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RESEARCH ARTICLE

Experimental Studies and Development of Modeling Equation of Rutin from Pineapple Peel using Soxhlet Extractor

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Abstract

Rutin is one of the flavonoid found in the various plant species. It shows anti-inflammatory, anti-oxidant and anti-bacterial activities. The present study was intended for the optimization of extraction of rutin from pine apple peel and its various physico-chemical parameters have been studied. For the extraction of rutin, the optimum results were observed for the effect of different solvents, soaking time, different solvent percentages, effect of pH, different volumes of hexane with methanol as solvent and extraction time. The highest rutin concentration for optimized condition was 30 µg/mL. Methanol was found to be the best solvent for the extraction of rutin from pineapple peel by soxhlet extractor. It was carried out for 90 min and an optimum concentration obtained at 50 min with a concentration of 38 µg/mL. This solvent extraction using soxhlet extractor was conducted to verify the mathematical model proposed in this work. The final form of proposed models were $E(t)=At^2+Bt+C$ Where A, B and C are constants, E_s=yield extract (µg/mL of rutin) and t=extraction time (min). The final form of proposed equation is $E(t)=-0.011t^2+1.2591t$ with $R^2=0.962$.

Keywords: Pineapple peel, rutin, soxhlet extractor, modeling equation, methanol.

Introduction

Rutin belongs to a class of plant secondary metabolites called flavonoids that are also known as rutoside, sophorin and rutin-3-rutinoside (α-L-rhamnopyranosyl-(1→6))-β-D-glucopyranose) (Srinivas Rao and Fazil, 2013). Rutin is a bioflavonoid, at times mentioned as vitamin P, which comprises citron, hesperidin and eriodictyl essential for assimilating vitamin C (Sajeeth *et al.,* 2010; Rajasekaran *et al.,* 2011). It is found in many plants including pineapple peel, tobacco leaves (Fathiazad *et al.,* 2006), buckwheat, the leaves and petioles of *Rheum* species and Asparagus. Tartary buckwheat seeds have been found to contain more rutin (about 0.8-1.7% dry wt.) than common buckwheat seeds (0.01% dry wt.). Rutin is also found in the fruit of the *Fava d'anta* tree (from Brazil), fruits and flowers of the pagoda tree, fruits and fruit rinds (especially the citrus fruits orange, grapefruit, lemon and lime) and apple, berries such as mulberry, ash tree fruits, aronia berries and cranberries. Rutin shows anti-inflammatory, anti-oxidant, anti-bacterial activities, anti-cancer and anti-hyperglycemic activities (Madaan *et al.,* 2011). Pineapple peal contains small amount vitamin A, vitamin P (rutin), quercetin and beta-carotene levels and these compounds are known to have antioxidant properties (Niture *et al.,* 2014). Considering the above facts, this study was aimed to extract the rutin flavonoids and optimization of physico-chemical parameters for the extraction of rutin namely effects of different solvents, soaking time, solvent percentages, pH, different volumes of hexane with methanol and extraction time with hexane was carried out.

Materials and methods

Chemicals and reagents: Methanol, distilled water, hexane, aluminium chloride, sodium nitrite, sodium hydroxide of Analytical grade was used for the study.

Collection, processing of the plant material and extract preparation: Pineapple peels were collected from local market at Visakhapatnam, Andhra Pradesh, India. Peels were cleaned, dried under shade and powdered. The powder is then passed in 100 mesh size and the fraction obtained are stored in an air-tight container. About 1 g of powder is added to 50 mL methanol (80%) in a conical flask. The solution is soaked for 1 d. After the soaking time, the solution is filtered using Whatman filter paper no. 1 and the filtrate is heated at 65°C, so that the solvent which is taken in glassware is evaporated. The resultant solution is cooled and make up to 25 mL with distilled water. This solution is added to 25 mL of hexane taken in a separating funnel. Incubate the solution of methanolic extract for 1 h.

