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POLARIZING FILTERS INSTALLATION IN BIOLOGICAL MICROSCOPE USING RECYCLED MATERIAL

Instalação de filtros polarizadores em microscópio biológico utilizando material reciclado

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RESUMO

A microscopia de polarização é amplamente utilizada, porém, infelizmente, os *kits* de polarização para microscópios são dispendiosos. O visor dos aparelhos de telefone celular possui um filtro polarizador de material plástico. Este estudo propõe desenvolver um *kit* de polarização para microscópio biológico usando aparelhos celulares sucateados e testar a eficiência do equipamento. O processo de desmonte dos aparelhos de telefone e a montagem do equipamento foram realizados manualmente. Este foi testado quanto à diferença na qualidade de imagem do microscópio com e sem o filtro analisador e, também, quanto à eficiência do recurso instalado. Os resultados foram satisfatórios, mostrando que o equipamento aqui apresentado é uma alternativa para o aprimoramento no ensino e na pesquisa.

Palavras-chave: birrefringência, filtro polarizador, luz polarizada, microscopia de polarização, técnica alternativa.

ABSTRACT

The polarization microscopy is widely used, but unfortunately the polarized kits for microscopes are expensive. The display of cellular mobile phones has a polarizing filter made in transparent plastic material. This study aimed to development an alternative polarizing kit for biological microscope using scrapped cell phones and to test the effectiveness of the equipment. The process of dismantling the cellular mobile phone and assembling of equipment were made manually. This was tested for difference in microscope image quality with and without the analyzer filter and also on the efficiency of the installed feature. The results were satisfactory, showing that the equipment presents here is an alternative for the improvement of teaching and research.

Keywords: alternative technique, birefringence, polarization microscopy, polarized light, polarizer filter.

INTRODUCTION

The polarization microscopy is widely used in obtaining information about the structure and organization of cells and tissues, promoting the optical anisotropy determination of these materials. Using data obtained through these studies, it is possible to interpret the physicochemical and functional characteristics of these preparations (VIDAL & MELLO, 1987).

The polarization microscopy was first used in 1828 by William Nicol, who discovered the effects of polarized light when observing objects at crossed pair of polarizer (FARINA, 2010). One of them is positioned between the light source and the condenser, and is named polarizer filter. The other one, named analyzer filter, is installed on the viewing head of the microscope, above the objectives and below the ocular lens (LAWSON, 1972).

The light from the light source of the microscope is not polarized, in other words, vibrates in different planes. Passing through the polarizer filter, only the rays oriented with the filter can cross it. The light then becomes polarized, vibrating in a single plane (Fig. 1A). Upon reaching the analyzer filter that is 90º relative to the polarizer one, the polarized light is unable to cross it (CURTIS & TYSON, 1976). As a result, the obtained image is black, not light reaching the eyes of the observer (Fig. 1A).

