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EVALUATION OF VEGETABLE EXTRACTS FROM THE SEMI-ARID AS NATURAL pH INDICATOR

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ABSTRACT

Given the various difficulties to expose the contents of the subject of chemistry is a constant search for alternative materials to facilitate learning. This may partly be due to chemical science to be a significant practical character. However, due to professional educational institutions and material limitations ends up being passed on to the student of predominantly theoretical way, requiring a high degree of abstraction and consequently in their disinterest the same. In this context , we investigated the use of ethanol extracts of various plants, such as: Jitirana (Ipomoea glabra), Íxora (*Ixora coccínea*), Centro (*Centrosema brasilianum*) and Candlebush (*Senna alata*) flowers, Beet (*Beta vulgaris L.*) fruit and Urucum (*Bixa orellana*) seeds as an acids and bases natural indicator, from laboratory tests capable of identifying properties demonstrate the pH. Initially we evaluated the variation in the coloration of extracts using for this buffer solutions at pH 3, 7 and 12. Among the cited vegetable flowers Jitirana, ixora and Centro presented activities relevant indicator as staining variants between pH 2:13. The extracts of plants were further added in glass tubes containing buffer solutions with a pH ranging from 2 to 13. The change in color of the extracts showed good activity has the same pH indicator.

KEYWORDS: Ethanol extracts, natural indicator Acid-Base, Vegetables

AVALIAÇÃO DO POTENCIAL DE EXTRATOS VEGETAIS ORIUNDOS DO SEMI-ÁRIDO COMO INDICADOR NATURAL DE pH

RESUMO

Diante das várias dificuldades para expor o conteúdo da disciplina de Química é constante a busca de material alternativo que facilite o aprendizado. Isto pode ser justificado pelo fato de a química ser uma ciência com um significativo caráter prático. Contudo, devido a limitações materiais e profissionais das instituições de ensino os conceitos acabam sendo repassados para o aluno de maneira predominantemente teórica, exigindo um alto grau de abstração e consequentemente no seu desinteresse pela mesma. Neste contexto, foi investigado o uso dos extratos etanólicos de diversos vegetais, tais como: flores de Jitirana (*Ipomoea glabra*), Íxora (*Ixora coccínea*), Centro (*Centrosema brasilianum*) e Candlebush (*Senna alata*), os frutos da Beet (*Beta vulgaris* L.) e as sementes do Urucum (*Bixa orellana*) como indicador natural de ácidos e bases, a partir de testes laboratoriais capazes de demonstrar propriedades identificadoras de pH. Inicialmente avaliou-se a variação na coloração dos extratos utilizando para isso soluções tampão com pH 3, 7 e 12. Dentre os vegetais citados as flores de Jitirana, Íxora e Centro apresentaram atividades indicadoras relevantes com colorações variantes entre o pH 2 e 13. Os extratos dos vegetais foram posteriormente adicionados em tubos de vidro contendo soluções tampão com pH variando de 2 a 13. A variação na coloração dos extratos mostrou que os mesmos têm boa atividade indicadora de pH.

PALAVRAS-CHAVE: Extratos etanólicos, indicador Ácido-Base natural, Vegetais

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1 INTRODUCTION

The lack of interest of the students verified during the classes of the Exact Sciences disciplines and, among those, Chemistry, has been teasing the academic environment about other possibilities to make the student gets involved in the discipline, awakening in them the pleasure of learning. The development of practical, low-cost activities may be an alternative of great importance to awaken the interest of the students for Chemistry, for this is characterized for being a science of expressive practical character. However, due to the material and professional limitation of the academic institutions, this discipline is passed on to the student as mainly theoretical, demanding a high level of abstraction by the student and, consequently, his lack of interest for the subject. So being, carrying innovative classes that involve the everyday life of the student is of vital importance for a type of learning that will stimulate observation, reflection, questioning and criticism.

In this context, the use of natural products in the teaching of Chemistry has been at the forefront in the field during the last years. This area of research is important for the discovery of substances that may substitute the toxic and expensive materials used in the routine of practical activities.

The great diversity of vegetable species available in nature that contain colorful organic compounds such as flavonoids, tannins, carotenoids and others, has allowed to carry out several studies involving didactic pieces and industrial applications (BISHOP, 1972). According to Giulietti et al. (2005) only in Brazil, the number of species of plants is higher than 56.000, which encompasses nearly 19% of the flora worldwide, being that the comprehension of the biodiversity in the country is still incomplete and does not reach even 5% of this total.

