

## Preliminary Report on the Physical and Morphological Properties of the Leaves of *Ficus Nota* (Blanco) Merr. (Tibig), a Native Philippine Plant

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**Abstract:** *Ficus nota* (Blanco) Merr., from the Family Moraceae, commonly known as tibig, is a plant native to the Philippines. While there are already many published information characterizing its chemical constituents and bioactivity, there is no data yet describing its other important properties. Specifically, the physical and morphological properties of the plant leaves were evaluated in this study for their potential application in phytoremediation (i.e., oil spill management). Investigation on these properties was conducted by studying the following: (1) microstructural features of the leaf's epidermal surface as examined using scanning electron microscopy (SEM), (2) wettability as determined using a tensiometer, and (3) oil sorption capacity. The micrographs revealed pointed, non-glandular trichomes that are sparsely distributed on the leaf surface. The mean contact angle was 86.07° (n = 3) and 93.85° (n = 3) for the abaxial and adaxial surfaces, respectively. Lastly, the average oil sorption capacity was found to be 407.88% (abaxial) and 436.17% (abaxial and adaxial), indicative of the strong capacity of this plant to absorb oil more than four times its original mass. Overall, the data obtained from this study shows the great potential of *F. nota* as an important plant in phytoremediation, particularly, in oil spill management. It is believed that this study is the first report on the microstructures and physical properties of *F. nota* leaves.

**Key Words:** *Ficus nota* (Blanco) Merr.; tibig; trichomes; wettability; oil sorption capacity

### 1. INTRODUCTION

*Ficus nota* (Blanco) Merr., of the family *Moraceae*, is commonly known as sacking tree or tibig in the Philippines, and is a species of fig tree. Its fruits are traditionally paired with sugar, and its leaves are included in vegetable dishes. It is native to the Philippines but is also found in northern Borneo, Malaysia (KEW, Royal Botanic Gardens). The tree is an

erect, spreading, dioecious perennial tree which grows to a height of 8-10 m. Its leaf extract was found to contain several phytochemical compounds such as alkaloids, flavonoids, phenols, saponins, terpenoids, and tannins (Santiago et al., 2017). It was reported to be used ethnomedically in the treatment of different kinds of medical conditions such as diabetes, muscle pain, fever, hypertension, and urinary tract infection (Polinag, 2003).

The physical and morphological properties of the *F. nota* leaf were investigated using scanning

electron microscopy (SEM) as well as contact angle and oil sorption measurements. The SEM is one of the most commonly used imaging technique for viewing, examining, and analyzing the micro and nano-structures of solid objects (Raval et al., 2019). The contact angle (CA) test is done by dropping a droplet of water and measuring the angle the droplet makes upon contact on the sample surface. A surface is considered hydrophobic when its contact angle is  $\theta \geq 90$ , and is hydrophilic when  $\theta < 90$ . At contact angles  $\theta \geq 145^\circ$ , a surface is considered superhydrophobic (Law, 2014). The researchers developed a modified oil sorption test method based on Zeiger et al. (2016) and Resurreccion et al. (2019).

To date, there have been no published data yet on *F. nota* reporting the leaf structures and associated properties. This preliminary study hopes to provide relevant information on how the plant's leaf properties can be explored especially in relation to phytoremediation.

## 2. METHODOLOGY

### 2.1 Plant Collection and Initial Preparations

The *F. nota* leaves were collected from De La Salle University (DLSU) Laguna Campus in Biñan, Laguna, Philippines, between September to November 2023. The plant was verified by the Bureau of Plant Industry, Crop Research and Production Support Division. Undamaged leaves of uniform color and size (four to six inches, as measured from the base to the apex) were selected for the study. The leaves were initially prepared following the procedures of Wang et al. (2014) and Resurreccion et al. (2021) with some modifications.

### 2.2 Experimental Design

#### 2.2.1. Scanning Electron Microscopy

The prepared leaves described in the previous section were cut into 0.5 x 0.5-inch squares and immediately attached to a glass slide using double-sided tape. To determine the *F. Nota* leaf surface characteristics, such as trichome type and density,

scanning electron microscopy (SEM; ThermoFisher Scientific Phenom XL Desktop type) was done at magnifications of 500x, 1000x, 3000x, and 5000x.

