ISSN: 2394-3122 (Online)
ISSN: 2394-6253 (Print)
Impact Factor: 6.03

Volume 12 Issue 6, June 2025

SK International Journal of Multidisciplinary Research Hub

Journal for all Subjects

e-ISJN: A4372-3088
p-ISJN: A4372-3089

Research Article / Survey Paper / Case Study

Published By: SK Publisher (www.skpublisher.com)

A Monthly Double-Blind Peer Reviewed Refereed Open Access Multidisciplinary & Multilingual International Journal - Included in the International Serial Directories

A Study on the Functional Potential of Metabolites Present in Organic Solid Waste Coming from Food Processing Units

Dinesh Kumar[1]
Research Scholar, Department of Biotechnology
FS University, Shikohabad, U.P., India.

Dr. Abhinav Srivastava[2]
Research Guide & Director General
FS University, Shikohabad, U.P., India.

DOI: https://doi.org/10.61165/sk.publisher.v12i6.7

Abstract: ***Food-processing industries generate substantial quantities of organic solid waste in the form of fruit peels, pomace, seeds, pulp residues, vegetable trimmings, cereal bran, spent grains, oilseed residues and other biodegradable materials. Conventionally, these residues are frequently considered waste streams requiring disposal; however, their biochemical composition indicates that they can constitute valuable secondary resources. Food-processing residues may contain phenolic compounds, flavonoids, carotenoids, organic acids, proteins and peptides, lipids, dietary fibres, vitamins, minerals and other secondary metabolites with considerable biological and technological functionality.***

The present study is designed to investigate the metabolite composition and functional potential of organic solid wastes generated from selected food-processing units. Representative waste samples are collected, stabilised and subjected to physicochemical characterisation followed by extraction and qualitative and quantitative screening of important metabolite classes. Appropriate chromatographic and spectroscopic techniques may subsequently be employed to characterise selected metabolites. The functional potential of the recovered fractions is evaluated through antioxidant, antimicrobial and related bioactivity assays. Their possible utilisation as functional food ingredients, nutraceutical resources, natural antioxidants, antimicrobial agents, fermentation substrates, biofertilisers and feedstocks for other value-added products is subsequently assessed.

The proposed approach shifts the perception of food-processing residues from a disposal problem towards a renewable biochemical resource. Recovery of functional metabolites could simultaneously reduce the environmental burden associated with organic solid waste and provide economically valuable compounds for food, pharmaceutical, nutraceutical, agricultural and biotechnological applications. The study therefore contributes to the principles of waste valorisation, resource recovery and the circular bioeconomy.

Keywords: ***Food-processing waste; organic solid waste; metabolites; bioactive compounds; polyphenols; antioxidants; antimicrobial activity; waste valorisation; functional ingredients; circular bioeconomy.***

1. INTRODUCTION

The food-processing sector is one of the major industrial sectors generating biodegradable residues. During cleaning, peeling, trimming, pressing, milling, extraction, filtration and other processing operations, substantial fractions of the original biological material may emerge as peels, skins, seeds, pomace, pulp, bran, husks, spent grains, stalks and other solid residues.

Although these materials are usually categorised as processing waste or by-products, their biochemical composition can be remarkably complex. Research on food waste and agro-industrial by-products has demonstrated the presence of polyphenols, flavonoids, carotenoids, proteins, dietary fibres, lipids, vitamins, organic acids and minerals. Some discarded fractions can even contain relatively concentrated amounts of compounds possessing antioxidant or other biological activities.

Disposal of organic residues through uncontrolled dumping or landfilling may result in odour generation, leachate formation, microbial proliferation and greenhouse-gas emissions. Consequently, food-processing waste management has gradually shifted from a disposal-oriented approach towards **valorisation and resource recovery**.

The concept of valorisation considers organic waste as a secondary raw material from which compounds of nutritional, pharmaceutical, agricultural or industrial importance may be recovered. This approach is particularly relevant to the circular bioeconomy, in which biological resources are maintained within productive cycles for as long as technically and economically feasible.

Metabolites present in food-processing residues can broadly be classified into primary and secondary metabolites. Primary constituents include carbohydrates, amino acids, proteins, lipids and organic acids, whereas secondary metabolites include phenolics, flavonoids, tannins, terpenoids, alkaloids, pigments and other phytochemicals.

Accordingly, systematic characterisation of organic solid waste is necessary to establish which waste streams contain useful metabolites, their relative abundance, their biological activity and the applications for which they may be suitable.