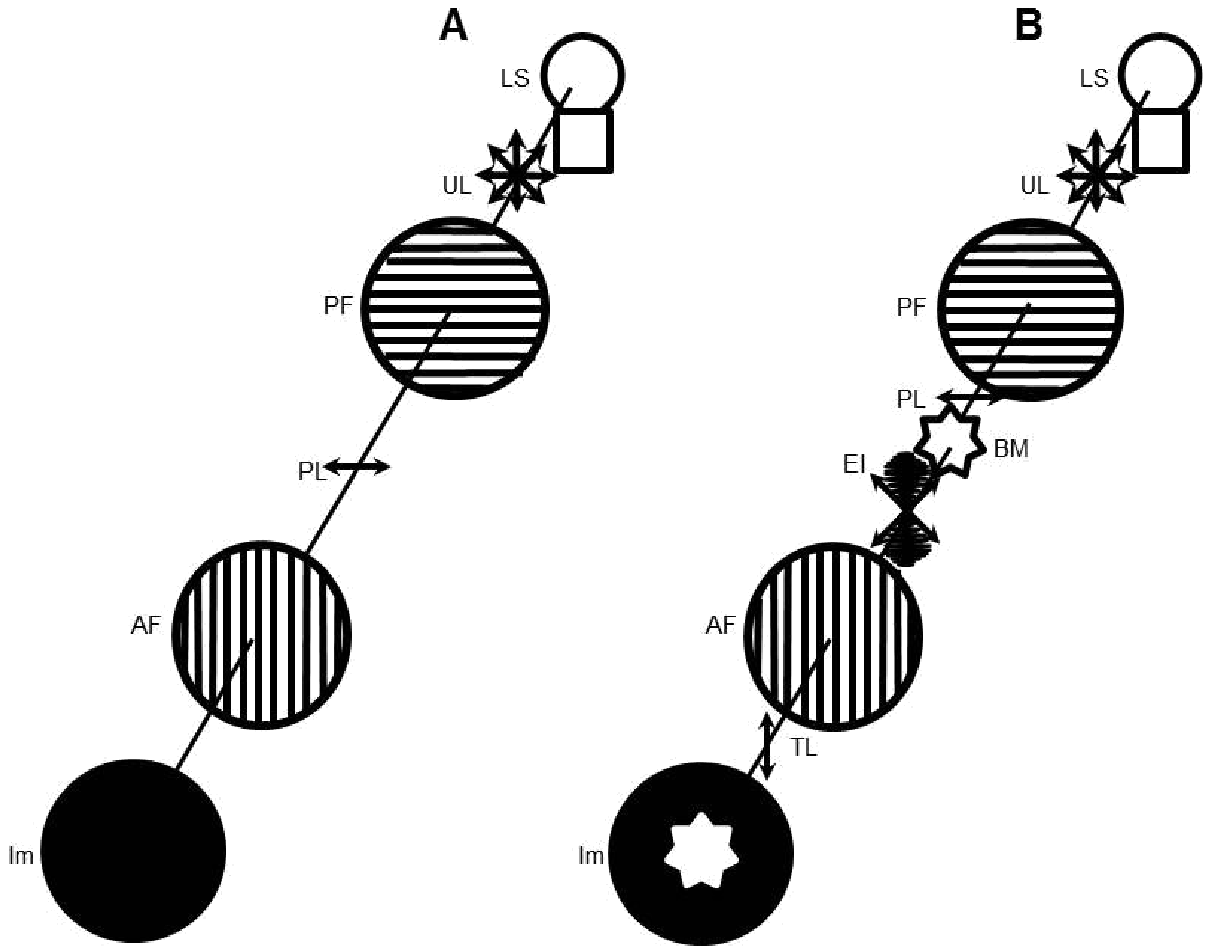

Figure 1. Graphical representation of the physical principles in polarization microscopy. **A.** With crossed polarizer and analyzers filters and without birefringent material between filters, resulting in a dark image. **B.** Like in A, but with birefringent material between filters, that leads in an elliptical interference resulting in a brilliant image. Abbreviations: **AF.** analyzer filter. **BM.** birefringent material. **EI.** elliptical interference. **Im.** Image. **LS.** light source. **PF.** polarizer filter. **PL.** polarized light. **TL.** transmitted light. **UL.** unpolarized light. Modified from Lawson (1972) and Curtis & Tyson (1976).

Some materials have a feature called anisotropy, and said birefringent (HECHT, 2002), as examples, the calcium oxalate crystals and starch grains, Birefringence is a properly of a body having two refraction indices. The light ray incident on a birefringent material is divided in two, where its propagation planes are oriented 90º to each other and 45º with the incident ray (Fig. 1B). One of them is faster, named ordinary, and another called extraordinary retarded in relation to the ordinary, resulting in a n elliptical interference type, perpendicular to the material (CURTIS & TYSON, 1976) (Fig. 1B).

When a birefringent material is observed at a polarization microscope, the elliptic interference resulted by the ordinary and extraordinary ways will be capable of crossing the analyzer filter, being in the same direction thereof, that is, perpendicular to the polarizing filter (CURTIS & TYSON, 1976). As a result, has the bright image of the birefringent body on a black background (LAWSON, 1972; FARINA, 2010) (Fig. 1B).