#### 2.2.2. Wettability

The prepared leaves were cut into 0.5 x 0.5-inch squares and immediately attached to a glass slide using double-sided tape. To determine the wettability of the leaf surface, the contact angle (CA) was measured using a tensiometer (Biolin Scientific Optical Tensiometer).

#### 2.2.3. Oil Sorption Capacity

The prepared leaves described in the previous section were cut using a puncher into circles 1.5 inches in diameter, air-dried for 2 hrs. under the shade, and then placed in between book pages to keep the leaves flat. The capacity of the *F. nota* leaf to absorb SAE 40W mono-grade motor oil (SEAOIL) was measured by submerging the abaxial side, and then both the abaxial and adaxial sides. The leaf mass was carefully measured before and after submersion.

The abaxial side of the leaf was placed carefully onto the motor oil for 90 seconds, making sure that the adaxial side was not in contact with the oil. Mass was carefully measured before and after this step. The difference between the two mass values was used as the oil sorption capacity of the abaxial surface ( $Ab_T$ ).

To obtain values for the adaxial side, a new set of leaf circles was completely submerged in motor oil. Again, the final and initial masses were measured and the difference was used as the oil sorption capacity of the submerged leaf ( $S_T$ ). Unlike in the previous step for the abaxial side, it was more difficult to measure the oil adsorbed by the adaxial side alone so this step became necessary. Hence, Equation 1 was used to calculate the oil sorption capacity of the leaf's adaxial side (OSCadaxial).

$$OSCadaxial = S_T - Ab_T \quad (\text{Eq. 1})$$

where:

$S_T$  = mass with oil (submerged)

$Ab_T$  = mass with oil (abaxial side only)

The percent difference in mass between the *F. nota* leaves before and after oil sorption was determined using Eq. 2 below.

$$\text{Percent difference} = \frac{\text{final} - \text{initial}}{\text{initial}} \times 100 \quad (\text{Eq. 2})$$

where:

*initial* = mass before oil sorption

*final* = mass after oil sorption

### 3. RESULTS AND DISCUSSION

#### 3.1 Surface Structures

Figure 1A shows the microstructures, including the trichomes and stomatal pores, present on the abaxial side of *F. nota* leaf. These trichomes are unicellular and non-glandular, tapering to a sharp apex, and exhibiting a distinctive hook-like structure at their apices (Figures 1A and 1B). Other plants in the genus *Ficus* (e.g., *F. pumila*, *F. pulmata*, and *F. auriculata*) also exhibit unicellular and non-glandular trichomes on their abaxial side (Khan et al., 2011). Figure 1C clearly shows the stomatal pores on the abaxial side of the *F. nota* leaf. On the other hand, the wavy or rugged surface structures are indicative of the presence of epicuticular wax crystals (Kim, 2008), which were found present in both the abaxial and the adaxial sides of the leaf (evident in Figures 1B to 1D).

The trichomes on the abaxial side are sparsely distributed. According to Pandey and Nagar (2002), leaves with a trichome density greater than 25 per sq. mm. are more hydrophobic. For *F. nota*, the low number of trichomes seen may initially suggest its water retention property or hydrophilicity although other parameters may also be relevant such as the presence of hydrophobic molecules. Lastly, Figure 1D shows that the adaxial side of *F. nota* lacks visible trichomes.