Determination of rutin: About 1 mL of methanolic extract is taken in a test-tube from the extract phase of the separating funnel. To this, 0.3 mL of 5% sodium nitrite was added. After 5 min, 0.3 mL of 10% $AlCl_3$ was added. After 6 min, 2 mL of 1M sodium hydroxide was added and the mixture was made up to 10 mL by adding distilled water. The absorbance of the reaction mixture was measured at 510 nm using colorimeter (Patel *et al.,* 2010). The concentration of rutin was determined by using calibration curve.

Solvent extraction using soxhlet extractor: Prior to the solvent extraction study, 200 mL of 80% methanol is taken in the extractor, 4 g of dried pineapple peel powder is placed in thimble and it is fixed to the condenser. Now the total apparatus is placed in the heater. Using the soxhlet apparatus (Prakash *et al.,* 2012) continuous extraction is done for 90 min. Solvent-Solvent extraction was done by hexane as solvent along with distillate of 1:1 ratio in separating funnel. After few minutes of solvent extraction with hexane, two phases like extract and raffinate phases were separated. Now collect 1 mL of extract phase for the determination of rutin.

Results and discussion

Effect of different solvents on extraction of rutin: For the extraction of rutin from pineapple peel powder, different organic solvents such as methanol, ethanol, water and ethyl acetate were used. Among these, methanol (Dixit, 2014) showed the best results and the concentration of rutin obtained was 12 µg/mL (Fig. 1).

Effect of soaking time on extraction of rutin: For the extraction of rutin from radish leaf powder, the samples were incubated for different time periods viz., 1, 2, 3 and 4 d. It was observed that, soaking for 1 d gave the best result and the concentration of rutin was 21 µg/mL (Fig. 2).

Effect of different solvent composition on the extraction of rutin: Different solvent percentages like 0, 20, 40, 60, 80 and 100% were used for extraction of rutin. The optimum solvent percentage was found to be 80% and its concentration was found to be 23 µg/mL (Fig. 3).

Effect of pH on extraction of rutin: To determine the effect of pH on extraction process, different pH values namely 5, 6, 7, 8 and 9 were used. The optimum concentration of rutin was 26 µg/mL observed at pH 7 (Fig. 4).

Effect of different volumes of hexane on the extraction of rutin: Different volumes of hexane with solvent in different ratios such as 1:1, 1:2, and 2:1 were used for the extraction of rutin. The optimum value is observed with the ratio 1:1 and the concentration of rutin is found to be 23 µg/mL (Fig. 5).

Effect of extraction time with hexane on extraction of rutin: To investigate the influence of hexane on extraction of rutin, different time intervals were taken viz., 1, 2, 3 and 4 h. Solvent-Solvent extraction was done with hexane as one of the solvent. It was observed that, at the 1 h, the concentration of rutin was 30 µg/mL (Fig. 6).

Modeling of extraction of rutin using soxhlet extractor: Methanol was found to be the best solvent for the extraction of rutin from pineapple peel by soxhlet extractor. It was carried out for 90 min and an optimum conc. obtained at 50 min with a conc. of 38 µg/mL.

Fig. 1. Effect of different solvents on extraction of rutin.

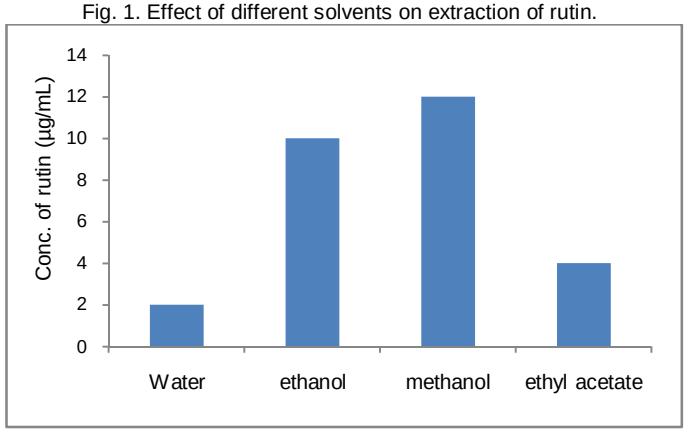


Fig. 2. Effect of soaking time on extraction of rutin.

