Spectroscopy Study of Honey Pineapple Peels Extracted in Different Solvents

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Abstract
In the present work, we investigated the extracts of honey pineapple peels in distilled water, ethanol, and acetone solvents. The spectroscopy study of each extract was performed using a Fourier transform infrared (FTIR) spectrometer, an ultraviolet-visible (UV-Vis) spectrophotometer, and a spectrofluorometer. The FTIR spectrum of the distilled water extract showed that it may contain alcohol and/or carboxylic acid compounds. Meanwhile, the ethanolic extract may contain alcohol and/or carboxylic acid and/or ether compounds. On the other hand, the acetone extract may contain alcohol and/or ether and/or aromatic and/or aliphatic compounds. The honey pineapple peels extracted in the distilled water showed a broad absorption signal at the UV region (< 300 nm) while the ethanolic extract showed four absorption signals at the UV region (232–368 nm). On the other hand, the acetone extract showed four absorption signals at the UV region (231–368 nm) with a weak absorption signal at the visible region of 559 nm. The distilled water and acetone extracts gave fluorescence signals, however, the ethanolic extract showed no fluorescence intensity. From the FTIR, UV-Vis, and fluorescence spectra, the extracted natural pigments from the honey pineapple peels in distilled water, ethanol, and acetone solvents were proposed. The distilled water extract may contain polar flavonoid and/or steroid compounds while the ethanolic extract may contain polar carotenoid pigments. On the other hand, the acetone extract may contain carotenoid and chlorophyll pigments as shown by an emission signal at 670 nm.

Keywords: maceration, honey pineapple, peels extract, solvent, spectroscopy

INTRODUCTION
Tropical plants are abundantly available in the South East Asia region, especially Indonesia as the country located in the greatest length of the equator line across both land and sea in the world [1,2]. As Indonesia has 10% of world plant species in 90 ecosystems [3], Indonesia becomes the second largest mega biodiversity country in the world. Because of these abundant natural resources, researches on the isolation and application of tropical plants and fruits have gained a lot of interest [4-6].

Among edible tropical fruits, honey pineapple (Ananas comosus L.) is particularly attractive due to its unique natural product contents [7-10]. Hossain et al. (2011) reported that pineapple fruit contains phenolic and flavonoid compounds thus yielding remarkable antioxidant activity [11]. Meanwhile, Debnath et al. (2019) reported that the bromelain compound in the pineapple extract gave high anticancer activity [12]. These natural products were extracted and utilized for food supplements [13, 14]. Other applications of these natural products for the advanced materials have been also evaluated such as for solid catalyst [15, 16] and aerogel material [17]. Although honey pineapple gives a remarkable application, in contrast, utilization of its fruit peel is rarely investigated and the peel is usually wasted since the benefit is unexplored.

The first important approach would be investigating the possible compounds in the honey pineapple peels. In our previous work, we evaluated mangosteen, honey pineapple, and red dragon fruit peels for yellow natural coloring agents...
[18, 19]. As the solvent affected the type of extracted compounds, in this work we used several solvents to extract the honey pineapple peels. It was revealed that honey pineapple peels extracted in distilled water, ethanol, and acetone solvents are promising to be used as yellow colorants. Therefore, in the present work, we further investigated the Fourier transform infrared (FTIR), ultraviolet-visible (UV-Vis), and fluorescence spectra to investigate the natural pigments in honey pineapple peels extracted in distilled water, ethanol, and acetone solvents.

EXPERIMENTAL

General

Local honey pineapple fruits were purchased from a traditional market in Malang, East Java, Indonesia. Meanwhile, ethanol 96% and acetone in the technical grade were supplied from DJ Labware.

Extraction of Natural Pigments from the Honey Pineapple Peels

The honey pineapple peels extracted in distilled water, ethanol, and acetone solvents were prepared in a similar procedure in our previous report [18]. Briefly, the fruit peel (5.0 g) was then chopped and macerated with distilled water or ethanol or acetone (50 mL) as the macerating solvent at room temperature for 24 h. After the maceration process was completed, each extract was filtered using a Whatman™ filter paper 1 (diameter 90 mm) to obtain a clear filtrate.

Characterization of Extracts from Honey Pineapple Peel

The FTIR, UV-Vis, and fluorescence spectra of each extract were recorded from a FTIR spectrometer (JASCO FTIR-6800), a UV-Vis spectrophotometer (JASCO V-760), and a spectrofluorometer (JASCO FP-8500), respectively. The FTIR spectrum was recorded at the 400–4000 cm⁻¹ range using an attenuated total reflectance (ATR) technique. The UV-Vis spectrum was investigated in the 200–800 nm range while the fluorescence spectrum was investigated at excitation peaks of 200–700 nm for emission peaks at 300–800 nm.

RESULTS AND DISCUSSION

Extraction of Natural Pigments from the Honey Pineapple Peels

The photographs of honey pineapple peels extracted in distilled water, ethanol, and acetone are shown in Figure 1. Even though the used solvent was different, it was found that all extracts appeared as a clear yellow solution. One could see that the peels indeed are still rich in natural pigments. The similar yellow solution implied that the same yellow pigments could be soluble in different solvents or each solvent dissolved different yellow-colored pigments. To clarify this matter, the honey pineapple peels extracted in different solvents were investigated using FTIR, UV-Vis, and fluorescence spectrometers.

