Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v30i19.3696

PRACTICAL APPLICATION AND ANALYSIS OF VARIOUS CHEMICAL EXTRACTIONS DERIVED FROM *CUCURBITA MAXIMA*, *PISUM SATIVUM*, AND *APHANUS SAIVUS L.*

Wajeeha Nusrat[1], Ghuncha Riaz[2], Uzma Shahid[3], Rabail Urooj[4], Kainat Nisar[5], Sahar Maqbool[6], Dr. Madiha Rohi[7*], Dr. Mahwash Aziz[8*], Arshad Rasool[9], Muhammad Mohsin[10], Tariq Rafique[11]

[1]Department of Food Science and Technology Government College Women University Faisalabad, Pakistan, Email: Wajeehanusrat@gcwuf.edu.pk
[2]Department of Food Science and Technology University: university of Haripur Email: ghunchariaz003@gmail.com
[3]Government graduate College for Women, Pakistan, Email: uzmatauqeer5900@gmail.com
[4]Department of Environmental Sciences, Sardar Bahadur Khan Women University, Quetta, Pakistan, Email: rabailurooj@gmail.com
[5]Department of Food science and technology, University of haripur, kainatnisar926@gmail.com
[6]Department of Food Science and Technology, Government College Women University Faisalabad, Pakistan, Email: sahaarmaqbool@gcwuf.edu.pk
[7*]Department of Food Science and Technology Government College Women University Faisalabad, Pakistan, Email: dr.madiharohi@gcwuf.edu.pk
[8]Department of Food Science and Technology Government College Women University Faisalabad, Pakistan, Email: dr.mahwashaziz@gcwuf.edu.pk
[9]Department School of Botany Institute: Minhaj University, Lahore, Pakistan, Email: arshad.botanyscholar@gmail.com
[10]Associate Editor, Research Journal of Innovative Ideas and Thoughts Email: mmrrcc001@gmail.com
[11]Assistant Professor Dadabhoy Institute of Higher Education, Karachi, Pakistan Email: dr.tariq1106@gmail.com
[*]Corresponding Author

