# The Butterfly Pea Flower as a pH Indicator

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**Abstract**

*Clitoria ternatea*, or butterfly pea, is an easily accessible Asian flower that can function as a pH indicator. A method of preparing the butterfly pea flower indicator is described, then a pH color scale between pH 2 and 12 is shown. The indicator is stored over 8 days and tested to determine its reliability over time. It is concluded that the indicator solution has an effective shelf life of less than 5 days. A method for creating pH paper is then described and its pH color scale is shown. The change in the pH color scale is shown while storing the pH paper at room temperature and under refrigeration over a period of 10 days. It is found that storing pH paper in a refrigerator extends its reliability.

**Keywords**: *Clitoria ternatea*, butterfly pea, pH indicator, color scale, indicator solution, pH paper

## I. INTRODUCTION

A pH indicator is a substance that can be used to qualitatively assess the pH of a solution. Several natural indicators are widely used, including red cabbage and lichen. An advantage of these indicators is that they are typically simple to make and can display a wide array of colors that allow an approximation of pH over a wide range. However, they are typically only usable shortly after their preparation, and the color gradient varies depending on factors such as the plant's environment, indicator concentration, and storage temperature.

*Clitoria ternatea*, or butterfly pea, is an easily accessible Asian flower that can function as a low-cost pH indicator. The chemical processes that underlie the use of the butterfly pea as an indicator are well established.[1] The molecule that causes the color change in the butterfly pea flower indicator is Anthocyanin, which is in equilibrium with other Anthocyanin molecules that have interacted with the acid/base solution. These Flavylium cations absorb different wavelengths of light depending on the pH level the Anthocyanin molecule was exposed to and hence a color gradient is produced.

However, a specific method for preparing the indicator for qualitative use has not been described, nor has the longevity of the indicator using different storage methods been studied. This paper proposes a reliable method of indicating pH using the *Clitoria ternatea* flower, while assessing the indicator's reliability over time.

## II. METHODS

An excess amount of butterfly pea flowers, including the stem, was completely dried in a 1 kW oven at 75°C. The dried flowers were crushed into a fine powder. A mass of 21.25 ± 0.01 g of powder was mixed with distilled water to make a 250.00 ± 0.15 mL solution using a volumetric flask. The solution was boiled for 60 seconds, cooled, and then filtered, so that any residue left in the water was removed, yielding a clear, dark blue, liquid. This solution was used for all tests described in this paper.

A volume of 4.00 ± 0.04 mL of the indicator solution was mixed with 6.00 ± 0.06 mL of a pH 2.00 buffer solution until a uniform color was achieved. The pH level was then measured with a pH probe. This was repeated with buffers of pH 4.00, 5.00, 6.00, 7.00, 8.00, 9.00, 10.00, 12.00. The solutions were photographed to record the color gradient produced by the indicator solution at each pH level. (The transmission spectrum of each of these solutions was also measured with a Vernier UV-VIS spectrophotometer. These spectra are beyond the scope of this paper, but can be viewed at www.isjos.org/ISJOSv11p2-ButterflyPeaIndicator-Data.pdf for those who are interested.)

The reliability of the indicator was assessed over time. The indicator was stored at room temperature in a beaker covered with Parafilm. Five and eight days after the indicator was made, the indicator was added to buffers of pH 2, 8, and 12, as before, and then photographed.

Indicator paper was made by soaking filter paper in the indicator solution for two minutes, then leaving it to dry at room temperature. The papers were divided into two plastic Ziploc bags, one of which was stored at room temperature away from sunlight and the other in a refrigerator. Four and ten days after making the indicator paper, the refrigerated and the non-refrigerated indicator papers were tested with the buffer solutions and photographed.

The photographs of the indicator solution and the pH paper being tested were adjusted digitally to show the color scales as perceived by the author.

## III. RESULTS AND DISCUSSIONS

The qualitative pH color scale for the freshly-prepared indicator solution is shown in Figure 1. There is a wide range of easily-distinguishable colors over the pH range tested, making this a qualitative pH indicator that is useful in a variety of laboratory activities.

