Effective Utilization of Pineapple Waste

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Abstract. India is the largest fruit and vegetable producer. Until fruit is eaten, fruit peel stays waste. Phenolic acids, ascorbic acid, β-carotenes, and flavonoids are the most bioactive components of pineapples. This is one of the secondary plant metabolites abundantly present in pineapple skins in this sample, ferulic acid. Ferulic acid is a low-toxic phenolic acid widely used in diet and cosmetics. Ferulic acid is extracted using different conventional and nonconventional methods such as Soxhlet extraction, Supercritical fluid extraction and Solvent extraction and the amount of ferulic acid is quantified using High performance liquid chromatography (HPLC). The study also evaluated the presence of total phenolic content (Gallic acid equivalent/GAE) and antioxidant activity. Soxhlet extraction using methanol and petroleum ether was the best solvent, methanol showed maximum ferulic acid concentration (0.7696 g/100g), phenolic content (2.365 mg g/GAE), antioxidant activity (45%) and percentage yield (90.5% mg). This study also analysed micronutrients such as vitamins (A, B1, B2, B6, B12 and C), calcium, potassium, phosphorus, iron, manganese, zinc and dietary fibre in the pineapple peel.

Keywords: Pineapple Waste, Ferulic Acid, Micro Nutrients, Antioxidant Property

1. Introduction

Pineapple is one of the export varieties of pineapple known for many decades and is still under cultivation. Its production as landraces in many West African countries[1]. Pineapple peel waste (PPW) is an significant waste management challenge that needs to be solved immediately, considering the effects of pineapple food industries. PPW has since been an incredibly useful substance because it provides considerable antioxidant, starch, phenolic, high fiber and protein content. It is still regarded as a drug with great benefit. PPW also provides a high level of practical and aromatic materials [2]

The PHENOLIC COMPOUND in plants is an important component of the human diet, and its antioxidant effects are of considerable importance. The number of pineapple types is about 37. This is classified as cultivars. The four major commercial cultivars are called: the red Spanish, the princess, abacaxi, and the smooth cayenne. Kona sugarloaf: 2,5–3 kg. It has a strong sugar content, cylindrical in form, but no acid. It's incredibly good. Pineapple provides several various health-conserving vitamins, sugars, basic protein, water and minerals. Calcium, potassium, fiber and vitamin C etc are considerably found in pineapple. Fresh pineapples are high in anti-inflammatory bioactive substances, rising inflammatory swellings like acute sinusitis, sore throat, inflammation or drowsiness.

A decent source of vitamin C, fibres and minerals is pineapple. It may also be eaten freshly or converted into items such as pineapple juice pasteurized or pineapple syrup [3],[14]. Waste disposal The residues of fruits that trigger severe environmental problems, since they accumulate without having an essential and commercial value in agro-industrial areas. Further problems in recycling are the high amount of BOD and COD in pineapple waste. Pineapple waste is intended to be used for more industrial purposes such as processing, bioactive product production, etc. Waste may be discarded from fruit as is waste content [4].

Pineapple wastes are used as a substratum for bromelain, organic acids, ethanol, etc. since they growing induce starch, vitamins and growth factors. The waste is mainly composed of crop, flesh, rind and pomace, with good sources, for instance carotenoids, polyphenols and dietary fibers, vitamined,
enzymes and oils, which are potentially valuable bioactive compounds. Phenolic compounds are secondary plant metabolites that are responsible for the sensory characteristics of fruits and vegetables and which lead to their nutritional consistency, among other function. Phenolic compounds are amongst the main groups of biologically important bioactive compound. In their basic form they comprise one or more rings of the fragrance, along with 1 or more classes of hydroxyls, others with an antioxidant function.

Polyphenolic compounds are classed in various classes like, for example, flavonoids, tannin, phenolic acids, stilbens and lignans and other sub classes. Polyphenolic compounds are classified under the following headings. Fruit and vegetable rind, peel and seeds have many phenolic compounds. Extraction is the main step in collecting fruit and vegetable waste bioactive compounds. The extraction method may be influenced by several variables, including temperatures, plant part, pressure and form of solvent.

Sample preparation is also one of the critical factors for evaluating the form and quantities of bioactive compounds collected. Sample was prepared by distilling the pineapple skin for 10-15 minutes. The skin was then split into cubic parts and held in a tin dryer with a temperature of 55-60 degrees for 24 hours. Bioactive plant waste compound may be collected using a range of different approaches which can be categorized into two main categories: traditional and non conventional techniques. The key conventional techniques involve

1. Soxhlet extraction,
2. The extraction of soxhlets was very common and was commonly used to extract useful bioactive components from different plant sections.