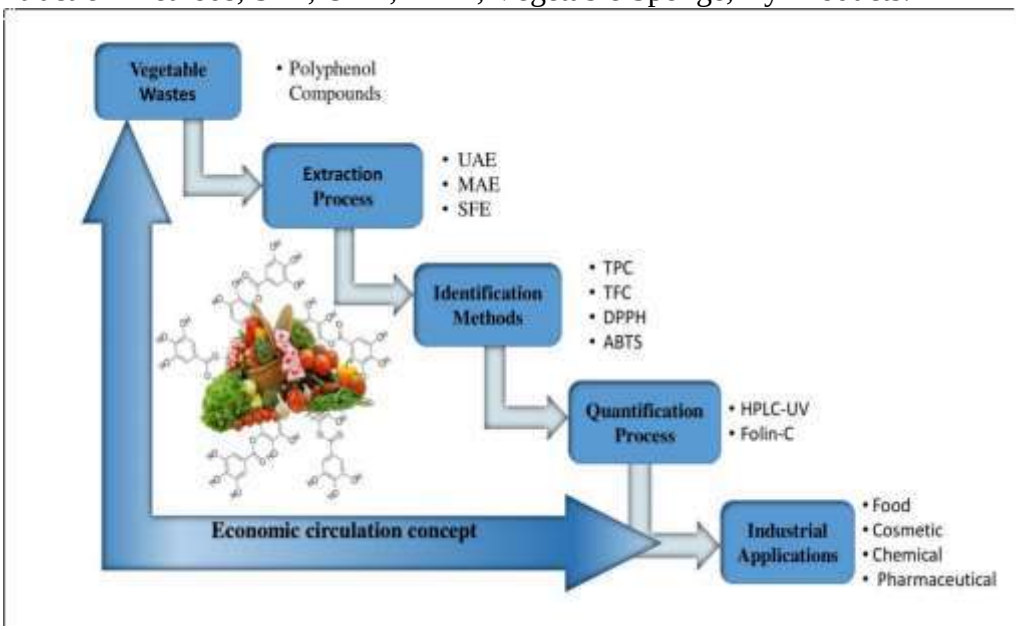
ABSTRACT

Planning/method/approach: Every year, the fruit and vegetable industry processes 1,300 million tonnes (MT) of wasted food. The skins and seeds of these vegetables, rich in flavonoids, phenolic compounds, pectin, lipids, and fiber, are discarded. To overcome the limitations and disadvantages of traditional extraction methods, new extraction technologies have been developed, such as B. extraction with pressurized liquid, microwave extraction, ultrasonically assisted extraction and extraction with supercritical fluids. Various extraction strategies for separating bioactive chemicals have been

extensively studied over the past two decades. This post focuses on innovative extraction technologies, their disadvantages and how to optimize the extraction of bioactive ingredients from fruit and vegetable residues.

Findings: This article analyzes the extraction methods, composition, and unique applications of the beneficial components that are separated from food waste using *Cucurbita maxima*, *Aphanus saivus L.*, and *Pisum sativum.* The Observe additionally highlights the contemporary studies on nutrient profile, pharmacological advantages and substance use.

Keyword: Extraction Methods, SFE, UAE, MAE, Vegetable Sponge, By-Products.



INTRODUCTION

The cucurbitaceae family includes edible plants like the pumpkin (*Cucurbita maxima*). There are around 27 distinct species of pumpkins (Cucurbita spp.), the most well-known of which are *C. maxima*, *C. pepo*, and *C. moschata* (Lozada et al., 2021). It is regularly utilized as a utilitarian nourishment and home-grown treatment. Pumpkin divisions are wealthy in supplements such as minerals, oils, proteins and carbohydrates. Phenols, flavonoids, tocopherols, carotenoids, terpenoids, cucurbitacin, muschatin, and phytosterols are just a few of the phytochemicals found in pumpkin sections. Minerals, cancerfighting chemicals, carotenoids, and phenolic compounds are all present in pumpkin skin (de Andrade Lima *et al.,* 2018). Due to its advantages over fluid solvents in terms of effectiveness and speed, carbon dioxide is a desirable fluid for chemical extraction. Present day extraction strategies such as microwave, ultrasonic, SWE and SFE have supplanted conventional strategies in later a long time due to the dangers postured by natural dissolvable buildups, the long extraction handle, natural harm and the potential corruption of the dynamic fixings of plants (de Andrade; Lima *et al.,* 2018). Supercritical Co_2 and subcritical water extraction have been found to be successful in the extraction of pumpkin peel extracts rich in carotenoids and phenols while preserving the integrity of canola oil and providing a conservative and ecologically friendly technique. The most frequently cultivated vegetable in the world is the pea (*Pisum sativum* L), Its cultivation has shifted from the Middle East to Europe and North America. In 2013, 18.5 million tonnes of peas were produced worldwide, according to the FAO. China, India, the Joined together States, France and Algeria are the driving nations creating this item (Sozer *et al.,* 2017). The phenolic of the pumpkin was 2.683% 0.128 (mg/g), the total phenolic content was 6.166% 0.104%, and the DPPH IC50 was 3.399% 0.0188 (mg/mL) (Hussain *et al.,* 2021).

