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Calculation of Volume and Surface Area by Determining Geometric Modeling of Some Microstructures

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***Abstract* –** In this study, it was determined that some plant microstructures that we can observe under the microscope have geometric modeling. We can easily observe that many living and non-living substances that share our planet with us have a geometric structure. In addition to the macrostructures of the visible external appearances of these substances, there are also microstructures that make up all of these structures and that we can only observe under a microscope. It is not possible to observe the microstructures of these substances with the naked eye. This study we conducted showed that the geometric models of these microstructures that have geometric modeling can be determined and the numerical properties such as volume and surface area can be determined. In mathematical evaluations, mathematical concepts determined in the light of literature were used to describe the geometric models of microstructures. In the study, literature information about geometric structures and their mathematical formulas was evaluated. In addition, the structures of the geometric models obtained from these definitions were shown with figures. As a result of our research, we found that the plant tissues whose microscopic structures we examined have half sphere + circle and half sphere + frustum conical the geometric models.

Keywords – Geometric Modeling, Microstructure, Sphere, Surface Area, Volumes.

I. INTRODUCTION

Most of the living and non-living entities that we share the same planet with have geometric structures. There are also microstructures that we cannot see with the naked eye but can observe with the help of a microscope. In this study, we determined that some micro morphological structures of plant secretion hairs have geometric modeling. In addition we determined that the biovolume and surface area of these microstructures can be measured and calculated with the help of similar geometric models.These micro structures take on specialized geometric shapes depending on the complexity of their functions. These shapes enable them to perform their duties in the most efficient way. In this study we gived, geometric modeling description and the math formulas of volume and surface areas of secretion hairs of some plant which are aromatic and often used as herbs, spices, folk medicines and fragrances. In our study, we detected two types of geometric modeling in the microscopic structures of some of secretion hairs we examined,

There are some mathematical studies in the literature on the visible external structures of plants [1], [2]. Geometric modeling studies of microstructures, which are the subject of our study, are quite limited. [3],

[4], [5]. In addition, no study has been found on the calculation of biovolume and surface area of these microstructures. There are similar studies in the literature defined with the help of geometric models and mathematical formulas. However, these studies are mostly on visible structures and macrostructures [6].

In this study, microstructures of plant secretion hairs were examined from a different perspective.

II. MATERIALS AND METHOD

To determine the geometric modeling of the microstructure of plant secretion hairs, sections were taken and examined under a microscope. The samples obtained were examined using a Leica DM 3000 light microscope. Afterwards, photographs of micromorphological structures were taken using a motorized Leica DM 3000 microscope.

In mathematical evaluations, mathematical concepts determined in the light of literature were used to describe the geometric models of microstructures. In the study, literature information about geometric structures and their mathematical formulas was evaluated. In addition, the structures of the geometric models obtained from these definitions were shown with figures (Figure 1,2). The numerical values of the geometric models of these microstructures examined under the microscope, the determination of mathematical formulas that can be used in calculating numerical properties such as volume and surface area, have been determined based on the geometry data in the [7], [8], [9]. Describe in detail the materials and methods used when conducting the study. The citations you make from different sources must be given and referenced in references.

III. RESULTS

Our study has shown that the micromorphological structures of some plant tissues have different geometric models and that these microstructures can be defined numerically and shown with formulas. In the study, the information on the subject in the literature was obtained in the evaluation of microstructures in a geometric framework.

As a result of our research, we found that the plant tissues whose microscopic structures we examined have half sphere+ circle and half sphere+ frustum conical the geometric models. The geometric structures of these geometric models, microscopic photographs showing their microstructures and the formulas for the numerical properties of these structures are given in the study (Figure 1,2).

Geometric models identified in the study;

1. Half sphere+circle

It has been observed that some of the microstructures we have examined have the half sphere + circle geometric models (Figure 1).

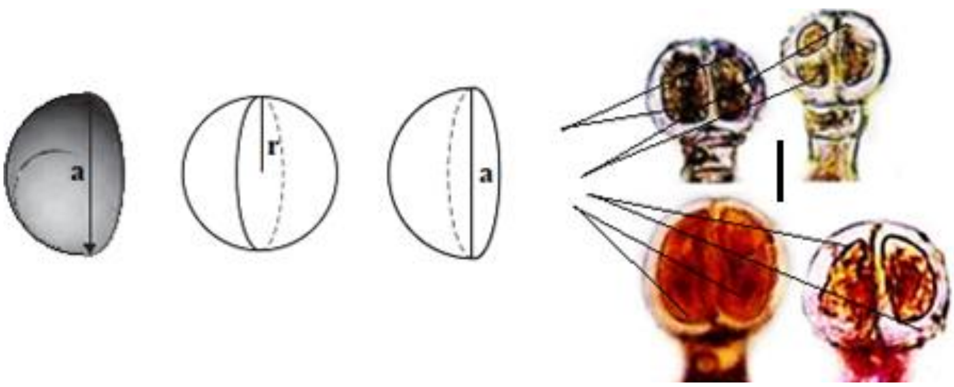

Fig. 1 Half sphere +circle micro structure (original microscope image) and geometric model [10]. Scala bar:15µm

The volume of the half sphere + circle (V):

The volume formula of the half sphere geometric model is shown below;

$$\mathrm{V} = \frac{1}{2}.V_1$$

$V_1 =$ Volume of sphere

$$V_1 = \frac{4}{3}\pi\left(\frac{a}{2}\right)^3$$

$$V_1 = \frac{4}{3}\pi\frac{a^3}{8}$$

$$V_1 = \frac{4}{24}\pi a^3$$

$$V_1 = \frac{4}{12}\pi a^3$$

V=Volume of the half sphere;

$$\frac{1}{2}V_1 = \frac{1}{2}.\frac{1}{12}\pi a^3$$

$$\frac{1}{24}\pi a^3 .$$

The area of the half sphere +circle (A):