There are many materials capable of polarizing the light, but usually are used synthetic polarizer filters that are produced in large scale and have thin thickness (LAWSON, 1972), which facilitates handing. Polarization kits specific for installation on microscope are expensive, often unaffordable to labs in early structuring, or unfeasible for installation in large number of microscopes for teaching. However, polarizer filters are part of the constitution of various appliances (TVs, calculators, cellular mobile phone displays and other equipments with LCD monitor) used in daily and are, in many cases, discarded when the device reaches the limit of useful life or becomes obsolete (MORAES *et al.*, 2010).

Thus, keeping in view the importance of using polarizing microscopy, installation costs and the need to reuse part of the junk, this study aimed to develop an alternative polarization apparatus for biological microscope and to test the efficiency of the equipment.

MATERIAL AND METHODS

To construct the equipment were employed a basic binocular microscope of school use, brand Bioval (Fig. 2A), two cellular mobile phone scraps (Fig. 2B) and a cleaned histological slide.

Withdrawal of polarizers

The process of dismantling the cell phones was done manually, seeking to avoid damaging the display. This was gently removed from the apparatus (Fig. 2C). To remove the polarizer filter initially was employed a razor blade in a sharp edge of the display window to separate the filter. This was them quickly pulled in a single movement, being careful to not mark the adhesive on the bottom surface (Figs. 2D-E).

Filters installation

To analyzer filter installation, the microscope viewing head was removed and the filter adhered directly in the metallic frame, such to cover the entire light input into this part (Fig. 2F) using the proper filter adhesive. The edges were removed with a razor blade, so that the filter does not exceed the limits of the metallic circle (Fig. 2F). The microscope was reassembled. The other filter, also with own adhesive, was adhered in a histological slide properly cleaned with sulfochromic solution (PURVIS *et al.*, 1964). The edges of the filter were trimmed with a razor blade (Fig. 2G). This peace is the polarizer of the system.

Testing the equipment

The equipment was tested for image quality difference of the microscope with and without the analyzer filter, which cannot be removed without being damaged, and also on the efficiency of resource installed by use the pair polarizer and analyzer filters. In the first case, were analyzed histological sections of inflorescence of the orchid *Rodriguezia venusta*. To the second case were analyzed scraping of *Phaseolus vulgaris* cotyledons (bean seed) and of *Tillandsia recurvata* (bromeliad) epidermis, because they contain didactic birefringent structures.

To operate the equipment, the slide with the polarizer filter was positioned between the light source and the condenser diaphragm so as not to allow the incident light without passing across the filter. This filter was oriented 90º to the analyzer one, in other words, to give the darkest background possible (Fig. 2H).