MAE (Microwave aided extraction) is the most promising new method for isolating bioactive compounds from waste products of natural sources. This method uses a heated generator powered by microwave energy to prepare tests either directly or indirectly. An electromagnetic wave in the microwave region has a wavelength between 1 cm and 1 m and is subject to mutual magnetic and electric forces between 300 MHz and 300 GHz. However, within the IEA, the recurrence ranges 915–2450 MHz are the foremost commonly used, while the foremost commonly utilized wavelength ranges are 12–20 cm (Ciriminna *et al.*, 2016; Garavand *et al.*, 2019). Pea had the greatest amounts of important polyphenols with values of 59.87 mg/100g, 19.94 mg/100g and 29.46, mg/100 g for epicatechin, 5-caffeoylquinic acid, and hesperidin respectively, out of all the studied extracts (Castaldo *et al.*, 2021). The external unit contains around 35-40% of the weight of a pea. *Aphanus saivus L.*, a radish due to the close proximity of several bioactive compounds including saponins, flavonoids, polyphenols, basic oil, and vitamins A and C, many theories have demonstrated the nutritional and restorative relevance of radish (Pasau, 2019). The microwave radiation directed at the test produces warmth as a result of the particle's turning and scattering, which warms the neighbourhood from the inside out (Maran et al. 2015; Mena-Garca et al. 2019). GPPP extraction was performed utilizing ultrasonically helped extraction. The effectiveness of ultrasonic control, sonication period, temperature for extraction procedure, and water. Green pea polysaccharide extraction as a function of raw fabric ratio cases was investigated using the center complex reaction surface technique. The point of the investigate was to optimize these factors in arrange to realize the most extreme extraction productivity. The GPPP extraction abdicate extended from 4.45% to 7.08%. From this consider we will draw the taking after conclusions: All phenolic compounds show within the pea pod were extricated utilizing ultrasonic technology. According to the criteria considered, these comes about give valuable data to progress the method of ultrasonically helped extraction of phenolic components from pea cases (Ordoñez et al., 2019). The objective of this inspection was to examine the useful and nutritional properties of pumpkin peel as well as the health advantages of these dietary supplements. The idea behind the study was to use pumpkin carotenoids (found in the flesh and mash) as a natural colouring agent with antioxidant effects. To attain this, inventive extraction procedures such as ultrasonic and microwave helped extractions and green solvents (corn oil) were utilized. The investigate is anticipated to discover application in different businesses counting nourishment, pharmaceutical and beauty care products.

Chemical Composition

Squash (*Cucurbita maxima*) is a consumable plant within the cucurbit family, commonly devoured as a vegetable, squash (*Cucurbita spp.*). In addition to phenolics, flavonoids, carotenoids, terpenoids, tocopherols, cucurbitacin, phytosterols and mochatin, pumpkins also include other phytochemicals. They are a rich source of other beneficial substances as well, including and vitamin C, polyphenols, and minerals. Carotenoids are particularly important since they precede vitamin A, have important antioxidant qualities, and may be a common colouring agent (Kulczy et al. 2020; Cobru and Nour. 2020). Pumpkin peel flour has notable concentrations of insoluble fibre (24.1 g/kg) and potassium (19.1 g/kg). Pectin, vitamins, and minerals are present in pumpkin peel (46 g/100 g) and pulp (152.5 mg/kg) (Hussain et al., 2022). They belong to the same group as xanthophylls and carotenes (Ouyang et al., 2022; Kehili et al.2017).

Due to its abundance in a variety of nutrients, including protein, complex carbs, fiber, minerals, vitamins, and agents that fight cancer, peas have long been a mainstay of human calorie tracking. Cholesterol and fat content in them rises with time. With significant values of 59,87 mg/100g, 29.46 mg/100g, and 19.94 mg/100 g, hesperidin, epicatechin, and 5-caffeoylquinic acid were the three polyphenols found in the tested extricates that stood out (Castaldo et al., 2021). About 35–40% of the weight of a pea is included in the exterior unit. In addition to notable amounts of protein, carbs, and minerals, pea units also provide enough fibre.The polyphenols included in pea units include phenolic

acids like the corrosive 5-caffeoylquinic acid and flavanols like catechin and epicatechin (Nasir et al. 2022).

