfully based on the set ratio of active ingredient to virgin coconut oil. Besides, the physicochemical properties of formulated ointments also have been analysed. From the physicochemical analysis of the formulated ointment, it shows that the ratio of 5:95 ginger to virgin coconut oil has the closest value to the commercial ointment. Therefore this formulation can be considered to be commercialized.

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