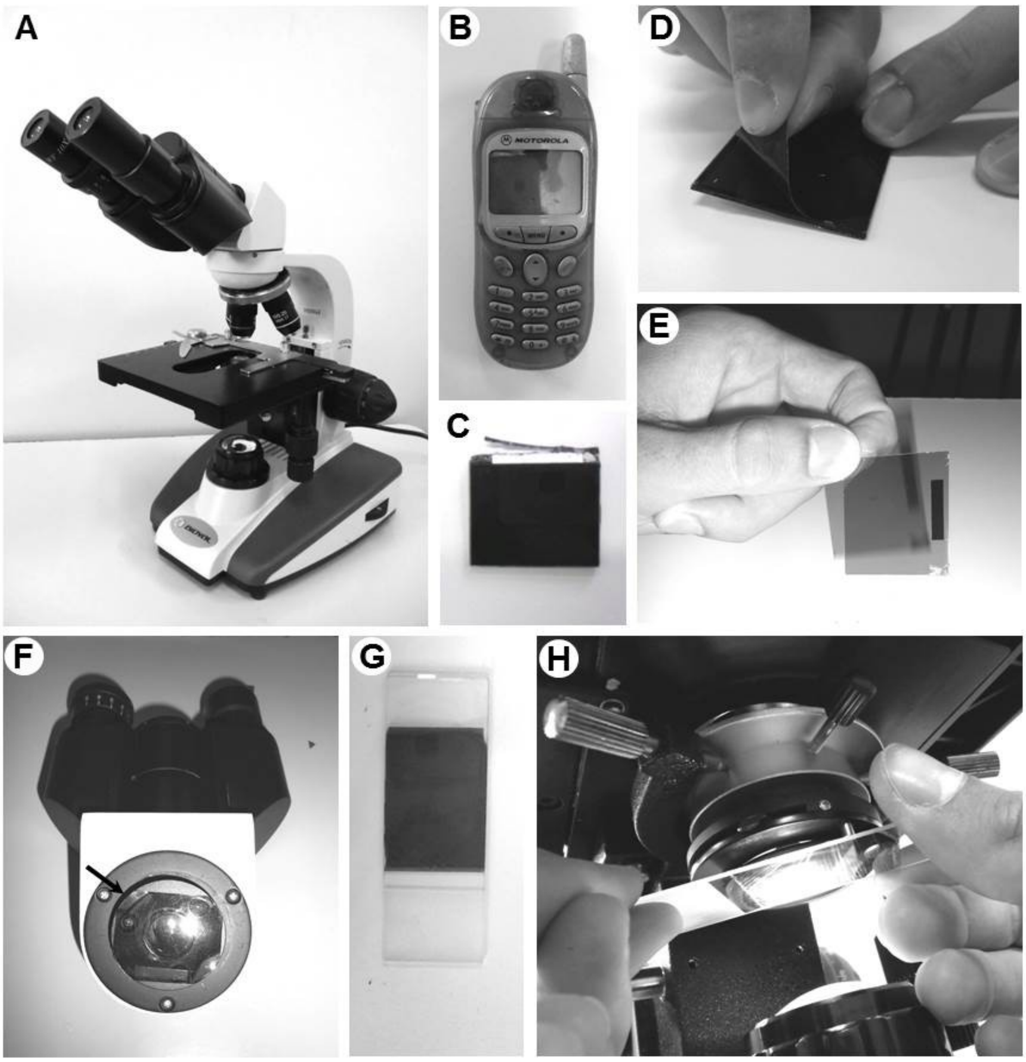

Figure 2. Polarization feature installation in a biological microscope. **A.** Bioval basic binocular microscope. **B.** Scrapped cell phone. **C.** Removed display. **D.** Manual removing of polarized filter. **E.** Polarized filter separate from the display. **F.** Polarizer filter (analyzer one) fixed at the base of the metallic bottom of the microscope viewing head, with edges trimmed (arrow). **G.** Slide with polarizer filter (polarizer one). **H.** Polarizer filters in use.

Photographic documentation

The micrographs were obtained by capture with a Samsung ES80 digital camera, directly from an eye piece of the microscope.

RESULTS AND DISCUSSION

The polarization kit for microscope constructed in this study proved effective in the visualization and identification of birefringent materials. These appear to shine over a dark background, as suggested by Lawson (1972) (Figs. 3A- D).

