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# Airlift Reactor Design for the Production of Antiviral Bioactives

## Cheap and Efficient Extraction of Bioactives from Fruit Peels

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**Abstract:- Plant-based bioactive molecules such as polyphenols, curcumin, sesquiterpenes, triterpenes, flavonoids, and carotenoids were reported to offer immunity against coronavirus. Increasing population can pressure agricultural land to grow more of these plants. Hence, it's important to look at alternative sources. Fruit peels also contain these bioactive molecules but are usually thrown as waste as the production of bioactive from fruit peels is not economical owing to the high cost of extraction. In this study, an inexpensive airlift bioreactor was designed which can help reduce the price of extraction and make the best use of waste fruit peels. The bioreactor was easy to operate and economical to carry out the pretreatment of peels and extract antiviral bioactive molecules from waste fruit peels. Further, the study also demonstrated its utility using citrus peels and pomegranate peels which were recently reported to be active against Coronavirus.**

***Keywords:-*** *Airlift Bioreactors, Bioactives, Fruit Peels.*

## I. INTRODUCTION

The processing of fruits and vegetables alone generates significant waste, which amounts to 25–30% of the more than a billion tons of total fruit production (1). During the pandemic, the whole world started looking at alternative complementary plant-based medicines. Some of the reported anti-COVID molecules include polyphenols, curcumin, sesquiterpenes, triterpenes, flavonoids, and carotenoids (2,3). Among all sources, fruit peels contain antiviral bioactive molecules but usually are thrown as waste as it's not economical to extract bioactive out owing to the high power and energy requirements of stirred tank reactors. The stirred tank reactors are very popular for the pretreatment and extraction of biomolecules but are likely to damage oxidative bioactive molecules due to mechanical shear. In this project, an easy-to-operate and economical Air-lift bioreactor was designed to carry out the pre-treatment and extraction of bioactives such as carotenoids, flavonoids, anthocyanins, and other polyphenols from fruit peels. An airlift bioreactor mixes both liquid-liquid or liquid-solid phases using air pressure across the two concentrically arranged tubes called the downcomer and the riser. Further, its utility was demonstrated using citrus and pomegranate peels which were recently reported to be active against Coronavirus. This bioreactor will enable economical extraction of bioactive from several biological sources that need stirring and enzymatic treatments.

## II. MATERIALS AND METHODS

➢ *Design and assembly of the Airlift Bioreactor*

The model airlift bioreactor consists of a tubular vessel in the center with one interconnecting zone containing a riser, where the air is sparged from the bottom, and a downcomer without any sparger was designed **(Fig. 1)**. The ALBR was assembled and tested for its utility.

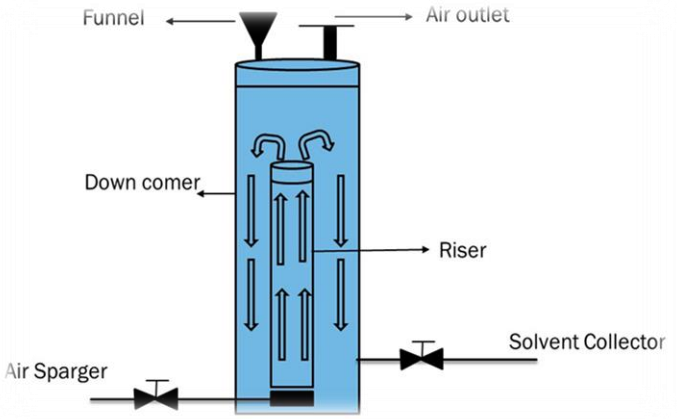


**Fig.1.** Airlift bioreactor design for enzymatic treatment and extraction of antiviral bioactives from Fruit peels.

➢ *Spectrophotometer*

The extraction of pigments was measured using a homemade spectrophotometer. It was made based on the electronic arrangements where white light from light-emitting diodes (LED) was pushed through a slit onto the sample with chromophores of molecules in solutions such as methylene blue. This light was received by a phototransistor which was then recorded on a digital voltmeter (DVM). The principle of Ohm's Law (V = IR) was used to measure the voltage that was developed across the resistor (sample). The voltage read on the DVM is proportional to the light intensity, or power (P). The data obtained was converted into an absolute absorbance number.