Studies involving the use of vegetable extracts as pH indicators are seen since the 18th Century, when Robert Boyle prepared a sort of liquor with violets and observed that its extract became red when immersed in acid solution and green when in basic solution. The researcher also had the idea of dripping the liquor on a white paper and then, some drops of vinegar, which resulted on a red-colored mixture. This can be considered one of the first works with pH indicators, both in solution and on paper (BOYLE, 1972a; BOYLE, 1972b).

As years went by and with the formalization of the concepts of acid and base, the studies involving these types of indicators through extracts of plants has increased a great deal. At first, the works were restricted to their application in the qualitative analysis of aqueous solutions mentioned in the 17th Century by many researchers, such as Boyle, Iorden and duClos, and only described in 1972 (BOYLE, 1972b; IORDEN, 1972; DuCLOS, 1972). Afterwards, William Lewis has described, for the first time, the use of extracts of plants in order to determine the last stage of neutralization titrations (TERCI; ROSSI, 2002).

According to Baccan et al. (1979,p. 46) “the acid-base pH indicators are weakly acidic (acid indicators) or weakly basic (basic indicators) organic substances that present different colors for their protonated and deprotonated forms; that means that they change colors according to the pH”. They can be classified according to color-changing mechanism or the type of titration in which they are applied (ROSS, 1989).

In their work, Teixeira and Queiroz (1994) have presented studies on the preparation of indicator papers from natural pigments of *Tradescantia diuretica* and *Brassicaceae abracea*, by adding the vegetable ethanolic extracts on filter paper. Similar studies have been carried out by Terci and Rossi (2002), wh have used the extract of fruits such as the blackberry (*Morus nigra*), jabuticaba (*Myrciaria cauliflora*), jamun (*Syzygiumcuminii)* and grape (*Vitis vinífera*).

The natural indicators may facilitate and serve as guidance in the classes of acid and base, for their change of color presents a visual effect that makes the students curious, which makes them show great interest and thus becoming an excellent tool for the learning of chemistry, besides being a cheap and alternative method of teaching (BROWN, 2007).

The experiment aims to generate and promote a meaningful teaching-learning process for the teaching of Chemistry, where the student will stop being a mere receiver and become an active individual in this process. This is the perspective on which we have based the proposal that natural indicators can facilitate and serve as tools in Chemistry classes, by incorporating the practical aspects of the content regarding acid and base, thus becoming an excellent alternative for the learning of this content, besides being a cheap and alternative method.

So being, this paper aims to evaluate the use of vegetable extracts natural from the semi-arid region as natural pH indicators. This study hopes to obtain alternative material and offer a didactic approach that is interesting for the High School student, for it allows them to observe the colors and define the acidic and basic characteristics of the substances, thus making it possible a direct linkage between Chemistry and the everyday life of the students.

2 EXPERIMENTAL PART

The species selected have been collected at the IFRN campus Apodi/RN. We have used, as vegetable material, flowers of Jitirana (*Ipomoea glabra)*, Ixora (*Ixora coccínea),* Centro *(Centrosema brasilianum)* and Candlebush (*Senna alata);* fruits of Beet (*Beta vulgaris L)* and Achiote (*Bixa orellana)*, and some of the information on them can be found in Table 1. The extraction of the pigments was made through maceration, where about 20g of each vegetable material was macerated on 25mL of ethanol and kept "resting" for 72 hours. After this period, the material was filtered and the solvent was evaporated in order to obtain the respective extracts.

Table 1: General information on the species used

SPECIES (Scientific names)	POPULAR NAMES	BOTANICAL FAMILY	REFERENCE
Bixa orellana	Achiote	Bixaceae	COELHO et al.; 2003
Beta vulgaris	Beet	Chenopodiaceae	CUCHINSKI; CAETANO; DRAGUNSK; 2010.
Ixora coccinea	Ixora	Rubiaceae	DUARTE; RESENDE JÚNIOR; CARNEIRO; 2006.
Ipomoea glabra	Jitirana	Convolvulaceae	COELHO et al.; 2004
Centrosema brasilianum	Centro	Fabaceae	KIILL; HAJI; LIMA; 2000.
Senna alata	Candlebush	Leguminosae	RODRIGUES; SOUZA FILHO; FERREIRA; 2009.

The buffer solutions used in order to evaluate the behavior of the extracts have been prepared using mixtures of acetic acid/ sodium acetate(CH_3CO_2H/CH_3CO_2Na) for pH values from 2 to 6, dibasic potassium phosphate/monobasic potassium phosphate (K_2HPO_4/KH_2PO_4) for pH

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values 7 and 8 and the mixture of ammonium hydroxide/ammonium chloride (NH_4OH/NH_4Cl) in pH values from 9 to 13. With these, we have managed to obtain the acidic, neutral and basic solutions before-mentioned.

