Identification of colour pigments in root vegetables - Carrot (*Daucus carota*) and Beetroot (*Beta vulgaris*) by foldscope

Subramani Prabhu and Mani Rajasekar*

Abstract— Foldscope is an inexpensive and light weight microscope, magnetic strip attached with ball lens for magnification aspects, and a battery-powered LED for illumination. In this paper carrot (*Daucus carota*) and beetroot (*Beta vulgaris*) are used to study with foldscope. The study led to identification of pigments in root vegetables which is the reason for the color of those vegetables. Carotenoids present in the cell leading to *Daucus carota* orange colour and *Beta vulgaris* contains betalains in vacuole showing red colour.

Index Terms—Foldscope, Mobile mounted foldscope, Portable microscope, Carrot cells, Beetroot cells, 140X magnification, *Beta vulgaris, Daucus carota.*

1. INTRODUCTION

Foldscope is an optical microscope that developed by Manu Prakash and designed to cost less than 1 USD to build. The Foldscope weighs 8 grams and that provide magnification from 140X to 2,000X [1]. It can be attach to a smartphone with the help of magnet for the user to take pictures of the magnification. It is compact and light, especially when compared with conventional field microscopes. It is a origami-based optical microscope assembled with magnetic coupled lenses [2, 3].

In addition, *Daucus carota* and *Beta vulgaris* is a root vegetables, the orange carrots are also more nutritious because the coloring is derived from pigment compounds called carotenoids. Specifically, orange carrots are colored by alpha- and beta-carotene [4], Nowdays, orange carrots only available in the markets, but it has more varieties. Red, yellow, white and purple are other varieties of *Daucus carota*. Colours not a matter we can eat all variety of colour carrots. The small red granules are inside a carrot cell that is called chromoplasts. Chromoplast is the pigments other than chlorophyll [5].

Beta vulgaris belongs to family of Amaranthaceae. The red pigments in beets are called betalains. Red beet is a rich source of water-soluble betalains; Beetroot is a useful subject for this experiment because of betalains pigment. These pigments are a useful to indicate membrane fluidity as they are typically contained within the vacuole of intact beetroot cells. An increase in membrane fluidity will cause the pigment to leak out of the cell. The roots of beet have long been used in traditional Arab medicine to treat a wide variety of diseases. It used for antitumor, carminative, emmenagogue, and hemostatic and renal protective properties and its used cardiovascular conditions [6]. Beetroot is known to be a powerful antioxidant [7]. Beetroot also believed to help enhance human sex hormones and as an aphrodisiac. The juice of beetroot is also consumed as a natural remedy for sexual weakness and to get rid of kidney and bladder stones [8]. Beetroot is a natural food to boost the energy in athletes [9, 10]. The beetroot leaves are recommended by the Father of Medicine "Hippocrates" for faster healing of wounds [11]. Recent reports indicate that *Beta vulgaris* extracts (root) possess antihypertensive, hypoglycemic, antioxidant [12], anti-inflammatory, and hepatoprotective activities [11, 13, 15]. Previously, red beetroot extract has been demonstrated to be an effective multiorgan tumor suppressing agent in laboratory animals [14, 16, 17].

2. MATERIALS AND METHODS

Foldscope is a small, handheld, paper-based microscope with a light-emitting diode (LED) light source. It can be held up to the eye for visualization of slides [1], however we secured it to the camera lens of an mobile tab (Samsung Tab A-SMT285) by tape and magnets. Microscope slides were manually manipulated under the phone-mounted Foldscope lens [18, 19], and the presence or absence of colour pigments was noted on the tab screen. Iodine solution and Microscopic slide purchased from MERCK Scientific India Pvt Limited. Mobile tab (Samsung Tab A-SMT285) purchased from Amazon.in.

2.1. STAINING AND OBSERVATION

Cut the carrot slices and stained with iodine solution. Place a coverslip and wipe-out the additional iodine solution. Lugol's iodine (IKI) is a brown solution that turns black in the presence of starches and can be used as a cell stain, making the cell nuclei more visible, so it helpful to easily identify the cells and nucleus. Slices the beetroot and the slices were soacked into the distilled water (H_2O_2) for 5-10 minutes for removing the stain from beetroot observed under foldscope to determine

• *Corresponding Author : Molecular and Nanomedicine Research Unit, Centre for Nanoscience and Nanotechnology, Sathyabama Institue of Science and Technology (Deemed to be University), Tamilnadu, India, Ph-91 9710230530. E-mail: mrajasekar_83@yahoo.com (Dr. M. Rajasekar)*

the colour pigments.

3. RESULTS AND DISCUSSION

Foldscope root vegetables cells results, the large patch of cells homogenized with another cells, Cells contains cell wall, orange colour carotenoids, it is clearly visible on foldscope (Figure 1A). They give some parts of plants the color of red, yellow and orange. But in carrots orange colour carotenoids presented, so this orange carotenoid gives orange colour to carrots.

A beetroot cells also looks like same only but in these cells contains cell wall, cytoplasm, nucleus and betalains containing vacuole. Betalains are dark red in colour it inside of the vacuole. In some cells betalain were wayout while soacked, these cells are colourless and betalain presented cells are colourful. (Figure 1B). *Daucus carota* and *Beta vulgaris* tissues observed under the phone-mounted Foldscope (Figure 1C and D).

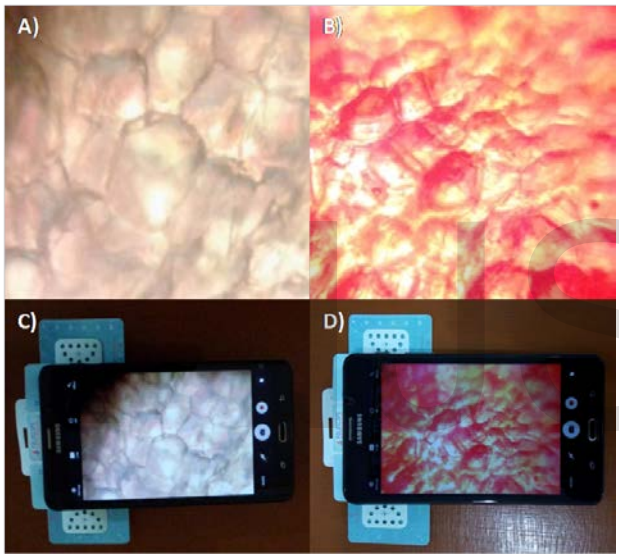

Figure 1. Both vegetables were observed at 140X magnification. A). *Daucus carota* cell wall and carotenoids. B). *Beta vulgaris* nucleus and betalains containing vacuole. C). *Daucus carota* cells and D).*Beta vulgaris* cells observed by mobile phone attached with foldscope.

4. CONCLUSION

The current studies about observation of colour pigments of root vegetables which gives the colour to that vegetables. In that review, carotenoids present in the cell and this is the reason for *Daucus carota* orange colour and *Beta vulgaris* contains betalains containing vacuole. Betalains is present inside of the vacuoles these are red in colour so the beetroots are red in colour.

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