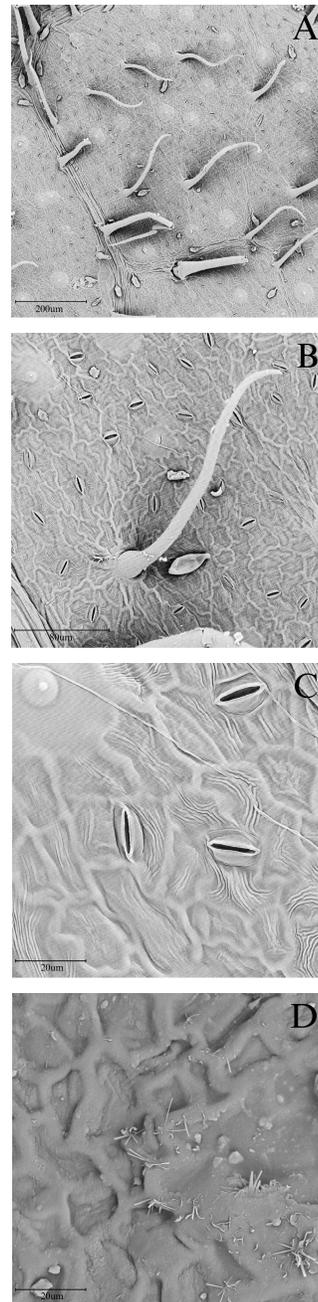


Fig. 1. Scanning electron micrographs of the abaxial (A, B, and C) and adaxial (D) leaf surfaces of *Ficus nota*. A: scale bar = 200 μm, 300x; B: scale bar = 80 μm, 1000x; C: scale bar = 20 μm, 3000x; D: scale bar = 20 μm, 3000x.

### 3.2 Wettability

The abaxial leaf surface of *F. nota* yielded a mean contact angle of  $86.07^\circ$  ( $n=3$ ), which, according to Law (2014), is classified as hydrophilic ( $\theta < 90^\circ$ ). Trichome density can be correlated to either hydrophobicity or hydrophilicity of the plant leaf surface. A study done by Wang et al. (2015) on *Cucurbita pepo* supports this claim. The adaxial leaf surface of *C. pepo* has a contact angle of  $70^\circ$  and was observed to be hydrophilic. Imaging revealed that its leaf surface was sparsely covered with villous trichomes. Another study by Lott (2021), compared the hydrophobicity of five different plants (*Elaeagnus umbellata*, *Malus* sp., *Ilex* sp., and two different *Manilkara* sp.). It was revealed that hydrophobicity increased as trichome density increased, regardless of trichome type. The paper of Resurreccion et al. (2021) that studied *Hibiscus tiliaceus* Linn. also verified this. The abaxial surface of the *H. tiliaceus* plant leaf was covered with dense stellate trichomes and exhibited high oil sorption capacity. It has a contact angle near  $140^\circ$  and is highly hydrophobic. *F. nota* shows a low density of hook-like trichomes on its abaxial side (Fig. 1A). However, epicuticular wax crystals are evident on this surface, as well as on the adaxial side of the leaf. This will be discussed in the next section, as their presence can explain the leaf's high oil sorption capacity.

The adaxial side of the *F. nota* leaf yielded a mean contact angle of  $93.85^\circ$  ( $n=3$ ). This classifies the adaxial side of the leaf as slightly hydrophobic ( $\theta \geq 90^\circ$ ) despite the absence of trichomes (Fig. 1D). Epicuticular wax crystals are present (wavy or rugged structures on the surface according to Kim (2008)). This might suggest the reason for the hydrophobicity (i.e., oleophilicity) of the adaxial side despite the absence of trichomes (Koch & Barthlott, 2006). The epicuticular wax crystals contribute to the hydrophobic nature of plant surfaces, preventing water from adhering to the leaf surface (Arand et al., 2021). The surface tension of water causes it to form spherical droplets, while the presence of epicuticular wax crystals significantly reduces both the contact area and surface adhesion (Koch & Barthlott, 2006). Furthermore, the main components of epicuticular waxes are known to exhibit hydrophobic

properties resulting to a contact angle between the range,  $94-109^\circ$  (Wang et al., 2015). In particular, the presence of components like 1-triacontanol significantly contributes to its water-repellent properties due to the molecule's lipid nature (Hagedorn et al., 2017).