The extracts obtained were initially evaluated in buffer solutions for pH values 3, 7 and 12, in order to evaluate its potential as an indicator. In each test tube containing 2,5 mL of the buffer solution, we have added 0,5 mL of each extract and the mixture was agitated. The observation of the resulting pigmentation was done 30 seconds after the addition of the extracts. The extracts which presented a positive result in the preliminary evaluation have been considered in the range of pH varying from 2 to 13.

For the vegetable extracts that have presented relevant activity as for their use as acid-base indicators, we have also prepared indicator papers based on the methodology proposed by Terci and Rossi (2002). The extracts were immersed in qualitative paper filter strips of 0,3 x 4,0 cm until approximately 2,0 cm high for nearly 4 hours and they were dried under the action of air for 1 hour.

The pH papers obtained were then immersed in buffer solutions with pH values varying from 2 to 13 in order to put together a scale referring to the pigmentation presented during the experiment.

3 RESULTS AND DISCUSSION

We have initially evaluated several extracts with buffer solutions of 3, 7 and 12 in order to verify the ones that presented relevant pigment variation when exposed to acidic, neutral and basic solutions, being easily identified by visual observation. The vegetable species used for this experiment were Jitirana (*Ipomoea glabra*), Ixora (*Ixora coccínea),* Centro (*Centrosema brasilianum)* Candlebush (*Senna alata*), Beet (*Beta vulgaris L.*) e o Achiote (*Bixa orellana*).

The first tests were carried out with ethanolic extracts of Beet and Achiote have not presented satisfactory outcomes since we could verify little or no variation in the pigmentation of the mentioned vegetable extracts. In Picture 1, we present the results observed when analyzing ethanolic extracts of Beet and Achiote. In the third experiment with Candlebush, the results obtained by the samples 3, 7 and 12 indicated the possibility of variation in the color of the extracts as a result of the change in the pH of the environment. This very extract, when evaluated in a wider range of pH variation (2 to 13) has presented low capacity of indicator activity, as shown in Picture 2.

The last tests were carried out with flowers of Jitirana (Picture 3), Ixora (Picture 4) and Centro (Picture 5), where we have observed an expressive variation in the pigmentation of these extracts when added to buffer solution with pH 3, 7 and 12.

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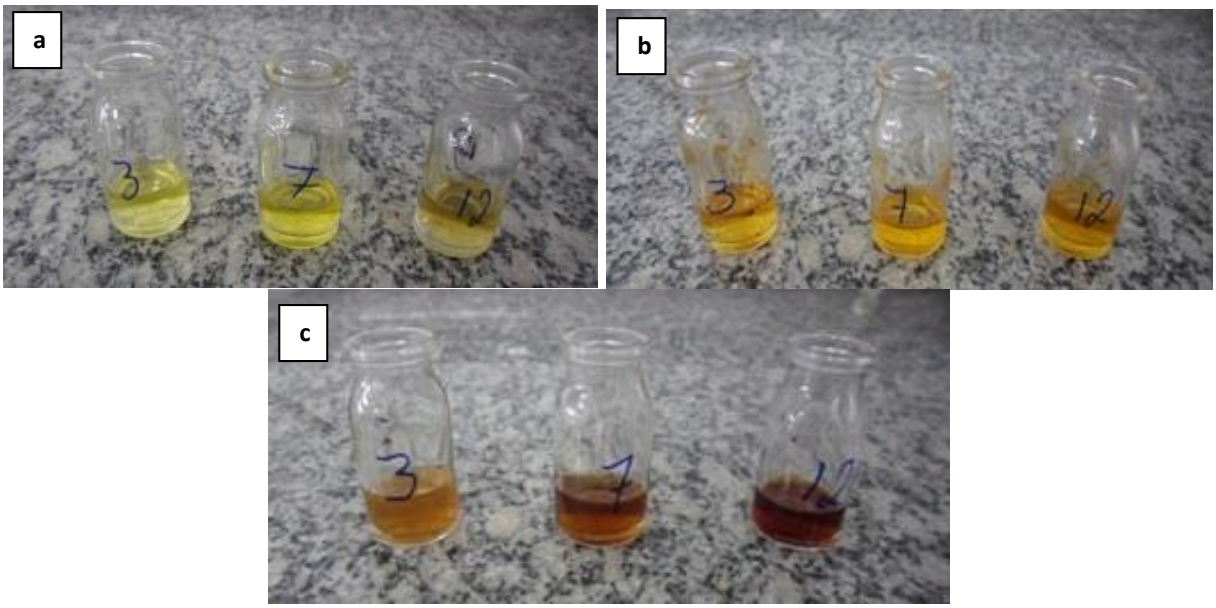

Picture 1 – Photograph of the behavior of the ethanolic extract of Beet (a), Achiote (b) and Candlebush (c) in pH 3, 7 and 12.