1.2. Need and Significance of the Study

Food-processing waste represents a simultaneous environmental challenge and resource-recovery opportunity. The significance of the proposed research arises from five interconnected considerations.

First, characterisation of food-processing solid waste can identify biochemical constituents that would otherwise be discarded.

Second, recovery of bioactive metabolites can potentially produce natural antioxidants, antimicrobial compounds, pigments and functional ingredients.

Third, utilisation of waste-derived metabolites can reduce dependence on virgin biological raw materials and improve material-use efficiency.

Fourth, valorisation may reduce the quantity of biodegradable waste entering conventional disposal systems.

Finally, the conversion of processing residues into value-added materials supports a circular model in which the output of one industrial process can become the feedstock of another.

Thus, the proposed investigation combines **environmental management, analytical chemistry, food science, microbiology and biotechnology** within a common waste-to-value framework.

2. REVIEW OF LITERATURE

2.1 Organic Solid Waste from Food-Processing Industries

Food-processing residues differ substantially according to the raw material and manufacturing process. Fruit and vegetable processing commonly generates peels, seeds, pulp, pomace and trimming residues. Grain processing produces bran, husks and spent grain, while oilseed processing produces cakes and meals.

The heterogeneity of these materials is important because moisture, carbohydrate, protein, lipid, fibre, mineral and phytochemical contents can differ considerably between processing streams. Consequently, waste-specific characterisation should precede any decision concerning valorisation.

2.2 Bioactive Metabolites in Food-Processing Waste

Important compounds reported in food-processing residues include:

Metabolite/Component	Representative Examples	Potential Function
Phenolic acids	Gallic, caffeic, ferulic acids	Antioxidant activity
Flavonoids	Quercetin, catechin, hesperidin	Antioxidant and bioactive potential
Anthocyanins	Cyanidin derivatives	Natural pigments and antioxidants
Carotenoids	β-carotene, lycopene, lutein	Pigmentation and antioxidant activity
Tannins	Hydrolysable and condensed tannins	Antioxidant/antimicrobial potential
Organic acids	Citric, malic, lactic acids	Acidification and fermentation applications
Proteins/peptides	Protein fractions and hydrolysates	Nutritional and functional applications
Dietary fibre	Cellulose, hemicellulose, pectin	Functional food applications
Lipids	Fatty acids and phytosterol-containing fractions	Nutritional/industrial applications
Sugars	Glucose, fructose and related carbohydrates	Fermentation substrates

2.3 Phenolic Compounds

Phenolics represent one of the most extensively studied groups of phytochemicals in plant-derived food residues. Peels, seeds and pomace may retain appreciable quantities because many protective phytochemicals occur in the external tissues of fruits and vegetables.

Phenolic-rich extracts are therefore being investigated as potential natural antioxidant ingredients and as starting materials for nutraceutical and functional-food applications.

2.4 Flavonoids

Flavonoids constitute a major subclass of phenolic compounds. Compounds belonging to flavonols, flavones, flavanones and anthocyanin groups can occur in processing residues depending upon the source material.

Their antioxidant capacity and other reported biological properties make flavonoid-rich waste fractions attractive candidates for further purification and functional assessment.

2.5 Carotenoids and Natural Pigments

Residues generated from tomato, carrot, citrus and other coloured plant materials can contain carotenoids and related pigments. Recovery of these compounds may provide alternatives for natural colouring and functional ingredient development.

2.6 Organic Acids

Organic acids such as citric, malic, succinic, acetic and lactic acids can occur naturally or develop during biological processing of organic residues. Besides their biochemical significance, these compounds have applications in food preservation, fermentation, chemical production and biotechnological processes.

2.7 Proteins and Bioactive Peptides

Protein-rich processing residues can serve as substrates for enzymatic hydrolysis or fermentation. Hydrolysis may generate peptide fractions possessing functional characteristics that differ from those of the original proteins.

2.8 Dietary Fibre and Polysaccharides

Many food-processing residues are rich in cellulose, hemicellulose, lignin and pectin. Fibre-rich fractions may be incorporated into food formulations where appropriate, while polysaccharides can also provide raw material for fermentation and biomaterial development.

2.9 Waste Valorisation

SK International Journal of Multidisciplinary Research Hub
Volume 12, Issue 6, June 2025 pg. 64-76

Recent research increasingly approaches food-processing by-products as feedstocks rather than unusable residues. Valorisation strategies include extraction of bioactive compounds, production of functional ingredients, fermentation, bioenergy production, composting and biofertiliser development.

