ABSTRACT

Cannabis sativa L. has been grown as an annual crop plant for its commercial worth for thousands of years. It is primarily found in the northern hemisphere and belongs to the Cannabaceae family. Its usage in traditional medicine and textile is extremely important. Cannabis is a rich source of many bioactive compounds and cellulose, it has attracted a lot of attention due to its multi-purpose uses and applications in medicinal industry. Many bioactive compounds derived from this plants have been shown to have essential biological functions, and are desperately required. Because of their biological activities, particularly as plant-based antimicrobials and antioxidants, volatile fractions (also known as essential oils (EOs)), lipids and phenolics are gaining greater interest from many areas. There are multiple extraction techniques for the extraction of aroma (essential oil), lipids, and phenolics from cannabis but if the extraction process is carried out under optimum conditions and a maximum possible control achieved upon the reaction parameters, the process can be made efficient and economical. This research project was aimed to carry out the extraction processes with three major objectives. The primary goal of the project was to optimize the process obtaining best possible conditions to carry it out. The second major goal was studying the kinetics of the process in order to gain a better control over it. The study was concluded analyzing the antioxidant activities and identifying the major components found in the products obtained, via GC-MS and LCMS. Literature survey, investigating various procedures established the fact that although the innovative energy-based extraction techniques (such as microwave and ultrasound) are much more efficient and environment friendly but at the same time, they are extremely costly to be carried out in university laboratories. This project is aimed to apply the primitive hydro distillation technique for extraction of aroma (keeping in view the pros and cons of more advanced techniques that come with greater financial stress), Soxhelt extraction for lipids and enzyme assisted solvent extraction for phenolics (keeping it economical but at the same time allowing profitable extraction), and checking the effectiveness of the design using response surface methodology (RSM). The cannabis leaves from collected and crushed for the extraction of aroma, lipids and phenolics and yield was calculated. The resulted optimum values of temperature and time for the extraction of aroma are 77.07^{0}C and 5.3h respectively providing the 5.5ml of aroma. ANOVA proved the reliability of the model giving an R2 value of 0.9780. GCMS analysis of aroma confirmed the presence

of α-Caryophyllene (peak surface area: 2965308), Humulene (peak surface area: 1740880), alpha-bisabol (peak surface area: 607108), Oxiran (peak surface area: 529126), Tetrahydro cannbivarin (peak surface area: 202901), Resorcinol (peak surface area: 185177), Cannbinol (peak surface area: 2166032), Nonacosane (peak surface area: 163573), Heneicosane (peak surface area: 274292) as major compounds. The resulted optimum conditions of acid cellulase, L/S ratio, incubation time and pH for the extraction of phenolics are 2.3ml, 9.2, 45.0min, and 6.9 respectively providing the 7.3mg of phenolics.). ANOVA proved the reliability of the model giving an R2 value of 0.9833. LCMS analysis of phenolics confirmed the presence of protochateuic (peak area: 17690), ferulic (peak area: 58308), coumaric (peak area: 226030), quercitin (peak area: 78760), kempferol (peak area: 71137), apegenic (peak area: 39497), synergic (peak area: 171108). The values of antioxidant assays i.e DPPH (% inhibition), FRAP ($mMFe^{+2}$/g of extract) and TEAC (mmol TE/g of extract) for aroma resulted in 39.02%, 5.58 and 6.04; for lipids resulted in 55.09%, 8.65, 10.02; and for phenolics the values were 61.29%, 12.82, 13.11 respectively.