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## III. RESULTS AND DISCUSSION

Airlift bioreactors (ALR) are agitated bioreactors that mix both liquid-liquid or liquid-solid phases using air pressure across the two concentrically arranged tubes called the draft tube (the downcomer) and riser. In this project, ALBR was deployed to extract bioactive from citrus and pomegranate peels. It's cheaper and uses less energy compared to the stirred tank bioreactor, which is typically used and causes less damage to bioactive molecules.

To make such a bioreactor, two hollow plastic tubing with 4-inch and 2-inch diameters were attached using 3M foil tape to construct the airlift bioreactor. An air pump was connected at the bottom center to make a perfect downcomer and riser. The unit was checked for leaks.


**Fig 2.** Materials (a-e) used in making airlift bioreactor for the extraction of the bioactive from fruit peels. The reactor was built (f-i) as per the design mentioned in **Fig 1.**

The final form of the bioreactor is shown in **Fig. 2.** was tested using citrus and pomegranate peels. Peels typically contain Cellulose, Hemicellulose, Lignin, Sugar, and Pectin. Hence, enzymes such as Pectinase, Amylase, Cellulase, and Protease were used to break down these molecules. The enzyme mix sold as dietary supplements was obtained over the counter from the local pharmacy (Fig 3.).

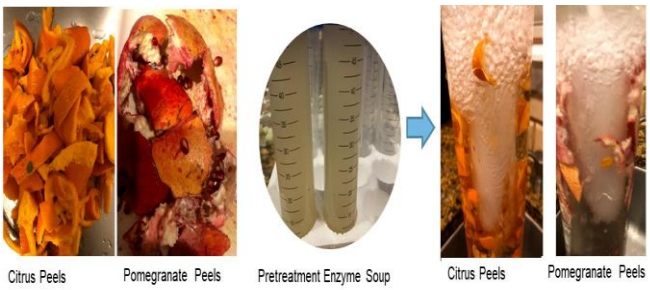


**Fig 3.** Treatment of citrus and pomegranate peels with enzyme mix in the airlift bioreactor.

For testing enzymic treatment, Enzyme soup was prepared by mixing 100 mg/ml of four enzymes (Pectinase, Amylase, Cellulase, and Protease) to a reactor volume of 500 ml. After enzyme treatment water was added along with a 25 percent mixture of 1:1 ratio of hexane and isopropanol to extract bioactive from the peels (Fig 4.) similar to a process reported earlier (4). The air sparging was stopped and the pigment present in the solvent phase was dried.

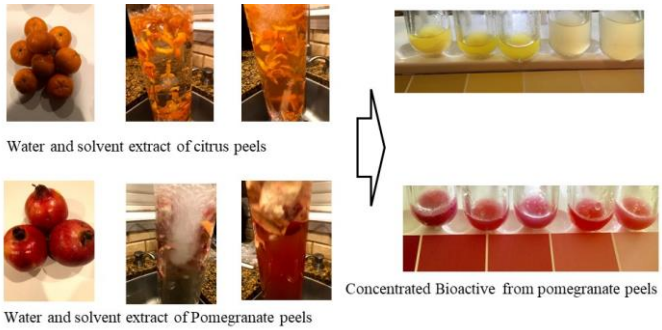


**Fig 4.** Solvent extraction and concentration of extracted bioactives from peels.

The extraction of pigments after enzyme treatment was monitored for 3-4 h using a spectrophotometer monitored at 430 and 450 nm (absorption maxima for flavonoids, carotenoids, or polyphenols). Based on color intensity, it was maximum at 3 hours and after that it was saturated, and no more color was extracted. On average (n=5), 5-8% (g/wet weight of peel) bioactives per unit of the peel's wet weight were recovered.

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