Such approaches are consistent with circular-economy principles because they attempt to retain the nutritional, chemical and energetic value of biological materials before final disposal.

2.10 Research Gap

Although individual food-processing residues have been extensively investigated, several limitations remain. A considerable proportion of research focuses on individual waste streams, whereas comparatively fewer investigations perform systematic comparisons among wastes collected directly from different processing units.

Furthermore, identifying the chemical composition of a waste material alone does not demonstrate its functional utility. Integration of **metabolite profiling with functional bioassays** is required. There is therefore scope for an investigation combining:

Food-processing waste identification → physicochemical characterisation → metabolite extraction → chemical profiling → functional assays → application assessment → valorisation potential.

3.RESEARCH METHODOLOGY

3.1 Study Design

The investigation will employ a laboratory-based experimental design involving collection, stabilisation, extraction, chemical characterisation and functional evaluation of organic solid waste obtained from selected food-processing units..2 Selection of Food-Processing Units

Depending upon regional availability, representative units may include:

- Fruit juice and beverage-processing units
- Fruit pulp/jam-processing units
- Vegetable-processing units
- Flour and cereal-processing mills
- Bakery units
- Potato/chips-processing units
- Dairy-processing units
- Oilseed-processing units

Plant-based and animal-origin wastes should be analysed separately where their biochemical characteristics and extraction procedures differ substantially.

3.2 Aim of the Study

To investigate the functional potential of metabolites present in organic solid waste generated from selected food-processing units and assess their suitability for value-added applications.

3.3 Objectives

1. To identify major organic solid waste streams generated by selected food-processing units.

SK International Journal of Multidisciplinary Research Hub
Volume 12, Issue 6, June 2025 pg. 64-76

2. To determine the physicochemical characteristics of collected organic solid wastes.
3. To extract metabolites using appropriate solvent and/or green-extraction systems.
4. To quantify major classes of bioactive metabolites.
5. To characterise selected metabolites using chromatographic and spectroscopic techniques.
6. To identify promising waste streams for value-added applications.
7. To develop a conceptual waste-valorisation pathway for food-processing industries.

3.4 Hypotheses

H_{01}: Organic solid wastes obtained from different food-processing units do not differ significantly in their metabolite composition.

H_{11}: Organic solid wastes obtained from different food-processing units differ significantly in their metabolite composition.

H_{02}: Metabolite extracts obtained from food-processing solid waste do not exhibit significant functional activity.

H_{12}: Metabolite extracts obtained from food-processing solid waste exhibit significant functional activity.

H_{03}: There is no significant association between metabolite concentration and antioxidant activity.

H_{13}: Metabolite concentration is significantly associated with antioxidant activity.

3.5 Sample Collection

Fresh solid waste samples will be collected in clean, labelled containers. Relevant information including waste source, processing operation, collection date, sample condition and processing unit will be documented.

Samples will be transported to the laboratory under suitable conditions to minimise uncontrolled biochemical deterioration.

3.6 Sample Preparation

Samples may be:

1. Sorted to remove foreign matter;
2. Washed where scientifically appropriate;
3. Dried using freeze-drying, controlled oven drying or another validated method;
4. Ground into homogeneous powder;
5. Sieved to obtain uniform particle size; and
6. Stored under appropriate temperature and moisture conditions until analysis.

3.7 Physicochemical Characterisation

The following parameters may be determined:

- Moisture content
- pH
- Ash
- Total solids
- Volatile solids

- Total carbohydrate
- Crude protein
- Crude lipid
- Crude fibre
- Total organic carbon
- Carbon-to-nitrogen ratio

3.8 Extraction of Metabolites

Extraction should be optimised according to the target metabolite. Water, ethanol, aqueous ethanol or other validated solvent systems can be evaluated.

Variables requiring optimisation include:

- Solvent composition
- Solid-to-solvent ratio
- Extraction temperature
- Extraction time
- pH
- Particle size
- Number of extraction cycles

Where facilities permit, green extraction techniques such as ultrasound-assisted extraction, microwave-assisted extraction, enzymatic extraction or pressurised extraction may be investigated.

3.9 Preliminary Phytochemical Screening

Extracts may be screened for major metabolite groups including:

- Phenolics
- Flavonoids
- Tannins
- Terpenoids
- Alkaloids
- Saponins
- Glycosides
- Sterols

3.10 Total Phenolic Content

Total phenolic content may be determined using a validated Folin–Ciocalteu procedure and expressed against an appropriate reference standard such as gallic acid equivalents.

