Proceeding books:
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

Anatomy Structure of Pericarpium and Pome Fruit

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ABSTRACT

Research on anatomical structure of pericarpium and pome fruit have not been done yet. The aim of this study is to know the anatomical structure from pericarpium and pome fruit. The sample for pericarpium fruit is apple and pear, while tomato and orange are used for the pome fruit sample. The anatomical structure were observed microscopically using transverse and longitudinal slices of the developing pericarp. The results of this study indicated the presence of stomates on the epidermis tissue and is founded epicarp of pome fruit. Another anatomical structures are supporter tissue i.e. sclerenchyme with lignified sclereides in it, and parenchyma with pigmentation. The anatomical structure of epicarp on pericarpium fruit consisted of epidermis cell, parenchyma cell and secretory cells. Mesocarp of four kinds of fruits consisted of parenchyma tissues that each of the cell contained starch grains with pigmentation (antosianin) and ergastic compounds. There are ergastic compounds i.e. crystal, and atsiri oil substances. Antosianin can be found in apple and tomato fruit skin, whereas pear and orange fruit contained more ergastic substances. The invention from the anatomical research can be associated for the function and the advantage from the plant or something special that affected by adaptation pattern.

Keywords: Pome fruit, pericarp, mesocarp, endocarp

INTRODUCTION

Fruits are found in three main anatomical categories: aggregate fruits, multiple fruits, and simple fruits. Simple fruits are formed from a single ovary and may contain one or many seeds. They can be either fleshy or dry. In fleshy fruit, during development, the pericarp and other accessory structures become the fleshy portion of the fruit [1]. The types of fleshy fruits are berries, pomes, and drupes [2]. The fleshy portion of the pomes is developed from the floral tube and like the berry most of the pericarp is fleshy but the endocarp is cartilaginous, an apple is an example of a pome [1].

In berries and drupes, the pericarp forms the edible tissue around the seeds. In other fruits such as Citrus and stone fruits (Prunus) only some layers of the pericarp are eaten. In accessory fruits, other tissues develop into the edible portion of the fruit instead, for example the receptacle of the flower in strawberries.

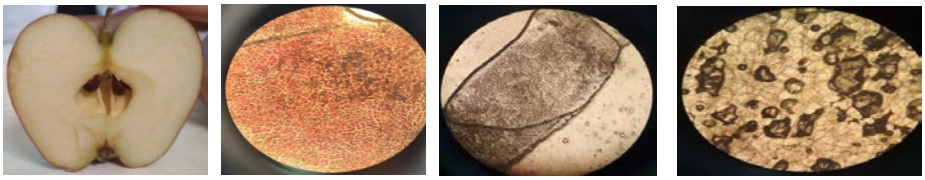
In fleshy fruits, the pericarp is typically made up of three distinct layers: the epicarp (also known as exocarp), which is the outermost layer; the mesocarp, which is the middle layer; and the endocarp, which is the inner layer surrounding the ovary or the seeds. In a citrus fruit, the epicarp and mesocarp make up the peel. Lately, the literature about fleshy fruits anatomy structure is still limited. Research about anatomy structure of plant organ is important for knowing tissue composition or structure, cell, and ergastic substances in the plant organ. The knowledge about anatomy structure can explain the reason for taste, odor, colour, and the merit of the plant organ hopely. The research anatomy structure of fruit is important for adding the information about the literature of fruit anatomy for teaching and research sources.

RESEARCH METHOD

Investigations were carried out using fragments of fruit and peel sampled from the equatorial part of the fruit. Hand-cut samples obtained from fresh material were also viewed under light microscope to detect the distribution of the cuticle, chlorophyll, and lignified stone cell walls. Hand-cut cross-sections from fragments of apple, pear, tomato, and orange fruit. The anatomical description was made analyzing semi-permanent and permanent slides made with transverse and longitudinal sections of the pericarp part. The slides were made in agreement with methodology described by Mourao & Beltrati [2].

RESULTS AND DISCUSSION

A pome is an accessory fruit composed of one or more carpels surrounded by accessory tissue. The accessory tissue is interpreted by some specialists as an extension of the receptacle and is then referred to as "fruit cortex"and by others as a fused hypanthium. It is the most edible part of this fruit. Although the epicarp, mesocarp, and endocarp of some other fruit types look very much like the skin, flesh, and core respectively of a pome, they are parts of the carpel. The epicarp and mesocarp of a pome may be fleshy and difficult to distinguish from one another and from the hypanthial tissue. The endocarp forms a leathery or stony case around the seed, and corresponds to what is commonly called the core. Pome-type fruit with stony rather than leathery endocarp may be called a polypyrenous drupe. The shriveled remains of the sepals, style and stamens can sometimes be seen at the end of a pome opposite the stem, and the ovary is therefore often described as inferior in these flowers.