The area surface formula of the half sphere geometric model is shown below;

Where *a* is diameter and *r* is radius;

$A_1 =$ Surface area of a full sphere

$A_1 = \pi a^2$

$A_2 =$ Surface area of half sphere

$A_2 = \frac{1}{2}\pi a^2$

$A_{3=}$ the area enclosed by a circle of radius;

$A_3 = \pi r^2$

The combined area surface A $=(A_2 + A_3)$ of the half sphere+circle is,

$A = \frac{1}{2}\pi a^2 + \pi\left(\frac{a}{2}\right)^2$

$A = \frac{1}{2}\pi a^2 + \frac{1}{4}\pi a^2.$

$A = \frac{3}{4}\pi a^2 .$

2. Half sphere+ frustum conical

It has been observed that some of the microstructures we have examined are composed of the combination of half sphere and frustum cone geometric models. A conical frustum is a frustum created by slicing the top off a cone (with the cut made parallel to the base).

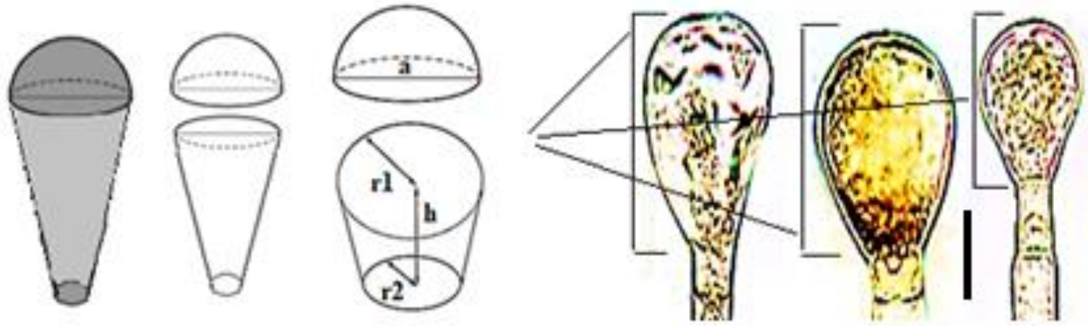

Fig. 2. half sphere+ frustum conical (original microscope image) and geometric model [10].
Scala bar:20µm

The volume of the frustum conical + half sphere (V):

The volume formula of the half sphere + frustum conical geometric model is shown below.

V = Volume of frustum conical + half sphere

$V = V_1 + V_2$

V_1 = Volume of frustum conical

Where r_1 is the radius of the top circle of the frustum conical, r_2 is the radius of the base circle and h is the height of the cone;

$$V_1 = \frac{1}{3}\pi h(r_1^2 + r_2^2 + r_1 r_2)$$

V_2 = Volume of half sphere

where a= $2r_1$, the volume of the half sphere (V_2):

$$V_2 = \frac{2}{3}\pi r_1^3$$

The combined volume V ($V_1 + V_2$) of the frustum conical and half sphere is,

$V = V_1 + V_2$,

$V = \frac{1}{3}\pi h(r_1^2 + r_2^2 + r_1 r_2) + \frac{2}{3}\pi r_1^3$.

The area of the frustum conical + half sphere (A):

The area surface formula of the half sphere + frustum conical geometric model is shown below;

$\mathrm{A} =$ Area of frustum conical + half sphere

$$\mathrm{A} = A_1 + A_2$$

$A_1 =$ Area surface of frustum conical

$$A_1 = \boldsymbol{\pi}(\boldsymbol{r_1} + \boldsymbol{r_2})\sqrt{(\boldsymbol{r_1} - \boldsymbol{r_2})^2 + \boldsymbol{h^2}}$$

$A_2 =$ Area surface of half sphere

Where a$= 2r_1$,
the area of the half sphere,

$$A_2 = \frac{3\pi}{4}\, a^2$$

The combined area surface A ($A_1 + A_2$) of the frustum conical and half sphere is,

$\mathrm{A} = A_1 + A_2$,

$$A = \pi(r_1 + r_2)\sqrt{(r_1 - r_2)^2 + h^2} \; + \frac{3\pi}{4}\, a^2 \; .$$

IV. DISCUSSION

As a result of the research, it was seen that the microscopic structures forming the secretion hairs of the plant samples that constitute the subject of the study have different geometric properties. With this study, it was tried to reveal the geometric properties and models hidden in some microstructures and to show that they can be used as sample models in many areas. The detection of these models in similar microstructures will enable the perfect functioning hidden in them to be put into use. In addition, it was seen that the microscopic structures belonging to different geometric models observed in the examined microstructures came together in a certain order and formed the whole. These geometric models they have enable them to perform their duties in the most efficient way.

By revealing the geometric modeling features of these hidden structures that can only be observed under a microscope, under the guidance of numerical concepts, we can provide the use of these microstructures as sample draft models in many different fields. There are similar studies in the literature on the micromorphological structures of plants having geometric models [11], [12], [13]. In addition, there are similar geometric studies on macro structures [14], [15].

In the study, the geometric structures of the samples examined microscopically, and the numerical formulas of these structures were evaluated using mathematical concepts determined in the literature.

V. CONCLUSION

These geometric models in microstructures, whose equivalents we find in geometry and can be defined in this sense, will enable us to obtain clear information about their functions by determining their quantitative properties such as volume and area with mathematical formulas. We think that this study will also bring a different perspective for future research in the relevant field.

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