Radish: (Aphanus saivus L) is a yearly plant of the Brassicaceae and is utilized as an eatable root. Due to its fantastic nutritious and phytochemical features, it is a well-known root vegetable all over the world. Due to the close proximity of many bioactive products including saponins, flavonoids, polyphenols, basic oil, and vitamins A and C, numerous studies have demonstrated the nutritional and restorative relevance of radish (Pasau 2019). This gives it antibacterial, anti-inflammatory and antioxidant properties. Phenol atoms are the foremost common auxiliary metabolites in plants and have as of late pulled in a awesome bargain of intrigued due to the various hydroxyl bunches, counting lignins, stlibins and flavonoids, which have tall free radical rummaging capabilities (Wang et al.2020).

TECHNIQUES OF EXTRACTION

Pumpkin: Using water as the dissolvable, Mahindrakar and Rathod attached UAE to seeds in a jostle in 2020 for 69 minutes at 79 °C and at a liquid-to-material ratio of 41 mL/g. The abdication of polysaccharide was particularly notable in 15.94% (Ma et al. 2020; Martínez et al. 2022). An UAE supported by the Reaction Surface Technique (RSM) was used in this study to evaluate the separation of bioactive extricates from dried pumpkin skins (Cucurbita moschata). Physicochemical analyses revealed that pumpkin peel flour (PPF) included significant quantities of inorganic nutrient including phosphorus, magnesium, calcium, sodium, zinc, and manganese, and a considerably more favorable profile of lipids (11.8 percent), proteins (6.2 percent), and dietary fiber (1.9 percent). Strong antioxidant (653.90-1698.20 mol TE/l) in PPF may be attributed to the high concentrations of TFC (44.08-89.68 mg CTE) and TPC (145-479 mg GAE/l) inside the material.

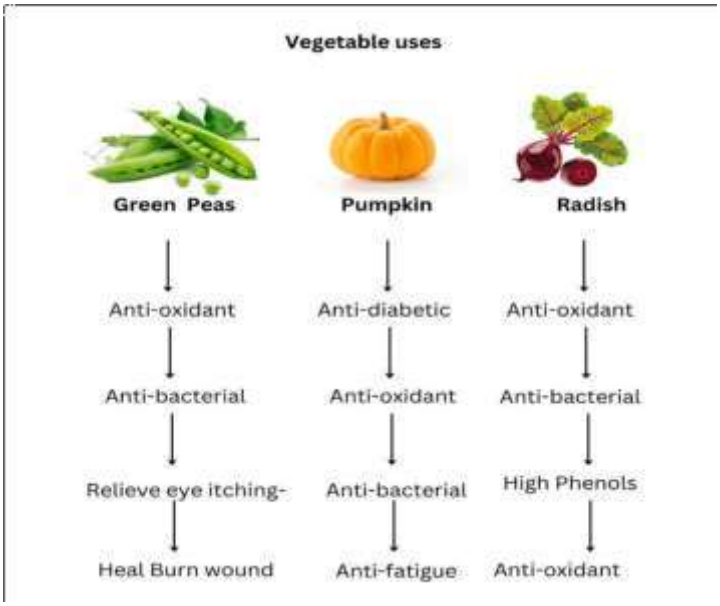
M. Sharma and R. Bhat (2021) examined the effects of MAE with maize oil on the extraction of carotenoids, polyphenols, and cancer-preventive chemicals from pumpkin skins in Nourishments. Results showed a total of PM2 UAE shell carotenoids material = 38.03 4.21; PM4 UAE peel = 33.78 1.76 g/g), whereas polyphenols 510 and 588 mg GAE/100 g extract in IGE and DPPH were between 88 and 93 % inside the IPI. The UAE and the MAE utilizing green dissolvable were centrifuged at 3500 rpm for 30 minutes (EFS); The extraction was carried out beneath perfect conditions for the recuperation of carotenoids and the total recuperation of phenolic compounds. The extricated solution was collected and put away in a vial within the refrigerator (Setyorini et al. 2018). Supercritical water extraction (SWE) and supercritical fluid extraction (SFE) were used to obtain pumpkin peel extract for use in the demonstration work. We examined the whole extent of the extricates, including all of the phenolic chemicals and carotenoid components. The total phenolic content in the extract produced using supercritical liquid extraction (SFE) was found to be more (353.5 mg GA/100 g extricate) than the amount obtained using subcritical fluid extraction (SWE), which was found to be only 213.6 mg GA/100 g. While SFE's extract included 11.48 mg/100 g extricate of carotenoid substance, SWE's extricate contained 15.22 mg/100 g extricate (Salami et al.2021).