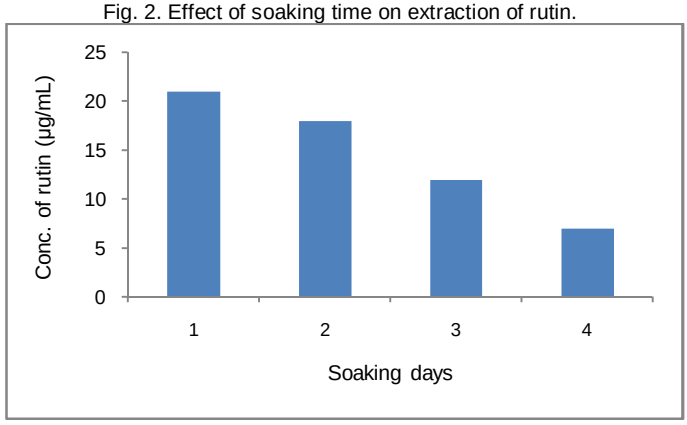


Fig. 3. Effect of different solvent compositions on extraction of rutin.

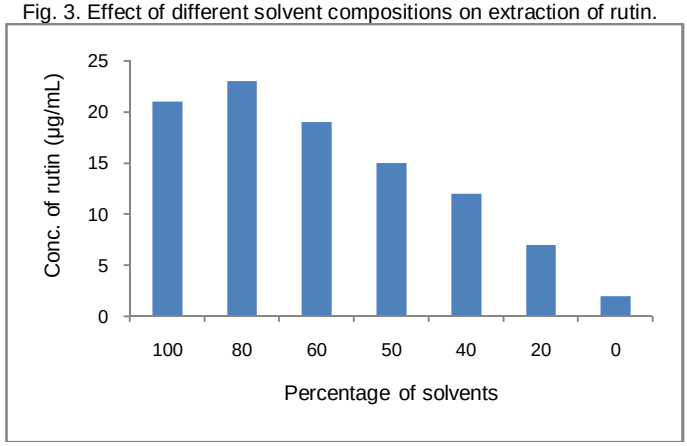


Fig. 4. Effect of pH on extraction of rutin.

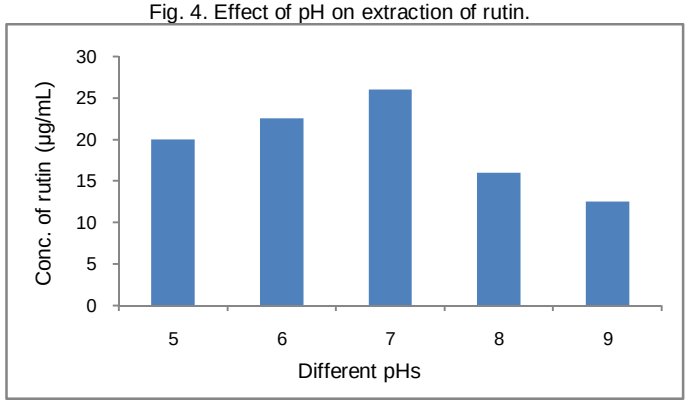


Fig. 5. Effect of different volumes of hexane on extraction of rutin.

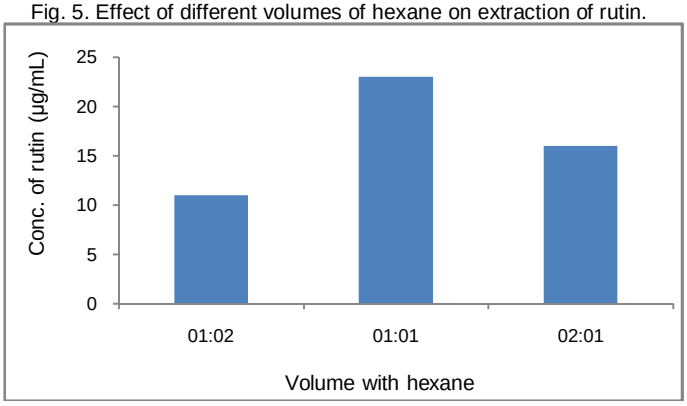


Table 1. Effect of yield extract with extraction time on rutin.