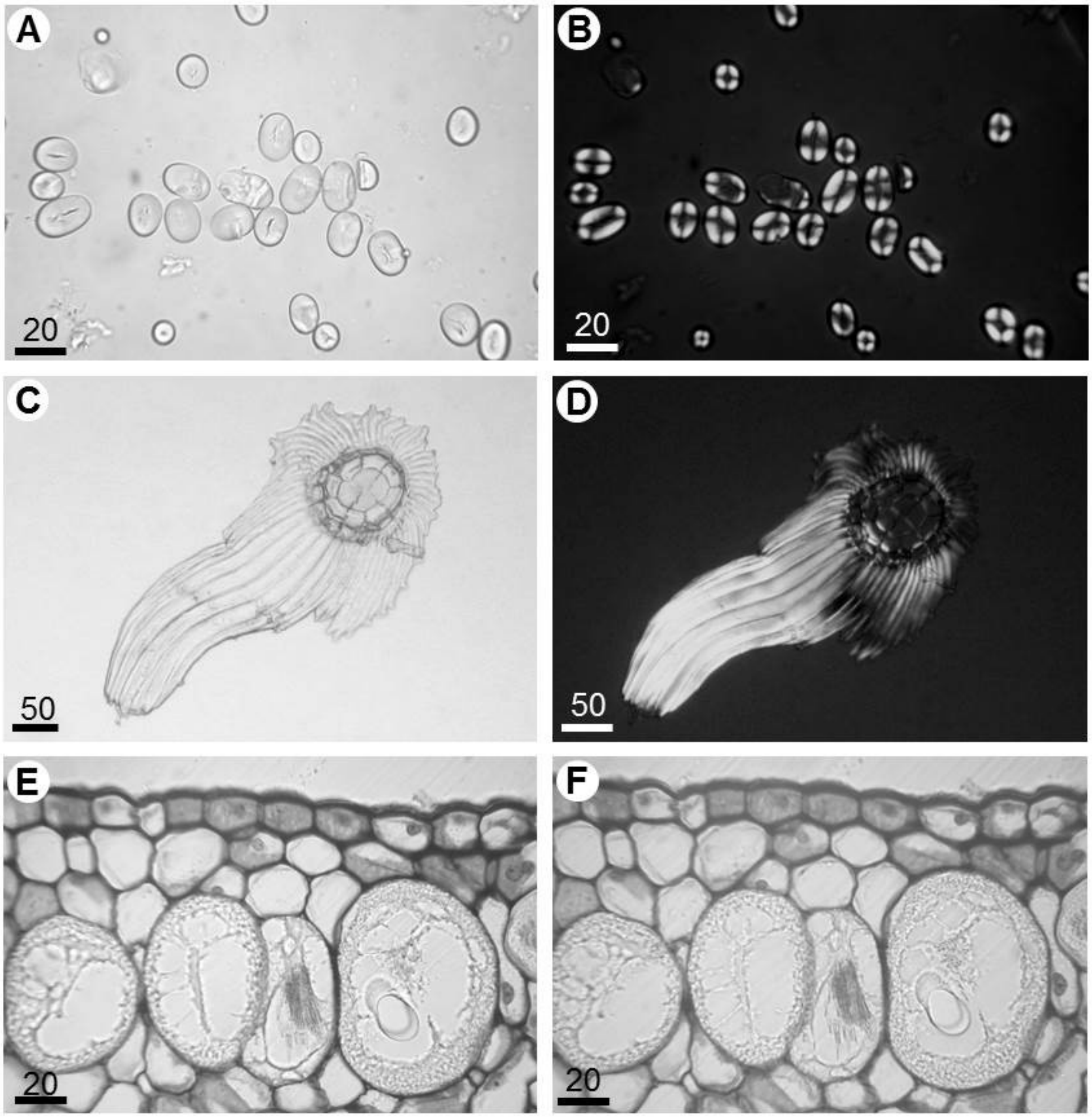

Figure 3. Images obtained at the microscope. **A.** Scraping of *Phaseolus vulgaris* cotyledon without polarization. **B.** Like C, but with polarized light. **C.** *Tillandsia recurvata* scale without polarization. **D.** Like E, but with polarized light. **E.** Histological section of the floral bract of *Rodriguezia venusta* without any polarizer. **F.** Like A, but with the analyzer filter installed. Scale bars in micrometers.

For simplification of equipment construction, the analyzer filter is permanently installed in the microscope viewing head; however it can be easily removed, although probably the filter becomes unusable. The microscope present an image slightly less bright, and with a deletion of sharpness almost imperceptible compared with a microscope without the analyzer filter (Figs. 3E-F). However, the installation of polarization in cases of demand of this feature is stimulated, especially if one second microscope is available for general purposes where the polarization light is not necessary. But when it comes in microscopes with specific analyzer bracket, the use of polarizer filters from cell phones can be a permanent solution to the equipment, possibly giving excellent results.

Currently, there is a great appeal for works that promote the reuse of obsolete materials. This trend is not just the recycling of materials, but also the low cost they have, being an inexpensive and effective alternative methodology (JORDÃO & TAKAKI, 1986; TAKAKI, 1987; LEITÃO & CORTELAZZO, 2008; MARINHO & LEITÃO, 2014; LEITÃO, 2015). The polarization microscope presented there is an initiative for the improvement of teaching and research, obtaining satisfactory results and promoting the recycling of electronic waste.

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