MAE; Pea pods are an abundant source of various useful chemicals and bioactive qualities (total phenols, total flavonoids, and antioxidant capacity), making them an important by-product of the pea processing industry. Results obtained show that Zap drying significantly reduces the dry time. Agreeing to (Zhang et al. 2022), the more color changes by convection than by microwave drying, the more color changes by convection than by microwave drying. When it came to efficiency, dry convection at 80 degrees Celsius for 135 minutes yielded the best results44, with the highest values for swelling and water holding capacity. Microwave and convection drying methods both increase the phenol and cancer-preventive agent content in pea pods. Due to the faster drying time and dramatically improved product quality, microwave drying has been recommended as a potential drying arrangement (Zhang et al., 2020). Pea units (Sai-Ut et al. al. 2021). **(UAE)**; Ultrasonic extraction of add up to

phenols was unequivocally impacted by time factors, S-L proportion and ethanol concentration in pea cases. Concurring to the criteria inspected, these comes about give valuable data to move forward the method of ultrasonically helped extraction of phenolic components from pea units (Sai-Ut et al. 2021).The comes about appeared that green pea unit polysaccharide (GPPP) had noteworthy DPPH free radical rummaging movement at a concentration of 0.9 mg/ml (91.).03% had diminishing control (0.63) and lessening press (0.34 mmol/L). These results indicated that GPPP may be a promising source of a common antioxidant for future applications. **(SFE)**; Campardelli, R. et al. showed how to submicronize palmitoylethanolamide using supercritical liquid extraction by rapid precipitation utilising several solvents and water as an anti-solvent. However, regardless of the molecular measurement approach, the quick precipitation produced PEA particles that were almost an order of magnitude smaller than those produced by the fly (Campardelli et al., 2016).According to results published by Campardelli et al. (2016), the total phenol content of radishes was calculated to be 68 mg GAE/gdb, the total flavonoid content was determined to be 12 mg QE/gdb, and the total antioxidant capacity was calculated to be 10.806 mg AAE/gdb.The data were extracted using four different methods (Campardelli et al., 2016). In the UAE, concentrations of TFC, TPC, TAC, and ABTS ranged from 71.82 percent to 34.43 percent, 71.5 percent to 31.3 percent, respectively. In addition, the MAE was successful, the TFC was at 100%, the TPC was at 66%, the TAC was at 37%, and the ABTS was at 37.25% (Nguyen and Ngoc, 2022). Beetroot peels had a total phenol substance of 1.049 0.099 (mg/g), a total phenolic content (TFC) of 1.669 0.028%, and a DPPH-Era (mg/ml) value of 5.114 0.0125 CI (Hussain et al. 2021).

Applications in different areas and industries

Pumpkin could be an assortment of pumpkin Cucurbita pepo whose mash is utilized to create purees, jams, jams and syrups (Zhou et al., 2017). The mash, seeds, and skins of the squash are rich in antibacterial chemicals and cancer prevention agents that have therapeutic employments. All of typically required to separate, characterize and utilize bioactive chemicals as therapeutics within the nourishment and pharmaceutical businesses (Hussain et al. 2022).It is commonly utilized as a utilitarian nourishment and home grown cure. Pumpkin divisions are a fabulous source of supplements such as minerals, oils, proteins and carbohydrates. The comes about of this ponder propose that common antioxidant from pumpkin peel can be utilized as an elective to engineered cancer prevention agents in eatable oil refineries since it contains phenolic and carotene ingredients in such times (Salami et al. 2021). The vegetable employments are given in figure 1.