Time (min)	Yield extract (µg of rutin/g of dried sample)
10	13
20	20
30	26
40	35
50	38
60	36
70	32
80	30
90	23

Fig. 6. Effect of extraction time with hexane on extraction of rutin.

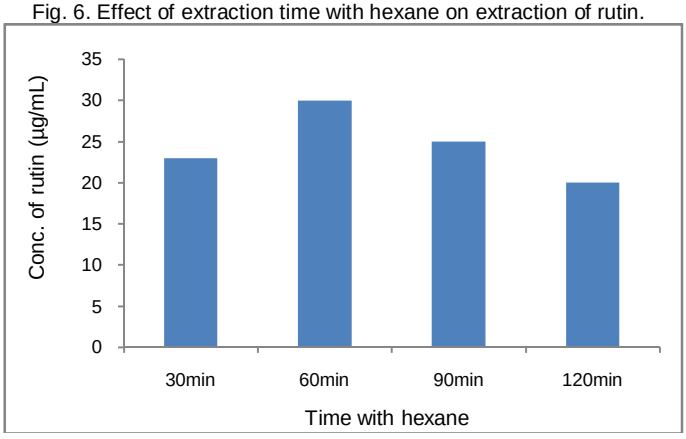
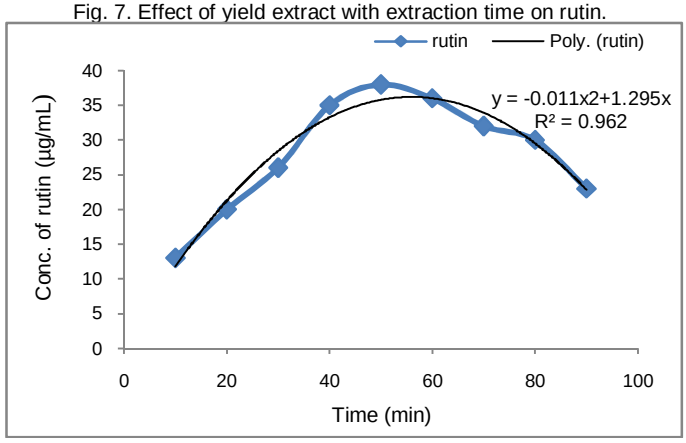


Fig. 7. Effect of yield extract with extraction time on rutin.



Modeling of extraction of rutin using soxhlet extractor apparatus was studied in order to describe the rutin from the peel of pineapple to the bulk of the solvent. The mass transfer coefficient is constant. The solvent in the extractor is perfectly mixed, while the transfer resistance in the liquid phase is negligible and the rutin concentration in the solvent depends only on time. The transfer of the rutin was a diffusion phenomenon and independent of time. By this hypothesis, an equation can be developed (Meena *et al.,* 2014).

$E(t) = At^2 + Bt + C$

Where A, B and C are constants, E_s=yield extract (mg/L of rutin) and t=extraction time (min) (Table 1 and Fig. 7). The final form of proposed equation is:

$E(t) = -0.011t^2 + 1.2591t$ with R^2=0.962

Conclusion

The present study was intended for the optimization of extraction of rutin and its various physico-chemical parameters have been studied. For the extraction of rutin the optimum results were observed for the effect of different solvents, soaking time, different solvent percentages, effect of pH, different volumes of hexane with methanol as solvent, extraction time with hexane were methanol, 1 d, 80% (v/v), 7.0, 1:1 ratio and 1 h respectively.

Highest rutin concentration for optimized condition was 37 µg/mL. Methanol was found to be the best solvent for the extraction of rutin from pineapple peel by soxhlet extractor. It was carried out for 90 min and an optimum concentration obtained at 50 min with a concentration of 38 µg/mL. This solvent extraction using soxhlet extractor was conduct to verify the mathematical model proposed in this work. The final form of proposed equation was $E(t) = -0.011t^2 + 1.2591t$ with R^2=0.962.

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