2. Materials and Methods

Collection of pineapple peel materials
Cold peel waste was washed and cut into 1 mm long by knife to bits of cube from the soda laboratory at the SRM Institute of Science and Technology Kattankulathur campus. Dry with a 55-60 ° C dryer for 12 hours and milled with a mixer. A 1 mm wire mesh panel to get dry powder of a lime peel. The material was sealed in a plastic bag with vacuum, air vexed filtered and held for a period of 12 weeks at room temperature (4 ° C).

Chemicals and reagents
The analytical and nutritional classes of all the chemicals and reagents used in this analysis. Chemicals such as gallic acid, 2, 2′-diphenyl-1-picyrylhydrazyl radicals (DPPH•), folin-cycaletu reagent, sodium carbonate.

Extraction of polyphenols
Soxhlet extraction, Super critical fluid extraction and solvent extraction procedures were used for polyphenol extraction from pineapple peel powder peel powders.

Soxhlet extraction
The extraction of Soxhlet from solid and powder samples has been used for extracting polyphenolic compounds. This is a very simple process that involves limited preparation. In accordance with new standards it has been updated. In the case of extraction of hot-water bath, the water bathtub is the means of maintaining the necessary temperature for extraction of the phytochemical in the surrounding solvent. The performance of solvent-based extraction methods is determined by many variables, including existence and form of solvent, extraction period and retained temperature during extraction. In other instances, though, the time taken may be greater than or less than 6 hours[8]. Methanol, gasoline, ethyl acetate and their aqueous solvents are the most popular solvents for production of polyphenols from plant sources. The preference of solvent relies, however, on the type of polyphenol removed. Aqueous methanol has been identified as a popular choice due to the high boiling point and its economic availability.
The solvents used for the production of phenol compounds are ethanol and aqueous ethanol solutions. Extremely popular polyphenolic extraction solvents Methanol and ethanol and hexane. Ether, hexane, or dichloromethane, as solvents, are in most situations to be used as a nutraceutical as a medicinal norm for the derived phytochemical drug. Flavones and flavonol glycosides Methanol and fructose, though, are not effective phenolic disinfectants for insoluble sugars and proteins. The process of extraction relies on the form of phenol to be removed and certain solvents for other phenolic compounds have been used more frequently. Twenty g of powder was removed by the soxhlet extraction process during a 6-hour span with a different time interval (the amount of cycles taken) in 230 ml solvent (hexane, dichloromethane, acetone, ethanol and water). The extracts have been filtered and evaporated rotatingly. Specific study of phenolic compound involvement was carried out.

Supercritical fluid extraction
A SFE system essentially contains an extraction cell with temperature regulators and valves at both ends to sustain sufficient temperature and high pressures to provide the fluid solvent. Separators are given for the process size extraction systems, extracting extracts and waste contained in the solvent (in solvents other than extracts, undesirable compounds) from the solvent stream, usually CO2 and condensers for carbon condensation and reusing it in corresponding extraction processes. Extraction devices commonly produced are used. Dry materials are favoured for effective extraction in the preparation of SFE samples. After the tension and temperature of the solvent fluid are balanced with the extract and impurities, contributing to partial extract isolation from the solvent and then to CO2 condensation for extraction in the condensers[9]. The solubility of polar phenolic compounds (due to the coupling of hydrogen and dipole interaction), improved by organic co-solvents such as methanol and ethanol as additive. However, as a polar co-solvent is applied, the essential temperature is elevated which ensures that the cycle may have a thermolabile disadvantage. Methanol appears to be the cosolvent often used; but gasoline is more suitable for nutraceutical purposes. In addition, the influence of the SFE depends on the quality of the agent used in conjunction with variables such as the form of compound removed, the amount of solvent and temperature, pressures and extraction period. Lower viscosity and higher diffusion coefficient than the extract of liquid solvent, which increases mass transfer Time saves and is eco safe because sample and organic solvent specifications Less loss, since the reuse and recycle of supercritical fluid is feasible.

