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Green, environment-friendly, analytical tools give insights in pharmaceutical and cosmetics analysis

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HIGHLIGHTS

- Green analytical chemistry (GAC) applied in pharmaceuticals and cosmetics
- Evolution of publications devoted to GAC analysis in pharmaceuticals and cosmetics
- Greening strategies implemented by analysts for environment-friendly methods
- Analytical techniques used and modifications toward greening
- Future perspectives for more eco-friendly analysis

ABSTRACT

Due to scientific and public concern about health and the environment, "Green", "Eco", "Environment-friendly" practices have been introduced into different research areas. In analysis of pharmaceuticals and cosmetics, analytical techniques are used for routine analysis, stability studies and quality control, but they can greatly affect researchers' health and safety and have a harmful impact on environment. Consequently, researchers' attention is drawn towards greening analytical methodologies and progressively taking into account the principles of green analytical chemistry (GAC) within their analytical procedures. This review presents GAC principles implemented in pharmaceutical and cosmetics analysis with special focus on direct analytical methods that have no, or limited, sample preparation, "the most polluting" step, and studies that reduced the use of hazardous solvents or replaced them by more benign, environment-friendly solvents. There is also a brief description of other modifications for greening analytical methodologies.

Keywords:
Analytical tool
Cosmetics analysis
Direct analysis
Eco-friendly analysis
Environment friendly
Green analysis
Green analytical chemistry
Hazardous solvent
Pharmaceutical analysis
Solvent reduction

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1. Introduction

Consciousness inside the analytical community has grown about the harmful impacts of hazardous chemicals on health and the environment, so trials and efforts are being made to lessen these. As a result**,** green analytical chemistry (GAC) aspects and principles have been increasingly implemented in analysis at both large and small scales. The GAC concept refers