Characterization of Extracts from Honey Pineapple Peel

The FTIR study was conducted to identify the functional groups of the extracted natural pigments from honey pineapple peels extracted in distilled water, ethanol, and acetone. The FTIR spectra of honey pineapple peels extracted in distilled water, ethanol, and acetone are shown in Figure 2. Each extract gave a different pattern of FTIR spectrum, indicating that the extracted pigments were different from each other depending on the used solvent. As depicted in Figure 2(a), the distilled water extract gave six main absorption signals at 3292, 2922, 2850, 1621, 1451, and 1012 cm⁻¹. The broad signal observed at 3292 cm⁻¹ would correspond to O–H stretching while weak signals at 2922 and 2850 cm⁻¹ corresponded to Csp³–H stretching. The sharp signal at 1621 cm⁻¹ was assigned to C=O stretching while the weak signal at 1451 and 1012 cm⁻¹ showed the presence of C–C and C–O stretching, respectively. Based on this spectrum, it could be proposed that the distilled water extract may contain alcohol and/or carboxylic acid functional groups.

Figure 1. Photographic images of honey pineapple peels extracted in (a) distilled water, (b) ethanol, and (c) acetone.

Figure 2(b) showed that the ethanolic extract exhibited five main signals at 3291, 2916, 1616, 1363, and 1010 cm⁻¹. The broad signal at 3291 cm⁻¹ was related to O–H stretching while the weak signal at 2916 cm⁻¹ corresponded to Csp³–H stretching. The sharp signal at 1616 cm⁻¹ corresponded to C–O stretching while sharp signals at 1363 and 1010 cm⁻¹ were contributed from the C–O–C bending and C–O stretching, respectively. It means that the ethanolic extract may contain alcohol and/or carboxylic acid and/or other functional groups. It was noted that the ether functional group was absent in the distilled water extract but exist in the ethanolic extract. On the other hand, the acetone extract exhibited seven main signals at 3396, 2934, 1597, 1584, 1508, 1301, and 814 cm⁻¹ as shown in Figure 2(c). The broad signal at 3396 cm⁻¹ corresponded to O–H stretching while the weak signal at 2934 cm⁻¹ corresponded to Csp³–H stretching. The sharp signal at 1597 cm⁻¹ could be assigned to C=O stretching while sharp signals at 1584 and 1508 cm⁻¹ attributed to C=C stretching. The sharp signals at 1301–978 cm⁻¹ may correspond to C–O–C, C–O, C–C, and other functional groups. The sharp signal at
Figure 4. 3D fluorescence spectra of honey pineapple peels extracted in (a) distilled water, (b) ethanol, and (c) acetone.
CONCLUSIONS
Extraction and spectroscopy study of honey pineapple peels extracts using three different solvents of water, ethanol, and acetone were performed and the possible extracted compounds were proposed. All extracts showed a yellow-colored solution, suggesting that they could be utilized as a yellow natural coloring agent. The spectroscopy study suggested that different compounds were successfully extracted when using different solvents. The honey pineapple peels extracted in the water contained alcohol and/or carboxylic acid functional groups, which originated from the flavonoid and/or steroid compounds. The ethanolic extract contained alcohol and/or carboxylic acid and/or other functional groups, which came from the carotenoid compounds. Meanwhile, the acetone extract contained alcohol and/or ether and/or aromatic and/or aliphatic functional groups which came from the carotenoid and chlorophyll pigments.

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Abstrak
Pada penelitian ini, kami mempelajari ekstrak kulit nanas madu dalam pelarut air, etanol, dan aseton. Studi spektroskopi tiap ekstrak dilakukan dengan spektrometer Fourier transform inframerah, spektrotometer ultraviolet-tampak, dan spektrofotometer. Spektrum FTIR dari ekstrak air menunjukkan bahwa ekstrak air dapat mengandung senyawa alcohol dan/atau asam karboksilat. Sementara itu, ekstrak etanol dapat mengandung senyawa alcohol atau asam karboksilat atau eter. Dalam sisi, ekstrak aseton dapat mengandung senyawa alcohol dan/atau eter dan/atau senyawa aromatik dan/atau alifatik. Ekstrak kulit nanas madu dalam air menunjukkan sinyal adsorbsi melebar pada daerah UV (< 300 nm) sedangkan ekstrak etanol menunjukkan empat sinyal adsorpsi pada daerah UV (232–368 nm). Di lain sisi, ekstrak aseton menunjukkan empat sinyal adsorpsi pada daerah UV (231–368 nm) dengan sinyal adsorpsi lemah pada daerah tampak (559 nm). Ekstrak air dan aseton memberikan sinyal flurosensi namun ekstrak etanol tidak memberikan intensitas flurosensi. Dari spektrum FTIR, UV-Vis, dan flurosensi, disusul pigmen-pigmen alam yang terkerek dari kulit nanas madu dalam pelarut air, etanol, dan aseton. Ekstrak air dapat mengandung senyawa flaunoid dan/atau steroid yang polar sedangkan ekstrak etanol dan aseton mengandung pigmen karotenoid polar. Di lain sisi, ekstrak aseton dapat mengandung pigmen karotenoid dan klorofil seperti yang ditunjukkan oleh sinyal emisi pada 670 nm.

Kata kunci: maserasi, nanas madu, ekstrak kulit, pelarut, spektroskopi