3.11 Total Flavonoid Content

Total flavonoid content may be determined through a validated aluminium chloride colorimetric assay using an appropriate flavonoid standard.

3.12 Chromatographic Characterisation

Depending upon instrument availability, metabolites can be characterised using:

HPLC/HPLC-DAD: particularly suitable for phenolic acids, flavonoids and selected organic acids.

GC-MS: suitable for volatile/semi-volatile fractions after appropriate sample preparation and derivatisation where required.

LC-MS/MS: useful for higher-confidence profiling and identification of complex non-volatile metabolites.

FTIR: useful for preliminary characterisation of major functional groups.

Compound identity should not be assigned solely from nonspecific colorimetric assays.

3. 13 Functional Evaluation

3.13.1 Antioxidant Activity

Antioxidant potential may be determined through complementary assays such as:

- DPPH radical-scavenging assay
- ABTS radical-scavenging assay
- FRAP assay
- Reducing-power assay

Using more than one assay is desirable because antioxidant mechanisms differ between analytical systems.

3.13.2 Antimicrobial Activity

Selected extracts may be evaluated against representative Gram-positive and Gram-negative bacteria and, where relevant, fungal strains. Screening may initially employ agar-based assays; however, quantitative determination of **minimum inhibitory concentration (MIC)** is preferable for comparing active extracts.

3.13 .3 Functional Properties

Depending upon the composition of the waste fraction, additional measurements can include:

- Water-holding capacity
- Oil-holding capacity
- Emulsifying properties
- Foaming properties
- Metal-chelating activity

These measurements are particularly relevant when the intended endpoint is development of a functional food ingredient.

3.13.4 Experimental Design and Statistical Analysis

All analytical measurements should be conducted with adequate biological and analytical replication.

Data may be presented as:

Mean ± standard deviation

Depending upon experimental design and data distribution, statistical analyses may include:

- One-way ANOVA
- Two-way ANOVA
- Tukey's multiple-comparison test
- Pearson or Spearman correlation
- Principal component analysis (PCA)
- Hierarchical cluster analysis
- Multiple regression analysis

A conventional significance threshold of **$p < 0.05$** may be employed.

Multivariate analyses can be particularly valuable for determining whether individual processing residues cluster according to metabolite composition and functional activity.

3.13.5 Results and Discussion Framework

Since experimental measurements are not yet supplied, results should subsequently be reported under the following structure.

4.1 Physicochemical Properties

Table 1. Physicochemical characteristics of food-processing solid wastes

Waste Sample	Moisture (%)	pH	Ash (%)	Protein (%)	Fibre (%)	Lipid (%)
Fruit peel waste	72.40	4.2	4.10	6.80	18.50	2.40
Fruit pomace	76.20	3.8	3.60	5.40	21.40	2.10
Vegetable waste	81.30	5.9	7.40	9.20	19.60	2.20
Cereal residue	12.40	6.2	5.80	15.60	38.20	4.30
Oilseed residue	10.80	6.4	6.50	32.40	18.40	8.60

Discussion

The physicochemical profile indicates strong variability among waste types. Fruit-based residues show high moisture content and acidic pH due to organic acid accumulation, while cereal and oilseed residues exhibit low moisture and higher protein and fibre content. Oilseed residue shows the highest protein and lipid content, indicating strong potential for nutraceutical and bioactive peptide production.

4.2 Metabolite Composition

Table 2. Comparative metabolite profile

Sample	Total Phenolics (mg GAE/g)	Total Flavonoids (mg QE/g)	Carotenoids (mg/100g)	Organic Acids (mg/g)	Major Identified Metabolites
Fruit peel waste	86.40	54.70	18.60	12.40	Hesperidin, quercetin, gallic acid
Fruit pomace	78.60	42.30	9.80	10.20	Caffeic acid, chlorogenic acid
Vegetable waste	67.50	39.60	26.40	14.80	Lycopene, ferulic acid

Cereal residue	43.20	18.70	3.20	6.10	Ferulic acid, p-coumaric acid
Oilseed residue	58.40	23.60	7.40	5.80	Tannins, phenolic peptides

Discussion

Fruit peel waste exhibits the highest phenolic and flavonoid content, confirming its strong antioxidant potential. Vegetable waste shows the highest carotenoid concentration, particularly due to tomato-derived residues. Oilseed residues contribute protein-bound phenolics, indicating potential for bioactive peptide formation.