Because of their powerful antioxidants, carotenoids are widely used as natural colorants or colorants in foods such as frozen candies, salami, butter, popcorn foods (e.g. popcorn), various beverages, etc. (Corbu et al. 2020). An opportunity to obtain pigments for the nourishment segment emerges from the developing request from pumpkin shoppers for normal colors with antioxidant potential. Much appreciated to its tall carotenoid substance, pumpkin can be an fabulous source of characteristic coloring andantioxidant substances, with potential employments in nourishment compositions (Sharma et al. 2021).

Table 1. Supplements and restorative employments of pumpkin peel

Sr. No	elements	Operations	Extract
1	Polysaccharides	Improves intestinal health, fights diabetes and cancer	(Ceclu et al. 2020), (Chen & Huang, 2019), (Ahmad & Khan, 2020),
2	Vitamin C as an element	Antioxidant activity	(Amin et al., 2019)
3	Peel extracts	Helps with eye irritation, has antiinflammatory and antibacterial properties	(Salami, Asefi, Kenari, & Gharekhani, 2020), (Huwait, 2020)
4	Lignin and non- starch polysaccharides	Anti-carcinogenic	(Mithra & Padmaja, 2017)
5	Peel paste	Used for burning wound healing	(Bahramsoltani et al., 2017)
6	Polyphenols as an element	Antioxidant activity	Sharma & Bhat, 2021)
7	Pectin, starches element	Improve digestion mechanism in organisms	(Bai et al., 2020)
8	Tocopherol as an element	Heal inflammation activity	(Tlili et al., 2020)

9	Pectin	Role of anti-diabetic	(Bai et al., 2020)
10	Carotenoids	Role of Anti-fatigue, & Antioxidants	(Hussain et al. 2021), (Ghosh & Biswas, 2016)
11	Alcohol insoluble polysaccharides	Anti-hyperglycemic activity	(Kotsanopoulos et al. 2022)
12	Cucurmosin	Role of anti-carcinogenic	(Hussain et al. 2022)

Squash, thanks to its high-water content and plenty of nutrients, has been incorporated into a variety of dishes and condiments (Tselaesele et al., 2023) for human consumption. The skin of a pumpkin contains significant quantities of protein content, minerals and fibers including calcium and magnesium (Ninevi Grassino et al., 2023; Tune et al., 2017). Pumpkin is rich in carotenoids, other nutrients, vitamins, and minerals. Pumpkin bark flour has shown encouraging results in composition and tactile qualities when used in various foods, including snacks and cakes (George, 2020; Campos et al., 2021).

Due to its high carotenoid and antioxidant composition, pumpkin peels have shown promise in a number of fields of study, including the culinary, restorative, and pharmaceutical industries (Sharma and Bhat, 2021). Pectin, a kind of dietary fiber present in pumpkin peels, has been shown to reduce the body's ability to absorb starches and may be useful in the treatment of metabolic disorders including diabetes (Bai et al., 2020). Pumpkin peel has been shown to have antihyperglycemic and antihyperlipidemic properties in in vitro studies (Hussain et al., 2022).

Gourd peel is used to heal stomach ulcers, liver disorders, and wounds in traditional Persian medicine (Bahramsoltani et al., 2017). Valine, lysine, and arginine are just a few of the amino acids that may be found in pumpkin skins (Bahramsoltani et al., 2017). Extricates from pumpkin peels showed antibacterial activity in a disc diffusion test (Tasiu, 2022).

