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Integration of Ethnochemical Concepts in Redox Reaction Learning

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Abstract. Learning about redox reactions is often considered difficult by students, especially because of its abstract nature and lack of connection to everyday life. In this case, an ethnochemical approach can be an effective solution to connect chemical concepts with local culture, so that students' understanding can be improved. This study aims to analyze how the integration of ethnochemical concepts in learning redox reactions can be implemented. The method used in this study is qualitative with a descriptive approach, through a literature study that discusses various academic references. The results of the study indicate that the application of ethnochemistry in learning redox reactions can be done through various cultural examples, such as the fermentation process of tape and tempeh, the use of natural dye oxidation in batik coloring, and metal processing in traditional crafts. This integration not only improves students' understanding of chemical concepts, but also enriches their insights into local wisdom and environmental sustainability. With a more contextual learning approach, students can more easily relate theory to real practice. This in turn can increase their interest and understanding of chemistry.

1. Introduction

Redox reactions are reactions that occur due to changes in oxidation numbers (Garnett & Treagust, 1992). The concept of redox reactions includes reduction and oxidation reactions. Reduction reactions are reactions that occur in which the oxidation number decreases through the capture of electrons (Kurniasari et al., 2019). Reduction-oxidation (redox) reactions are one of the important concepts in chemistry learning, but are often considered difficult by students (De Jong et al., 1995). This difficulty is caused by the abstract nature of redox reactions, which involve electron transfer and changes in oxidation numbers, thus requiring a deep conceptual understanding (Özkaya, 2002). In addition, limitations in connecting the concept of redox with everyday life are also a challenge in improving students' understanding of this material (Garnett & Treagust, 1992).

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The ethnochemical approach is one solution to bridge the gap between chemical concepts and students' real experiences(Rahmawati & Sastrapraja, 2017). Ethnochemistry-based learning can influence people's views on chemistry, as chemistry is not only something dangerous because it is widely found in everyday life, for example, the use of baking soda in making bread (Rahmawati et al., 2017). Ethno refers to members of a community group in any cultural environment that can be identified through cultural traditions, codes, symbols, myths, and certain ways used to consider and conclude (Aikenhead, 2006). Various previous studies that apply ethnochemistry in learning through the use of cultural products show positive results, such as the results of research conducted by through the use of cultural products as learning resources have an impact on improving students' cognitive learning outcomes, influencing students' scientific attitudes, and human rights (Wahyudiati & Fitriani, 2021).

Ethnochemistry integrates chemistry with local culture, so that students can understand chemical concepts in a context that is more relevant to their lives (Sutrisno et al., 2020). Thus, ethnochemistry-based learning can increase student engagement and facilitate their understanding of abstract concepts in chemistry, including redox reactions (Rahmawati & Sastrapraja, 2017). The suitability between local cultural potential and learning materials cannot be separated from the location where the culture originates (Parmin et al., 2017). The integration of culture with chemistry not only creates more meaningful chemistry learning for students but also helps preserve the nation's culture (Azizah & Premono, 2021). This study aims to examine the integration of ethnochemistry concepts in redox reaction learning.

Chemistry is closely related to culture, especially in Indonesia, with its rich culture, so this integration not only creates meaningful chemistry learning but also preserves the nation's culture (Gay, 2010). Indonesia, with its rich culture, has the potential for opportunities to be explored, not only to engage students in their culture, but also to maintain students' cultural identity in the face of globalisation (Rahmawati et al., 2017). Therefore, with this research, it is hoped that a more contextual and effective learning strategy can be found in teaching the concept of redox reactions to students (Aikenhead, 2006).

2. Materials and Methods

This study uses a qualitative method with a descriptive approach to analyse the integration of ethnochemistry in redox reaction learning for education and its implications for chemistry and science learning. This study focuses on an in-depth understanding of academic references that discuss the use of local wisdom, traditional practices, and culture in science teaching. The data in this study were collected through literature studies from various published journals. These journals include research related to ethnochemistry in redox reaction learning, culture-based education, and the integration of science with local

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and spiritual values. The literature study was conducted by reviewing the results of previous studies that discussed the integration of local wisdom in science learning, culture-based education approaches, and the use of technology in improving students' understanding of scientific concepts.

3. Results and Discussions

Fermentation of Tape and Tempe as an Example of Redox Reaction

Fermentation is a biochemical process that involves oxidation-reduction reactions (Nout & Kiers, 2005). In the manufacture of tape and tempe, microorganisms such as mould and yeast play a role in converting complex carbohydrates into simpler compounds (Rizal et al., 2021). In tape fermentation, yeast containing microorganisms such as Saccharomyces cerevisiae helps in breaking down starch into glucose and alcohol (Rizal & Kustyawati, 2019). During this process, a redox reaction occurs in which organic compounds act as electron donors and acceptors, resulting in changes in compounds that give tape its distinctive characteristics (Rizal et al., 2021).