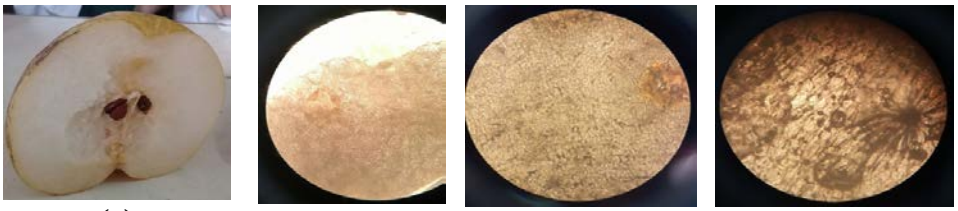


(a) (b) (c) (d)

Fig 1. The emergence of apple fruit sections: Apple in macroscopically (a); Apple outer epicarp in microscopically (b); Apple inner epicarp in microscopically (c); Apple mesocarp in microscopically (d)

A cross section of a apple shows the star-shaped endocarp housing the seeds (Figure 1). Each of the 5 chambers houses 1-2 seeds. The total number of seeds per apple (5-10) depends on the energy resources of the tree.

Around the star-shaped seed capsules are ten yellow-green dots that are the remnants of the flower stamens. The sepals surrounding the petals of the flower are at one end of the apple. Hypanthium that grows up and around the ovary housing the soon-to-be seeds, and filled with starch granules synthesized by the leaves over a summer's worth of sunlight.



(a) (b) (c) (d)

Fig 2. The emergence of pear fruit sections: Pear in macroscopically (a); Pear outer epicarp in microscopically (b); Pear inner epicarp in microscopically (c); Pear mesocarp in microscopically (d)

Pears, like apples, are members of the rose family, Rosaceae. Members of this family have fleshy fruits, known in botanical circles as pomes. The major parts of the pear are the core, the hypanthium and the stalk. The pear's core is the seed-bearing ovary of the fruit. Surrounding the numerous seeds is the ovary wall. Although the ovary wall is edible, its texture is a bit thick and dry. When you core a pear, you remove both the ovary wall and the seeds. The part of the pear that you eat is the hypanthium. In pears, this structure is referred to as accessory tissue because it is not part of the actual ovary. A pear's hypanthium contains numerous stone cells with thick walls. These cells give the pear its unique, grainy texture. The skin is part of the hypanthium. The stalk connects the fruit to the tree and supports the leaves. This part of the fruit is not edible.

The epidermis in both cultivars was formed by rectangular cells, whose height (length of anticlinal walls) was greater than the width (length of periclinal walls) (Figure 2). In this stage of fruit development, the epidermis exhibited features of meristematic tissue, as divisions of its cells were noted. At some sites, the epidermis was single-layered and divisions were visible along anticlinal walls; at other sites, the epidermis formed two cell layers as a result of division along the periclinal walls.

The hypodermis cells contained numerous chloroplasts and the cytoplasm of the epidermis cells contained cell nuclei, mitochondria, chloroplasts containing a few starch grains, and endoplasmic reticulum. The hypodermis in the fruits of both cultivars exhibited.

According to Tao et al. [4], the number of sclereids in pear parenchyma determines longterm storability of fruits and the length of their shelf life. Cultivars with stone cells (with lignified cells in the skin) lose lower amounts of water through microcracks and lenticels than these with nonlignified cells [5]. The emergence of pears (Figure 2.d) indicates the presence of secondary metabolites. Tannin is one of secondary metabolites. Lees et al. [6] have found that a high content of tannin compounds, which have preservative-bactericidal activity, enhances fruit storability. In the present paper it has been observed that high amounts of tannin materials are frequently accompanied by great numbers of stone cells.

