CHAPTER 2

LITERATURE REVIEW

2.1 National Status

In India, increasing attention has been given to natural pigments obtained from plants because of their potential as alternatives to synthetic colourants. Turmeric (Curcuma longa) is an important Indian crop and a major source of curcumin, the principal yellow-orange pigment of turmeric. Curcumin has been investigated for its colouring, functional and value-added applications.[1][2] Indian research and development activities have also explored natural pigments for bio-based pH-sensitive indicators. For example, ICAR-CIAE, Bhopal, reported a bio-based intelligent indicator incorporating anthocyanin-rich black carrot pigment, betalain from beetroot and curcumin from turmeric for monitoring food freshness through colour changes.[3]Anthocyanin-rich plant materials are also being investigated in India for their potential as natural colourants and functional ingredients. Studies on Indian rose varieties have demonstrated the presence of anthocyanins and other phenolic compounds in rose petals[4]. These pigments are being considered not only for their attractive colours but also for their possible antioxidant and pH-indicating properties. The availability of diverse plant resources in India provides considerable scope for the development of low-cost and environmentally friendly pigment-based products.[2] [4]

2.2 International Status

Internationally, natural pigments such as curcumin and anthocyanins have been extensively studied for their extraction, chemical properties, stability and applications.[2] [5] Reviews have reported that natural pigments are increasingly investigated because of their colouring properties and potential functional benefits. However, their practical application is limited by factors such as sensitivity to pH, temperature, light and oxygen.[5] [6]

Anthocyanins have received particular attention because their colour changes markedly with pH. Chemical studies have demonstrated that changes in pH can alter the structural forms of anthocyanins and consequently their visible colour[5]. Studies have investigated methods such

as copigmentation, encapsulation and other stabilization techniques to improve anthocyanin stability[6]. Curcumin has similarly been investigated as a natural pigment and as a pH-responsive material because of its characteristic colour and sensitivity to environmental conditions[2 7].International research has also explored the use of natural pigments in food products, pharmaceutical preparations, cosmetic formulations, textile materials, smart packaging and natural indicator systems.[2 8] Despite these developments, maintaining the original colour and improving the shelf life of natural pigments continues to be a major challenge.[6 9]

2.3 Summary of Previous Studies

Previous studies have established that ethanol and other suitable solvents can effectively extract natural pigments from plant materials. Studies on turmeric have confirmed curcumin as the major pigment responsible for its yellow-orange colour, while studies on flowers and other plant materials have demonstrated the presence and usefulness of anthocyanins as natural colourants.[1 2 4]Research has also consistently shown that pigment stability depends strongly on environmental conditions. Anthocyanins are particularly sensitive to pH and temperature, while curcumin also shows changes in stability and colour under different environmental conditions.[5 7] Research specifically on rose petals has demonstrated that anthocyanin colour changes with pH and that temperature-related processing can influence anthocyanin stability.[10 11] Recent reviews emphasize that improving the stability of natural pigments remains an important area of research.

Several studies have further reported that extraction efficiency depends on factors such as solvent type, extraction time, temperature, particle size and the ratio of plant material to solvent.[2 11] Proper selection of these conditions can improve pigment recovery and colour intensity. However, excessive heating and exposure to unfavourable environmental conditions may contribute to pigment degradation. Therefore, simple tests involving colour observation, solubility and stability are useful for obtaining preliminary information about the quality and behaviour of extracted pigments.[5 9]

2.4 Research Gap

Although numerous studies have investigated the extraction and applications of individual natural pigments, many investigations involve advanced extraction, purification, stabilization or instrumental characterization techniques.[2 6 11] Comparatively fewer simple laboratory studies demonstrate the extraction and basic characterization of pigments using easily available plant materials and uncomplicated methods.

There is therefore a need for studies that examine the basic properties of plant-derived pigments through simple observations such as colour, solubility, pH response, thermal stability and colour retention. Such studies can provide a useful preliminary understanding before more advanced instrumental analysis is undertaken. They can also help students and researchers understand the relationship between pigment structure and its visible response to different environmental conditions. In addition, simple experimental approaches may be more suitable for educational laboratories and small-scale investigations where sophisticated instruments are not readily available.

2.5 Need of the Study

The present study was undertaken to investigate plant-derived pigments as potential natural colouring materials. Curcumin obtained from turmeric and anthocyanin obtained from red rose petals were studied using simple extraction and characterization methods. The study helps to understand their physical properties and their responses to pH, temperature and water exposure.The investigation is also relevant because natural pigments are renewable plant-based resources, while their stability remains an important limitation for wider applications[6 9].Understanding these basic properties can help in evaluating their possible use in natural colouring and other pigment-related applications. The study may also provide useful information for selecting suitable plant sources and extraction conditions for future work. Furthermore, it supports the development of simple, economical and environmentally friendly methods for studying natural pigments and their potential as alternatives to synthetic colourants.The thermal-stability observations further indicated that temperature influences the stability of the extracted pigment. The colour retention observed on cotton cloth after washing with distilled water suggests that the extracted pigment showed some degree of attachment and colour retention on the fabric. However, this was a preliminary observation and not a standardized colour-fastness test. The findings are consistent with earlier studies reporting red rose petals as a natural source of anthocyanins and demonstrating their characteristic sensitivity to pH and temperature[4 10 11]. Overall, the results indicate that red rose petals have potential as a natural source of anthocyanin pigment.