In addition to tape, tempeh also undergoes a redox reaction during the fermentation process (Nout & Kiers, 2005). The mould Rhizopus oligosporus secretes enzymes that hydrolyse soy protein into peptides and amino acids (Rizal et al., 2021). In this process, fat oxidation occurs, which causes changes in colour and texture in fermented soybeans. In addition, microorganisms also produce natural antimicrobial substances that help increase tempeh's resistance to contamination by pathogenic bacteria (Nout & Kiers, 2005).

The existence of redox reactions in the fermentation of tape and tempeh shows that chemistry has a very close role in the cultural practices of the community (Sutrisno et al., 2020). The use of these microorganisms has been passed down from generation to generation and has become part of local wisdom that is not only related to food but also to health (Berkes, 2012). The fermentation process that produces natural antioxidants also has health benefits for the body, such as improving digestion and enriching the probiotic content in food (Rizal et al., 2021).

By understanding the redox reactions in fermentation, students can more easily connect chemical concepts with everyday life (Rahmawati & Sastrapraja, 2017). The application of literacy methods in fermentation learning can be done by inviting students to read scientific journals, watch scientific documentation, and conduct simple experiments to observe the changes that occur during fermentation (Parmin et al., 2017). This approach can increase students' interest in learning chemistry while introducing them to the concept of biochemistry in everyday life (Sutrisno et al., 2020).

Batik Colouring with Natural Dyes Oxidation

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The batik colouring process using natural materials is one real example of an oxidation-reduction reaction in everyday life (Martuti et al., 2019). Some natural materials, such as Indigo leaves (Indigofera tinctoria), undergo an oxidation process to produce a distinctive blue colour (Olusola et al., 2012). When Indigo leaves are crushed and fermented in water, the indican compound is converted into indigotin, which is a blue dye (Saikhao et al., 2018). This indigotin will only be visible after the cloth dipped in the solution undergoes oxidation when exposed to air (Olusola et al., 2012).

In addition to Indigo, other natural dyes such as tingi bark and mengkudu roots also undergo redox reactions in the dyeing process (Pujilestari, 2016). Tingi bark contains flavonoids and tannins that undergo oxidation to produce a stronger reddish brown colour (Pujilestari, 2016). Likewise, dyes from mengkudu roots react with oxygen in the air, thus accelerating the colour fixation process on the fabric (Martuti et al., 2019).

The use of natural dyes in batik not only provides distinctive colour results but is also environmentally friendly (Saikhao et al., 2018). Unlike synthetic dyes that contain heavy metals and toxic compounds, natural dyes are more easily decomposed in the environment and do not pollute river water or soil (Walters, 2008). This shows that the application of the redox reaction concept in batik not only has aesthetic value but also has a positive impact on environmental sustainability (Berkes, 2012).

Literacy-based chemistry learning can be applied by learning more about the oxidation process in natural dyes, as well as conducting simple experiments such as extracting dyes from natural materials (Sutrisno et al., 2020). In this way, students can better understand how chemistry is applied in everyday life and at the same time appreciate local cultures that are rich in scientific knowledge (Rahmawati & Sastrapraja, 2017).

Metal Processing in Traditional Crafts

In the traditional craft industry, metals such as copper and silver undergo various oxidation and reduction processes during their formation (Untracht, 1975). One example is the copper firing process to remove dirt and oxides that stick to its surface (Rehren et al., 2012). In this process, copper metal is heated under certain conditions so that a reduction reaction occurs that restores the original properties of the metal, making it easier to forge and shape (Untracht, 1975).

In addition, in the metal dipping process to produce more attractive colours, the metal is given an oxidising solution such as nitric acid or certain salt solutions (Rehren et al., 2012). This process causes the formation of an oxide layer on the metal surface, which gives a natural colour effect and increases the

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metal's resistance to corrosion (Untracht, 1975). This technique is widely used in making silver and copper jewellery (Rehren et al., 2012).

The importance of understanding redox reactions in metal processing is also seen in soldering and brazing techniques, where two different metals are joined together using a connecting metal such as tin or silver (Untracht, 1975). During this process, heating causes the reduction of the metal compound, allowing for strong bonding between the metals (Rehren et al., 2012). This technique has been used since ancient times and is still practised in the jewellery and craft industries (Walters, 2008).

Through literacy-based learning, students can learn more about how the concept of redox reactions is applied in metal crafts (Sutrisno et al., 2020). By reading scientific articles, observing documentation, and conducting simple experiments such as the process of metal oxidation in acidic solutions, students can better understand how chemistry plays a role in traditional and modern industries (Rahmawati & Sastrapraja, 2017).

5. Conclusions

The integration of ethnochemistry in learning redox reactions provides a more contextual and applicable understanding for students. Fermentation in the manufacture of tape and tempeh shows how microorganisms play a role in oxidation-reduction reactions to convert organic compounds into simpler and more useful products. The process of colouring batik with natural ingredients also involves oxidation reactions, which not only create distinctive colours but are also more environmentally friendly than synthetic dyes. In addition, metal processing in traditional crafts uses the principle of redox reactions in various stages, such as heating, dyeing, and soldering, to improve the quality and aesthetics of the product. By understanding the application of redox reactions in various aspects of culture and industry, students can better appreciate the role of chemistry in everyday life.

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