The pharmacological benefits of pea units incorporate antidiabetic, hepatoprotective, renoprotective, renoprotective, antibacterial, and antiamylase impacts. Due to the healthy lifestyle movement, concerns have arisen about high-fiber diets. According to the evaluation, pea pods could be used in baked goods and convenience foods (Nasir et al.2022). Radish (Raphanus sativus) (Wang et al. 2015) is a phyto-anthocyanin pigment with diverse economic, nutritional, and pharmacological values around the world (Nishio 2017; Gao 2020). Depending on the number of anthocyanins present, it can be white, green or red (Anugrah et al. 2023). While crimson radishes have more vitamin C, anthocyanins, and total phenols, green radishes have greater quantities of proanthocyanidins, carotenoids, and chlorophylls. It turns out that species vary greatly from one another (Anugrah et al. 2023). Much obliged to their antioxidant properties, these bioactive fixings act against infections, microscopic organisms, unfavorably susceptible infections, aggravation and as cancer prevention agents (Goyeneche et al., 2018). Typically common within the pharmaceutical, nourishment and chemical businesses.

Wellbeing and wholesome significance of pea shells

Table 2. Nutrients and healing uses of gourd peels

Sr. No	**Components**	**Uses**	**Citations**
1	Flavonoid content	Anti-microbial activity, Role of anti-oxidant	(Hussain et al., 2022)
2	Phenol content	Anti-microbial activity, Role of anti-oxidant	(Leichtweis et al., 2022)

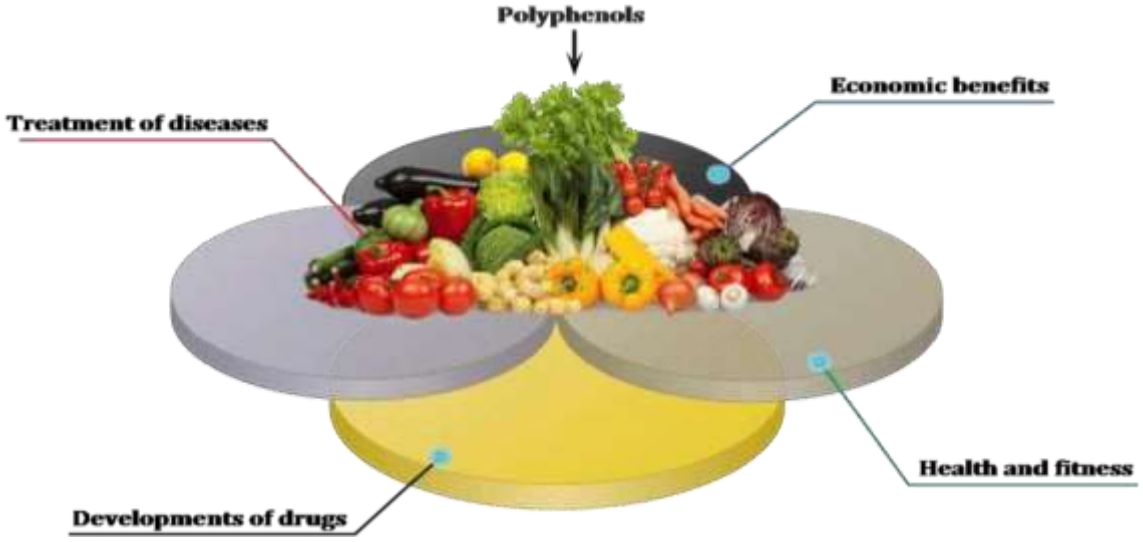
3	Pea peel waste	Used for cellulase synthesis agent	(Nasir et al., 2022)
4	Pea peel extract	Anti-microbial activity, Role of anti-oxidant	(Ishaq et al. 2023)

