Electron Microscope and Diffraction Study of Snake Fruit 
(*Salacca zalacca* (Gaert.) Voss) Peels

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**Abstract.** Electron Microscopy study of snake fruit (*Salacca zalacca* (Gaert.) Voss) peels has been carried out by scanning at the surface part of the snake fruit peel (outer and inner) using Scanning Electron Microscope (SEM) combined with energy-dispersive X-ray spectroscopy (EDS). The SEM micrograph of outer snake fruit peel shows patterned some spots with percentage of carbon (55.73%), oxygen (23.28%), silicon (20.36%) and other components (0.63%). While on the inside part shows the shape like a fiber with carbon composition (46.40%), oxygen (50.43%) and other components (3.17%). Further treatment of snake fruit peel biomass by heating 500 °C and confirmation by X-ray diffraction (XRD) showed that, the presence of carbon and crystalline phase of quartz silica. Furthermore, SEM-EDS shows some porous pattern with the percentage of carbon (58.9%), oxygen (28.87%), silicon (5.71%) and other components (6.52%).

1. **Introduction**

Biomass-based materials are currently being developed due to abundant biomass resources and their renewable characteristics. Various biomass material applications in the energy sector [1] and the environmental pollution management [2–4] have been developed. Biomass-based materials have also been developed in the process of adsorption in reducing various pollutants. Snake fruit peels is one of the underutilized biomass, having a serrated texture resembling snake skin so it is often called snakefruit [5]. Snake fruit peels has previously been used as a precursor for activated carbon material for various applications such as absorption of dyes [6,7].

Chemical content study of biomass is important to optimize the utilization of snake fruit peels in various applications. In previous studies, snake fruit peels was reported having phytochemical contents such as flavonoid, tannin, phenol, triterpenoid, saponin and alkaloid [8]. Other studies, *Salacca zalacca* peels and its modified form as bio sorbents for Hg²⁺ removal from aqueous solution. The bio-sorbent were prepared by refluxing of *Salacca zalacca* with dithizone 5% followed by drying the solid materials at 60 °C [9]. This preliminary study was carried out by scanning at surface parts using SEM analysis combined with chemical content determination using EDX and their characteristics by X-ray diffraction (XRD). The study was also carried toward the product calcinations snake fruit peels at 500 °C.
2. Methods
Snake fruit peels, the type of "salak pondoh" were obtained from the fruit market in Bengkulu City, Indonesia. The sample was cleaned, cut into small pieces (1 x 1 cm) then washed and dried at room temperature. An amount of the dried sample was taken to see its surface morphology using SEM-EDX, while the other part was grinded and sieved using a 100 mesh sieve. The sieved sample was then heated at 500 °C for 3 hours. Characterization of snake fruit biomass by using several tools including scanning electron microscopy (SEM) combined with energy-dispersive X-ray spectroscopy (EDX) (JEOL JSM 6510 LA) and X-ray diffraction (XRD) (XPERT POWDER PANalytical PW30/60; 2θ= 10° – 80°).

3. Result and Discussion
Snake fruit peels biomass has the potential as a source of inexpensive and easily available material. Figure 1 shows the morphology of snake fruit peels biomass using SEM at magnifications of 100×, 500× and 1000×. The appearance of the outer surface of the snake fruit peels shows a unique shape with a patterned white spot about 5 - 10 µm size (Figure 1a). Whereas the inner surface part shows the shape resembling a fiber (Figure 1b).

![Figure 1. SEM micrograph of snake fruit peels (a. outer; b. inner)](image)

Further confirmation using EDX in the selected area (Figure 2), the outer of snake fruit peels shows the presence of carbon (55.73%), oxygen (23.28%), silicon (20.36%) other component such as Cl and K (0.63%) (Figure 2a). On the hand, the inner side containing some elements such as carbon (46.40%), oxygen (50.43%) and other component such as Ca, K, Cl, Na, Mg, S, Al (3.17%). Based on these results, it means that the snake fruit peels consists of hydrocarbon with silicon-compound at outer side.

The results of further treatment of the snake fruit peels powder by calcination at 500 °C for 5 hours produced a gray powder (Figure 3). The powder was subsequently analyzed using XRD and SEM combined with EDX. Diffractiongram of calcined snake fruit at 500 °C shows carbon and quartz silica which has not transformed yet into cristobalite silica at the applied temperature. Figure 4 shows two peaks at 28.36° and 40.53° which is in line with JCPDS for quartz silica JCPDS No 05-0492.[10]
Figure 2. EDX pattern of snake fruit peels biomass (a. outer; b. inner)

Figure 3. Snake fruit peels (a. before calcination; b. after calcination at 500 °C)

Figure 4. XRD pattern of calcined snake fruit at 500 °C
Furthermore, Figure 5 shows the morphology and elemental analysis of the produced grey powder after calcinations of snake fruits at 500 °C. Based on these images, at 800x magnification shows that the snake fruit biomass particles form a porous material resembling a matrix (Figure 5a). Further confirmation by EDX in the selected area (Figure 5a) shows the composition carbon (58.9%), oxygen (28.87%), silicon (5.71%) other component (6.52%). It means that the matrix is in the form of a carbon matrix with pores about 20 µm size and silicon distributed in the matrix. The presence of silicon in the matrix was further observed at magnification of 10000x and confirmed by EDX in the selected area (Figure 5b) which shows the composition of carbon (30.66%), oxygen (45.22%), silicon (19.79%) and other component (4.33%). Based on these results, it is noteworthy that snake fruit peels has a potential source of carbon and silicon material in addition to other silicon sources that have been found previously [11,12].

![Image of SEM-EDX](image_url)

**Figure 5.** SEM-EDX of calcined snake fruit at 500 °C in magnification (a. 800x; b. 10000x)

4. Conclusion
Electron Microscope study of snake fruit (*Salacca zalacca* (Gaert.) Voss) peels in the selected area, the outer part of snake fruit peels shows the presence carbon, oxygen, silicon and other minor elements. On the inside part of the snake fruit peels is composed of carbon, oxygen, and other components in the absence of silicon. Diffractogram of calcined snake fruit peels at 500 °C shows the carbon and quartz silica. The EDX analysis in the selected area confirmed a composition of carbon, oxygen, silicon, and other component. Based on studies that have been done, it is known that snake fruit peels has a potential source of carbon and silicon material.
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