### 3.3 Oil Sorption Capacity

Table 1 shows the oil sorption capacity of the *F. nota* leaf. The abaxial side of the leaf can absorb 4.08 g (407%) of oil per gram of leaf, while the whole leaf can absorb 4.36 g (436%) of oil per gram of leaf. The oil sorption capacity of the adaxial side of the *F. nota* leaf can be computed by computing for the difference between the average percent change of the submerged leaf and that of the abaxial side. The small percentage value (28.37%) of this side is due to the absence of trichome structure and the presence of only epicuticular wax crystals on the adaxial surface of the leaf. As such, it can be said that the *F. nota* leaf has the capability to absorb oil four times more than its original mass. It is evidently seen from the results that the abaxial side constitutes most of the oil sorption capacity of the leaf. A previous study on *Hibiscus tiliaceus* Linn. has shown high sorption capacity ( $1.4227 \pm 0.0622$  g/g and  $1.7693 \pm 0.0793$  g/g using mineral oil and motor oil, respectively), and this was attributed to the surface structures of the leaf (Resurreccion et al., 2021). The *H. tiliaceus* leaf has a dense and complex network of overlapping stellates. In the case of *F. nota* leaf, the abaxial surface has sparse trichomes with hook-like structures at their apices. Although the leaf surface characteristics of *H. tiliaceus* and *F. nota* leaves are different, both leaves exhibit excellent oil sorption capacities. Hence, the high oil sorption capacity of *F. nota* cannot be entirely due to trichome density. The presence or absence of wax crystals on these surfaces may have also contributed to the ability of the leaves to absorb oil.

*F. nota*'s oleophilic (oil sorption) capability can be used in various applications, such as oil spill cleanups. There are multiple ways of cleaning up oil spills, among them is through the use of oil sorbents. Oil sorbents are made from organic, inorganic, or synthetic materials capable of absorbing oil from the ocean

(International Tankers Owners Pollution Federation, n.d.). Plants such as *Salvinia molesta* and *Pistia stratiotes* have been noted by Zeiger et al. (2016) for their oleophilic capabilities, rivaling that of artificial oil sorbents. Furthermore, plants such as *Colocasia esculenta* have also shown potential for oil spill cleanup (Bing et al., 2013). The *F. nota* plant can become a cheaper, more accessible, and sustainable alternative to conventional oil sorbents as it is native here in the Philippines and is also not listed as a plant of concern by the IUCN.

Table 1. Oil sorption results for *F. nota*

	Abaxial	Submerged
Initial	0.1921g	0.1998g
Final	0.9752g	1.0716g
Average percent change	407.88%	436.17%

#### 4. CONCLUSIONS

Scanning electron micrographs revealed that the abaxial surface of *F. nota* exhibits pointed, non-glandular trichomes characterized by sparse, hook-like structures. The abaxial surface of the leaves gave a mean contact angle of 86.07° (n = 3), which makes the surface hydrophilic as its contact angle is less than 90°. In contrast to this, the adaxial (upper) surface of the leaves demonstrated a mean contact angle of 93.85° (n = 3), which is categorized as slightly hydrophobic as its wettability exceeds 90°. For the oil sorption capacity, the average percent change in mass of the abaxial surface was 407.88 %, while the submerged leaf was 436.16 %.

From the SEM micrographs, information on the presence or absence of trichomes on both the adaxial and abaxial surfaces of *F. nota* was gathered. The varying wettability results suggest that the two sides of the leaf have different interactions with water and other liquids. Additionally, the average percent change in oil sorption capacity for both the abaxial and submerged (both sides of the leaf) leaf surfaces demonstrated a high capacity for oil sorption, a valuable factor in

evaluating the leaf's potential in phytoremediation.

To gain a deeper understanding of the factors that influence the hydrophobicity of the leaf surfaces in *Ficus nota* and other plant species, future studies should assess and evaluate the leaf surface characteristics using a more quantitative approach. Specifically, measuring the trichome density and epicuticular wax crystal distribution may help in investigating the contribution of these microstructures to hydrophobicity. Furthermore, incorporating advanced analytical techniques, such as Fourier-Transform Infrared Spectroscopy (FTIR), to identify the functional groups present on the leaf's surfaces will provide an enhanced perspective of how these components interact with unidentified variables that affect the hydrophobicity of the leaf surface.

#### 5. ACKNOWLEDGMENTS

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