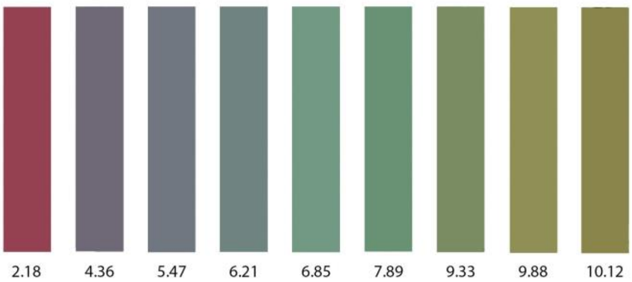



**Figure 1.** pH Indicator Solution Color Scale. Note that the pH levels of the original buffer solutions were changed due to the addition of a relatively large quantity of indicator. solution.


**Figure 2.** pH Indicator Color Scale 5 days after indicator solution made.


**Figure 3.** pH Indicator Color Scale 8 days after indicator solution made.

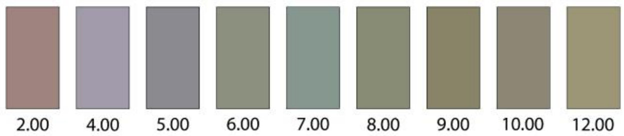
The solution was tested again after being stored for 5 days and 8 days. It reacted to the selected pH levels tested as shown in Figures 2 and 3.

It can be seen that, while a distinctly varying color scale is shown when the pH indicator is used on the same day as preparation, the color response fades over time as the colors seem to degrade to a nearly uniform yellow-green over the pH range after 5 and 8 days.

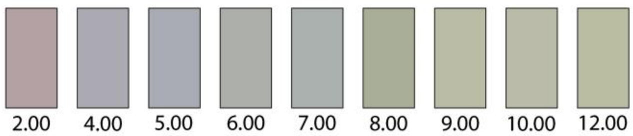
The qualitative indicator paper color scales for each of the storage methods are shown in Figure 4. The colors of the indicator paper are not as varied, and are not as clearly distinguishable as the colors for the indicator solution across the pH range tested. However, the indicator paper maintains its colors fairly well over the 8 days tested, with the refrigerated indicator paper being more stable over time.

A qualitative color scale has been described for both the indicator solution and for the pH paper. It was found that both the solution and paper indicators degrade over time, but the pH paper appears to have a longer shelf life, with Ziploc storage maintaining

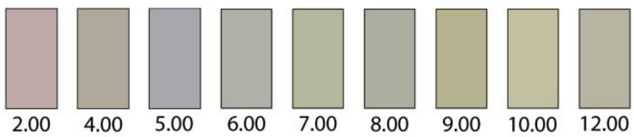
(a) pH Paper Color Scale on the day it was made.



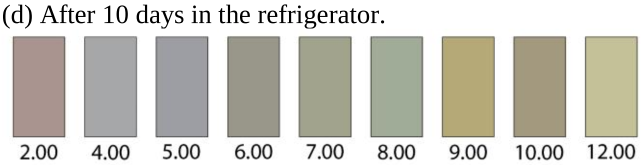

(b) After 4 days in the refrigerator.




(c) After 4 days stored at room-temperature.




(d) After 10 days in the refrigerator.




(e) After 10 days stored at room temperature.

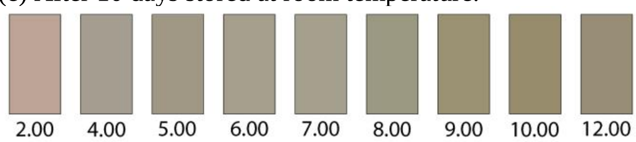



**Figure 4.** pH Paper Color Scales for all days and storage methods

distinguishable colors even after four days of storage. Refrigeration seems to extend the life of the paper indicator significantly, but after 10 days the colors decrease in intensity and converge to a lighter yellow for all pH levels, just as the indicator solution did.

Approximately a year after the indicator powder was originally prepared, it was used to make a new indicator solution with distilled water and produced a color scale similar to figure 1 when tested. This shows that a viable method of long-term storage may be to keep the indicator in powdered form until it is needed.

Future research into the effect of refrigeration in extending the life of the indicator solution is recommended. It is also suggested that the experiment be replicated to verify the consistency of the pH color scales for flowers grown under different conditions, as solution was prepared from only one batch of flowers.

## IV. CONCLUSION

A method has been described for creating a pH indicator solution and pH paper using the Butterfly Pea flower. A pH color scale for the freshly-made indicator solution and pH paper is shown. It is recommended that the indicator be used on the day of preparation, as indicator color degrades quickly, however, refrigeration can extend the reliability of the pH paper. It is also possible to store the prepared powder for extended periods and prepare the solution when needed.

## REFERENCES

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