Picture 2 – Photograph of the behavior of the ethanolic extract Candlebush (c) in pH 2 to 13.

Among the vegetables analyzed in these preliminary studies, the best result was obtained for the Jitirana, considering that, in acidic solution (pH 3), we have observed pink pigmentation in the mixture and neutral environment (pH 7) we have verified the depigmentation of the extract. In pH 12 (basic) the extract has presented light green pigmentation, as showed in Picture 3.

Picture 3 – Picture of the behavior of the ethanolic extract of the Jitirana flower (Ipomoea glabra) in pH 3, 7 and 12

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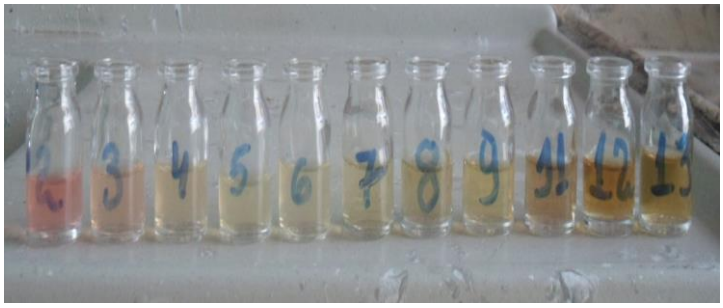
Picture 4 – Picture of the behavior of the ethanolic extract of the Ixora flower in pH 3, 7 and 12

Picture 5 – Picture of the behavior of the ethanolic extract of the Centro flower in pH 3, 7 and 12

From the results mentioned, as well as the experiment carried out with the Candlebush. we have evaluated the behavior of the vegetable extracts with the best indicator capacity (Jitirana, Ixora and Centro) in a wider range of pH values (2 to 13). The results obtained are presented in the following Pictures 6, 7 and 8.

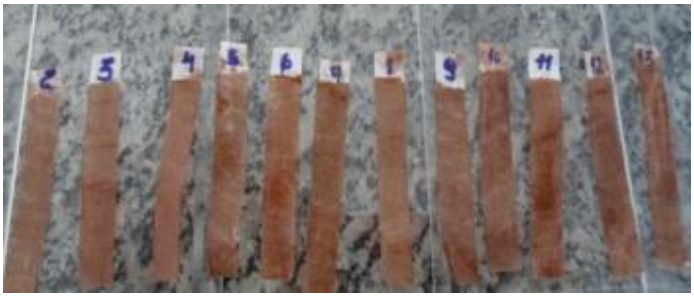
Picture 6 – Picture of the behavior of the ethanolic extract of the Jitirana flower in pH 2 to 13



Picture 7 – Picture of the behavior of the ethanolic extract of the Ixora flower in pH 2 to 13

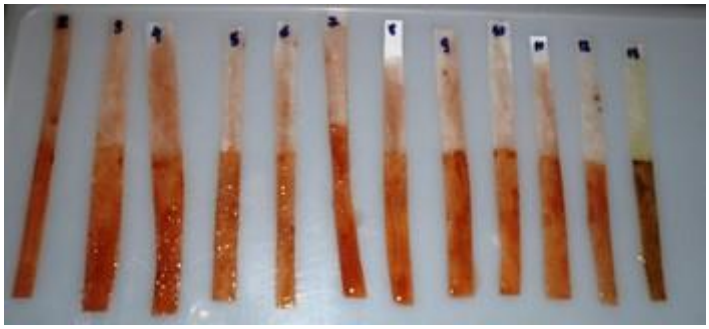
Picture 8 – Picture of the behavior of the ethanolic extract of the Cetro flower in pH 2 to 13

As in the solution, the analysis of the use of natural indicator paper obtained through the extracts of the Jitirana and Centro has been carried out. The extracts were initially added to small strips of filter paper (Pictures 9 – 11) and later on, immersed in the respective buffer solutions.