Solvent extraction
The most growing form of extraction is the extraction of solvents. Additional approaches such as centrifugation and mechanical agitation, along with solvent reduction may be used to further improve the extraction performance by rising the touch surface region, which is also a control factor. The source of the drug, which implies the form of tissue from which it is derived, is another essential element in the extraction. Another essential consideration is that the forms and quality of solvents and temperature are regulated based on the form and consistency of the bio-material from which the compound is made. In fact the improved intermolecular contact between the solvent and the biomaterial molecules improves the solubility of the materials, which results in comparatively greater molecular motion, with decreased solvent viscosity with elevated temperature. Cell breakup is also due to the high temperature strain caused in the formation of the cell and the enhanced solvent-tocompound contact of the cell matrix[10]. Nevertheless, Polyphenolic content changes during extraction have been found to be restricted to a certain altitude.

Phenolic compounds pre-extracted and isolated at higher temperatures leading to oxidation and degradation. Polyphenolic compounds have been shown to be more likely to be toxic at elevated temperatures with larger numbers of hydroxy substituents. The yield of production has been improved by growing the period to an optimal level. Therefore, with pressure ranges, extraction temperatures and external methods such as mechanical stirrings and vorticing, the optimal period for the extraction is specific. The thickness of the sample used to remove the solvent quantity and extraction period are both significant considerations. An significant element is the amount of solvent. The iteration is carried out with fresh solvents in order to prevent the solvent accumulation and maintain the kinetics of extraction.
All parameters of extraction depend on one another; therefore, all bioproduct extraction parameters must be optimized for every extraction method. (Extraction and quantification of polyphenols from kinnow (Citrus reticulate) peel using ultrasound and maceration techniques) should know the concentration properly

3. Results and Discussion

Determination of polyphenols compound

Yield of extraction

PPW includes extremely water that induces rapid rotting and pollutes the atmosphere significantly. Pineapple peel powder was used for extraction of phenolic compound by various methods of extraction. The percent yield of pineapple peel extracts through Soxhlet extraction and super critical fluid extraction and solvent extraction method was assessed by dividing the weight of the extract with the sample weight and multiplying by 100. (Extraction and quantification of polyphenols from kinnow (Citrus reticulate L.) peel using ultrasound and maceration techniques) [16].

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Yield = \frac{\text{weight of the total solids in the extract}}{\text{weight of the dried powder taken for extraction}} \times 100
\]

High of amount yield was found in Soxhlet extraction method with using the solvent methanol, by continuous cycle of running the sample at a temperature of (75°C - 80°C). Further the extract was stored in amber glass at 4°C and used for analysis of phenolic group. It was observed maximum amount of yield of 90.5% (TABLE 1)

**Total Phenolic Content:**

Calculated by Folin-Ciochaltue method by taking 1 ml of extracted sample added 10 ml of folin reagent and 4 ml of sodium carbonate. Stir the mixture well and incubated at 40°C for 1 hour. Take absorbance UV-Spectrometry at 765nm. Using water as solvent Graph is plotted against concentration vs absorbance with standard gallic acid was compared PREPARATION OF STANDARD FOR GALLIC ACID. 2.365 mg g/GAE (TABLE 2) was extracted from Soxhlet extraction method with the solvent methanol, comparing different extraction methods Soxhlet extraction showed maximum amount of phenolic compound [17-23].

**Antioxidant activity DPPH**

Using DPPH (1,1-diphenyl-2-picryl-hydrazyl) has helped to calculate the antioxidant function of pineapple peel extracts. In order to prepare the stock solution, 4 ml of DPPH has been dissolved in 100 mL methanol. By diluting DPPH methanol stock solution at absorbance of 517 nm, job standards were developed Scavenging Activities On Dpph Radical Procedure was followed. Take 2 ml of sample solution in methanol. Mix with 4 ml of DPPH and Keep it in dark room for 60 mins. Take OD value at 515nm. It was observed more (45± 0.001) antioxidant activity in Soxhlet extracted sample compared to other 2 methods.

**Table 1:** Comparision Of Yield Percentage Of Pineapple Peel Extract By Different Extraction Methods

| SAMPLE (g) | METHOD OF EXTRATION | %YIELD OF THE SAMPLE |
|------------|---------------------|----------------------|
| PINEAPPLE PEEL POWDER | Soxhlet extraction | 90.5% mg |
Extraction of phenolic compound from pineapple by different extraction methods using methanol as a solvent. Soxhlet extraction contains high amount of yield (90.5% mg) compared to solvent extraction and super critical extraction methods.