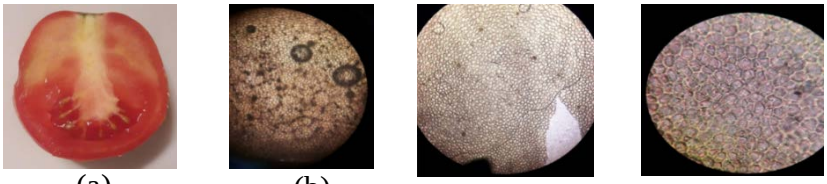


Fig 3. The emergence of tomato fruit sections: Tomato in transverse section of five locule tomato fruit macroscopically (a); Tomato epicarp in microscopically (b); Tomato mesocarp in microscopically (10x) (c); Tomato mesocarp in microscopically (40x) (d)

The tomato though commonly classified as a vegetable is really a fruit, a berry in fact. Tomato fruits exibit all of the common characteristics of berries. The fruit develops from the ovary of the flower. The tomato is fleshy due to the pericarp walls and skin (Figure 3). Finally there are several seeds in each tomato. Tomatoes can be either bilocular or multilocular. Most cultivated varieties except cherry tomatoes have four or five locules. The locules are surrounded by the pericarp. The pericarp includes the inner wall, columella; the radial wall, septa; and the outer wall. The pericarp and the placenta comprise the fleshy tissue of the tomato. The seeds are located inside of the locular cavities and are enclosed in gelatinous membranes.

There are vascular bundles throughout the outer wall of the pericarp and travelling from the stem to the center of the tomato and from there radiating to each seed. Tomato fruit consists of pericarp and seeds. Pericarp is composed from: exocarp, mesocarp and endocarp. Outer layer of cells in the exocarp is epidermis and below there are two to three layers of hypodermal cells with thick cell walls. Epidermis hasn't stomata and has relatively thin cuticle, and the thickness of cuticle increases with the fruit growth.

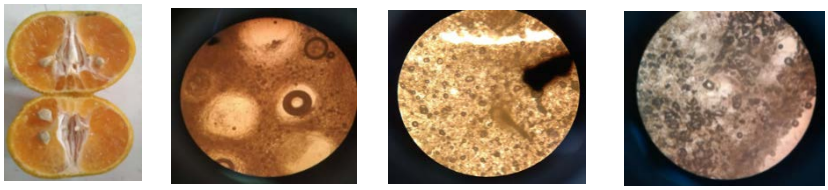
Mesocarp is the fleshy middle layer of the pericarp of a fruit that made from large thin wall cells and vascular tissue. The mesocarp is found between the epicarp and the endocarp and usually the part of the fruit that is eaten. For example, the mesocarp makes up most of the edible part of a peach, and a considerable part of a tomato. Mesocarp may also refer to any fruit that is fleshy throughout. Fruit vascular tissue is connected to pedicel vascular tissue. One vascular branch pass trough central and radial mesocarp to the seeds, while other vascular branches radialy pass through outer layer of mesocarp parallel to fruit surface, with week branching on proximal side, but more on distal side with simultaneously decreasing ratio of xylem and increased ratio of phloem.

Endocarp is unicellular layer boundaring locular cavity. Carpelar septe divide ovarium into two or more loculi. Elongated central placenta, with attached seeds, is made of parenchima tissue and represents primary tissue which later fills the locular cavities.

In citrus fruit, the mesocarp is also referred to as albedo or pith. It is the inner part of the peel and is commonly removed before eating. In citron fruit, where the mesocarp is the most prominent part, it is used to produce succade.

Endocarp is a botanical term for the inside layer of the pericarp (or fruit), which directly surrounds the seeds. It may be membranous as in citrus where it is the only part consumed, or thick and hard as in the stone fruits of the family Rosaceae such as peaches, cherries, plums, and apricots. The endocarp is separated into sections, which are called segments. These segments are filled with juice vesicles, which contain the juice of the fruit. Citrus fruit is considered a berry because it has many seeds (pips),

is fleshy, soft and develops from a single ovary. Citrus fruit is characterized by nonclimacteric development. Pericarp tissue surrounding a seed that develops from the ovary wall of the flower.



(a) (b) (c) (d)

Fig 4. The emergence of orange fruit sections: Orange in macroscopicaıly (a); Orange epicarp in microscopically (b); Orange endokarp in microscopically (c); Orange mesocarp in microscopically (d)

The exocarp is the orange rind contains numerous pits containing volatile oil glands. Albedo mesocarp is a spongy white tissue on the inside of the rind. Albedo consists of spongy layers of perenchymatus cells rich of glycosides (flavanones). Pectin and pectic enzymes make it bitter. The thread-like vascular bundles run from the albedo along the fruit's axis forming a network outside the carpels. They are rich in peroxidase.

CONCLUSIONS

The anatomical structure of epicarp on pericarpium all fruit consisted of epidermis cell, parenchyma cell and secretory cells. The invention from the anatomical research can be associated for the function and the advantage from the plant or something special that affected by adaptation pattern.

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