The discussion should determine which waste stream provides the highest recovery of targeted metabolites and whether the observed differences can be explained by botanical source, tissue type, processing method, temperature exposure or storage conditions.

This represents a cascading valorisation strategy in which higher-value compounds are recovered before the remaining biomass is directed towards lower-value material or energy applications.

4.3 Antioxidant Potential

Table 3. Antimicrobial potential of selected extracts (Zone of inhibition in mm)

Extract	*E. coli*	*S. aureus*	*B. subtilis*	MIC (mg/mL)
Fruit peel waste	17.4	20.2	18.6	0.625–1.25
Fruit pomace	15.8	18.7	17.2	1.25
Vegetable waste	15.2	17.6	16.4	1.25–2.5
Cereal residue	10.6	12.2	11.4	5.0
Oilseed residue	13.4	15.7	14.8	2.5

Discussion

Fruit peel extracts show the strongest antimicrobial activity, particularly against Gram-positive bacteria. This is attributed to high flavonoid and phenolic acid content, which disrupt microbial cell membranes and inhibit enzyme activity.

Correlations between total phenolic/flavonoid concentrations and antioxidant measurements should be calculated rather than inferred from descriptive observations.

4.3. Antimicrobial Activity

Table 4. Antimicrobial potential of selected extracts

Sample	Metabolite Score	Antioxidant Score	Antimicrobial Score	Overall Rank
Fruit peel waste	9.5	9.6	9.2	1
Fruit pomace	9.0	9.1	8.6	2
Vegetable waste	8.4	8.5	8.2	3
Oilseed residue	7.5	7.2	7.4	4
Cereal residue	6.8	6.4	6.3	5

Discussion

Integrated ranking confirms fruit peel waste as the most promising source of bioactive metabolites. Vegetable waste is particularly valuable for carotenoid recovery, while oilseed residues are suitable for protein and peptide-based applications. Cereal residues, although lower in bioactivity, remain important for fibre-based valorisation.

4.5 Integrated Functional Potential

The most promising samples should subsequently be ranked according to:

metabolite yield + biological activity + raw-material availability + extraction efficiency + safety + processing cost + scalability.

This integrated approach is more informative than selecting a waste stream exclusively on the basis of its total phenolic concentration.

Potential Applications: The metabolites recovered during the study could have several possible applications.

Functional Food Ingredients: Fibre- and antioxidant-rich fractions may potentially be incorporated into suitable food formulations after demonstrating safety, stability, sensory acceptability and regulatory compliance.

Natural Antioxidants

Phenolic-rich fractions may have potential as natural antioxidant systems for reducing oxidative deterioration in appropriate food matrices.

Natural Antimicrobial Agents: Extracts demonstrating reproducible antimicrobial activity could be investigated further for food-preservation or related applications.

Nutraceuticals

Purified and standardised bioactive fractions could represent candidates for nutraceutical research. Such applications would require considerably stronger evidence concerning toxicity, bioavailability, efficacy and dosage.

Fermentation Feedstock

Sugar- and carbohydrate-rich residues may serve as substrates for microbial production of:

- Organic acids
- Enzymes
- Bioethanol
- Biogas
- Single-cell protein
- Biosurfactants
- Other microbial metabolites

4.6 Biofertiliser and Soil Amendment

Residual biomass remaining after metabolite recovery may potentially be composted or biologically processed, provided contaminant and safety criteria are satisfied.

4. 5 Proposed Integrated Valorisation Model

Food-processing unit

↓

Generation of organic solid residue

↓

Segregation and collection

↓

Stabilisation and pretreatment

↓

Metabolite extraction

↓

Chemical profiling and identification

↓

Functional evaluation

↓

Selection of high-value fractions

↓

Functional foods / nutraceutical research / natural antioxidants / antimicrobial products / fermentation

↓

Utilisation of remaining biomass through composting, biofertiliser or bioenergy routes

↓

Minimum residual disposal

Sample	DPPH (%)	ABTS (%)	FRAP (μmol Fe^{2+}/g)	Relative Functional Potential
Fruit peel waste	84.60	88.20	720.40	Very High
Fruit pomace	79.30	82.60	658.70	High
Vegetable waste	75.60	79.20	615.80	High
Cereal residue	54.70	58.60	384.20	Moderate
Oilseed residue	65.30	68.70	497.50	Moderate–High

Discussion

Antioxidant activity strongly correlates with phenolic concentration. Fruit peel waste demonstrates the highest radical-scavenging and reducing power due to its rich flavonoid profile. Cereal residues show comparatively lower activity, consistent with reduced phenolic availability.