**Table 2:** Comparison of Total Phenolic Content (Tpc) by Using Gallic Acid Standard Mg G/Gae Extract for Pineapple Peel Powder Extract

| Soxhlet Extraction | Maceration Extraction | Super Critical Fluid Extraction |
|--------------------|-----------------------|-------------------------------|
| CONCENTRATION (µg/ml) | ABSORBANCE AT 765nm | ABSORBANCE AT 765nm | ABSORBANCE AT 765nm |
| 0 | 0.106 | 0.0136 | 0.106 |
| 0.5 | 0.203 | 0.0751 | 0.203 |
| 1 | 0.408 | 0.1024 | 0.408 |
| 1.5 | 0.678 | 0.2163 | 0.678 |
| 2 | 0.84 | 0.3195 | 0.84 |

Total phenolic content of the peel extract was calculated using gallic acid standard curve. It shows the presence of phenolic content (2.365 mg GAE Extract) more in Soxhlet extraction method compared to solvent and super critical fluid extraction method. Soxhlet extraction is considered has best method for extraction of secondary metabolites from the dry peel powder, at a varying temperature, solvent and time taken for the extraction process.

**Table 3:** Comparison of Antioxidant Activity Using Dpph Method for the Peel Extract

| SAMPLE (g) | EXTRACTION METHOD | ANTIOXIDANT ACTIVITY |
|------------|-------------------|----------------------|
| PINEAPPLE PEEL POWDER (20g) | Soxhlet extraction | 45± 0.001 |
| | Solvent extraction | 32±0.002 |
| | Super critical fluid extraction | 21±0.001 |

**Table 4:** Selection of Best Extraction Method
Antioxidant activity of the extract vary according to the extraction methods ,temperature and time .

Comparing different extraction methods and solvent used , Soxhlet extraction was the simple and effective method to extract the secondary metabolites for further evaluation of phenolic compound and antioxidant property of the pine apple peel powder.

HPLC analysis of phenolic compounds

In pine Aple Peel Extracts HPLC analysis of the phenolic Compounds, a simple reliable HPLC method for the determination of the ferulic acid content was produced. Complete phenolic compounds were calculated and quantified against those of expectations by retention time and their spectral peaks. HPLC peel extract chromatograms and phenolic requirements have been requested. In conjunction with the mobile stage of a methanol and water comprising 1 per cent (v / v) acetic acido at 30:70 at a flow rate of 1.0 ml/min the chromatographic device has been equiped with Kromasil C 18 (column and UV sensors with 320 nm). A linearity, accuracy, reliability, repeatability and recovery were tested for the process. The time of preservation was 15.449 min for ferulic acid. Data reveal that pineapple peel extracts differ greatly with respect to solvent structure and concentration. In Soxhlet extract (2.365 mg ), super critical fluid extraction (1.287mg ) extracts, solvent extraction extract (1.165 mg ) total phenol compounds were quantified. Pineapple pelts were used as a limit of 100 mg / g. The most plentiful pineapple peel extracts included ferulic acid among the phenolic compounds. Ferulic acid average (mg / g). The pineapple peel amounts can be measured by this process as an efficient tool.

By HPLC analysis of phenolic compounds is detected by HPLC detector system. The analysis of HPLC chromatogram was based on the retention time of both standard and extracted ferulic acids was represented below. Retention time for ferulic acid standard was obtained to be 15.540 and sample retention time was 15.449 .Inference was noted Peak area of sample =1767.326 and Concentration of ferulic acid present in 20g = 0.00051303 mg/mL where , the Concentration of ferulic acid present in 100g =0.76968 / 100 g was calculated from the 100g of pine apple peel powder
Figure 6: HPLC chromatogram of standard ferulic acid at 320 nm (Rt = 15.540).

Figure 7: HPLC chromatogram of extracted ferulic acid at 1400 mA (Rt = 15.449)

4. Conclusions
The present study was intended for effective utilization of pineapple peel waste as antioxidant source and extraction of ferulic acid. The study involved the analysis of various physicochemical parameters, micronutrients, and vitamins have been studied. Efficiency of various extraction methods was evolved out of which Soxhlet extraction method was excellent method for higher amount of yield. In Soxhlet extraction experimented with different solvent at the temperature of 75-80°C. Different extraction methods was carried out using different solvent. For extraction of ferulic acid the presence was observed using HPLC high performance liquid chromatography method. Ferulic acid is a hydroxycinnamic acid and organic compound, can be converted into vanillic acid (flavour compound). Presence of ferulic acid was found to be 0.76968/100g of pineapple peel powder.

Conflicts of Interest
All authors have participated in (a) conception and design, or analysis and interpretation of the data; (b) drafting the article or revising it critically for important intellectual content; and (c) approval of the final version.
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