The radish is also used for natural treatment (Khan et al. The radish plant is edible from the petiole down to the root sheath and the root mash. Meat has a very low quantity of these regions, despite its unique bioactive and antioxidant capabilities. Radish skins. Antimicrobial and antioxidant attributes were found in plants high in flavonoids and polyphenols, according to research by Yang et al. (2022). Pea body extract was tested for its antibacterial effects against Staphylococcus aureus and grampositive (*S. epidermidis*) and gram-negative (*P. aeruginosa, E. coli, and Salmonella enterica*) bacteria. Ethyl acetate extract showed strong antibacterial activity compared to studied microorganisms, like that of methanol extract. The MIC for ethyl acetic acid derivation extricate against P. aeruginosa was 350 g/ml, making it the more effective of the two. However, using an ethyl acetic acid derivation extract, the highest MIC value recorded for E. coli was 850 g/ml Yafetto (2022) explored the conceivable utilize of pea frame squander for cellulase generation by strong culture utilizing Trichoderma reesei. Analysts utilized pea frame squander as the carbon source in a arrangement of clump tests beneath solid-state development conditions.The comes about appeared that the ideal conditions for the generation of cellularase by T. reesei were 30°C and pH 5.0. In expansion, the consider appeared that adding whey hydrolyzate and wheat starch to the medium essentially expanded FPase action. The creators concluded that utilizing pea frame squander, a low-cost source, for cellulase generation may be a promising and cost-effective approach that moreover makes a difference with squander management. (Yücetepe, Altin and Özçelik, 2021) detailed the viability of dark radish root peel polyphenol extricate as an antioxidant nourishment added substance. A powerful antioxidant extricate has been found with FRAP, DPPH and CUPRAC tests scoring 462, 911.5, 172, 723.05 and 796.51 10.4 mg TE per g add up to antioxidant capacity (TAC) in dry weight. Peel, peeled root, and unpeeled root juice of black radish (Raphanus sativus) grown in Mongolia were evaluated for their DPPH and ABTS levels by Enkhtuya and Tsend, 2020. Rummaging movement, their decreasing control, their add up to phenolic compounds and portrayed flavonoids. Due to the tall substance of phenolic compounds, peeled root juice has tall antioxidant activity. (Chorol, 2019), radish peel is tall in phenols and antioxidants. The TPC values were most noteworthy within the combined radish grow extricate (methanol and acetone). Radish peel appear noteworthy antioxidant action and can be utilized as a dietary supplement. (Altaweel et al. 2022) Different radish peel extracts were tried out, including ones made from ethyl acetic acid, ethanol, petroleum ether, water, and methanol. An agar well diffusion test determined the efficacy of the extracts as an antibacterial agent. Microorganisms of both the Gram-positive and Gram-negative varieties, including Staphylococcus aureus, Bacillus subtilis, and Micrococcus luteus; and *S. typhi, E. coli, P. aeruginosa, B. bronchiectasis, K. pneumonia* and *E. aerogenes.* The efficacy of the extricates was measured in millimeters of restraining zone against various types of microorganisms. The MIC and MBC amounts were established by analyzing the calculations of the experiment with the standard antibiotic gentamicin. The exhibited extracts also seemed to have antimicrobial effect.

Table 3. Supplements and medicinal services of radish peel

Sr. No	Components	Uses	Citations
1	Polyphenols component	Antioxidant activity	(Yücetepe, Altin, & Özçelik, 2021,

2	Phenols component	Antioxidant activity	(Enkhtuya & Tsend, 2020), (Chorol, 2019)
3	Flavonoids component	Antioxidant activity	(Enkhtuya & Tsend, 2020)
4	Peel extracts	Role of anti-bacterial	(Yang et al. 2022)



Outcome

This writing audit centers on the removal of phenolic content utilizing unadulterated CO_2 and adjusted CO_2 as co-solvents. The survey highlighted the esteem of utilizing supercritical liquid extraction for polyphenol extraction and the challenges it presents. The point of the think about was to supply valuable data approximately biologically active compounds contained in pumpkin, radish, and pea cases, such as: B. Polyphenols, TPC, DPPH and TFC, which can be utilized successfully in nutraceutical details. The utilize of green methods extraction such as microwave and ultrasonic extraction was examined to utilize natural product and vegetable squander as a foundation of biological active compounds with applications within the pharmaceutical and nourishment businesses. These generated commodities may be used as a source of bioactive chemicals using quick, sensitive, and inexpensive extraction procedures, as the paper depicts several extraction processes for extracting compounds from natural product trash that are regularly used in Pakistan. And consolidated within the nourishment, pharmaceutical and chemical industries.

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