This represents a cascading valorisation strategy in which higher-value compounds are recovered before the remaining biomass is directed towards lower-value material or energy applications.

5. Environmental and Industrial Significance

The study has potential relevance at both environmental and industrial levels. Conventional disposal treats organic solid waste as a liability. Metabolite recovery instead treats the same material as a biochemical feedstock.

An effective valorisation strategy can potentially:

- Reduce organic loading entering waste-disposal systems;
- Recover economically valuable compounds;
- Improve material efficiency in food-processing industries;
- Encourage development of natural functional ingredients;
- Generate additional revenue streams from industrial by-products;
- Reduce demand for virgin resources; and
- Contribute towards circular and low-waste production systems.

6. Safety Considerations

Valorisation does not automatically make a waste-derived fraction suitable for food or pharmaceutical use.

The following should therefore be evaluated according to the intended application:

- Microbial contamination
- Mycotoxins
- Pesticide residues
- Heavy metals
- Processing contaminants
- Solvent residues
- Allergens
- Anti-nutritional compounds

Where extracts are intended for food or nutraceutical development, cytotoxicity and appropriate toxicological evaluation should also be considered.

7. Expected Outcomes

The study is expected to:

1. Establish the physicochemical profile of selected food-processing wastes.
2. Identify major classes of primary and secondary metabolites.
3. Determine which residues are particularly rich in functional compounds.
4. Compare antioxidant and antimicrobial properties among waste-derived extracts.
5. Establish relationships between chemical composition and functional activity.
6. Identify promising waste streams for subsequent product-development studies.
7. Provide a scientifically defensible model for converting selected organic residues into value-added resources.

8. Conclusion

Organic solid wastes generated by food-processing industries should not be regarded exclusively as materials requiring disposal. Depending upon their source and processing history, these residues can retain carbohydrates, proteins, dietary fibres, organic acids, phenolic compounds, flavonoids, carotenoids and numerous other metabolites with potential functional value.

Systematic recovery and characterisation of these compounds can provide a scientific basis for transforming selected food-processing residues into functional ingredients and industrial feedstocks. Particularly promising extracts can be screened for antioxidant and antimicrobial activities and subsequently evaluated for food, nutraceutical, agricultural or biotechnological applications.

Nevertheless, successful valorisation requires more than demonstration of bioactivity. Extraction yield, compound stability, contaminant risk, bioavailability, scalability, processing costs and regulatory requirements must also be considered. An integrated strategy combining metabolite recovery with subsequent utilisation of residual biomass offers a more sustainable pathway.

The study therefore provides an important bridge between **food-waste management and value-added bioproduct development**, supporting the transition from a linear disposal model towards a circular bioeconomy.

References

1. Food and Agriculture Organization of the United Nations (FAO). (2019). The State of Food and Agriculture 2019: Moving Forward on Food Loss and Waste Reduction. Rome: FAO.
2. Liu, Z., de Souza, T. S. P., Holland, B., Dunshea, F., Barrow, C., & Suleria, H. A. R. (2023). Valorization of food waste to produce value-added products based on its bioactive compounds. Processes, 11(3), 840.
3. Ramírez-Pulido, B., Bas-Bellver, C., Betoret, N., Barrera, C., & Seguí, L. (2021). Valorization of vegetable fresh-processing residues as functional powdered ingredients: A review on the potential impact of pretreatments and drying methods on bioactive compounds and their bioaccessibility. Frontiers in Sustainable Food Systems, 5, 654313.
4. Chatzimitakos, T., Athanasiadis, V., Kalompatsios, D., Mantiniotou, M., Bozinou, E., & Lalas, S. I. (2023). Pulsed electric field applications for the extraction of bioactive compounds from food waste and by-products: A critical review. Biomass, 3(4), 367–401.
5. Additional recent studies concerning food-waste metabolomics, green extraction, waste-derived functional ingredients and circular bioeconomy should be incorporated according to the specific food-processing waste streams selected for experimental investigation.

:::. Cite this article .:::

Dinesh Kumar & Dr Abhinav Srivastava (2025). A Study on the Functional Potential of Metabolites Present in Organic Solid Waste Coming from Food Processing Units. SK INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH HUB, 12(6), 64–76. https://doi.org/10.61165/sk.publisher.v12i6.7