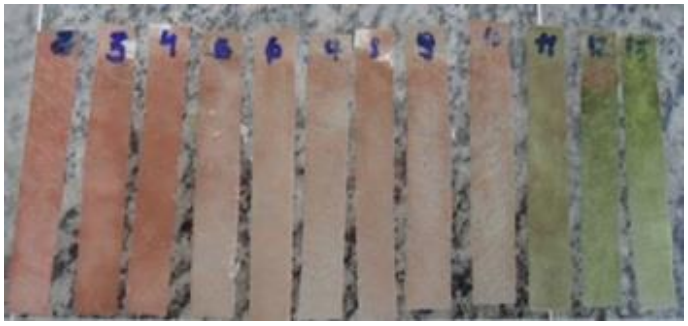
Picture 9 – Photograph of filter paper with ethanolic extract of the Jitirana

Picture 10 – Photograph of filter paper with ethanolic extract of the Centro

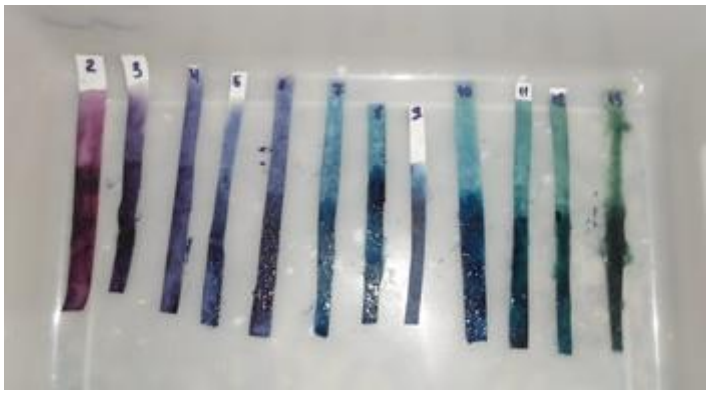


Picture 11 – Photograph of the pH paper varying from 2 to 13 of the Ixora

After the immersion of filter paper strips in buffered solutions of different pH values, we have observed a significantly positive outcome through the observation of the color variation. As observed in Pictures 12 and 13.



Picture 12 – Photograph of the pH paper varying from 2 to 13 of ethanolic extract of the Jitirana



Picture 13 – Photograph of the pH paper varying from 2 to 13 of ethanolic extract of the Centro

The indicator papers with the extracts of Jitirana and Centro have been good indicators considering the color variation observed in different pH values. The paper obtained through the extract of the Ixora, after the immersion of filter paper strips in buffered solutions of different pH values has shown a negative outcome, because one cannot notice the its color variation.

From the results obtained, we can determine that the color variations observed indicate that the Jitirana and Centro extracts can be used as acid-base indicators, in solutions as well as in paper, because for each pH value we have observed a characteristic color that allows us to determine it.

4 CONCLUSION

According to the outcomes discussed, we can conclude that among the vegetable and flower extracts studied by us, the only ones that have presented the behavior of a natural indicator of pH using solution were the flowers of Jitirana (*Ipomoea glabra Choisy*), Centro (*Centrosema brasilianum*) and Ixora (*Ixora coccinea*). These possess good potential to be used in practical activities of Chemistry classes, thus assisting in the development of innovative and motivating classes. We highlight that future studies aiming to apply the methodology described in the academic routine is of vital importance for an evaluation of the acceptance and viability of

the same, either from the students as from the teachers and reflects future goals for the studies. The proposal comes out as appealing for the schools without laboratory infrastructure, for the experiments can be carried out in a simple way and have reduced costs, thus making it possible to approach several contents by this practice, pointing out:

- Concepts of acidity and basicity, approaching the pH scale through the variation of colors resulting from the modification of the pH of the solution;
- Chemical Reactions, for a change in the pigmentation is many times associated to changes in the chemical structures of the substances;
- Preparation of solutions, which are necessary for obtaining a buffer solution of appropriate pH value, and allowing the teacher to approach matters such as Solubility, Molality, Molar Mass among others;
- Physical and Chemical Phenomena, for the methodology proposed involves solvent evaporation steps (Physical process), acid-base reaction (Chemical process), dissolution (Physical process) among others.

Another important point to highlight is that the practical activity be carried out, referentially, by the student (under teacher's guidance), turning him into the main character of his own teaching-learning process and thus contributing for the student to overcome the rejection of Chemistry as a discipline in the schools and demonstrating the real goal of Chemistry: To understand the behavior of the macroscopic world through knowledge of the microscopic world, base of all scientific and technologic advances nowadays.

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