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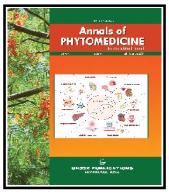

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Phytochemical profiling of pigmented traditional rice variety Aruvatham Kuruvai: GC-MS study

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Abstract

Rice, a staple food for half of the global population, is often consumed as white rice, which is nutrient deficient. In contrast, pigmented rice varieties are rich in phenolic compounds, flavonoids and essential nutrients that offer health benefits. This study aimed to analyze the bioactive secondary metabolites and health promoting properties of the traditional pigmented rice variety, Aruvatham Kuruvai. Gas chromatography-mass spectrometry (GC-MS) analysis identified 150 metabolites in the rice dehusked seeds, of which 17 were recognized for their health-promoting properties. The secondary metabolites classes included flavonoids, tetraterpenoids, indoles, hydroxycinnamic acids, benzoic acids, steroids, and amino acids. Enrichment pathway analysis shows that steroid biosynthesis, tryptophan metabolism, ascorbate, and aldarate metabolism potentially contributed to the rice's antioxidant, anticancer, anti-inflammatory and antidiabetic effects. The presence of specific bioactive compounds such as ferulic acid, β-sitosterol, p-coumaric acid, catechin, and GABA suggests that consuming Aruvatham Kuruvai could potentially benefit human health by preventing cancer, liver cirrhosis, hyperlipidemia and neurotoxicity. This research underscores the potential therapeutic applications of Aruvatham Kuruvai and encourages further exploration of its bioactive compounds.

1. Introduction

Rice (*Oryza sativa* L.) is a staple food for half the world's population, with 80% of the global rice cultivation area concentrated in Asian countries. As a cereal grain, rice is a primary dietary staple, both directly as human food and indirectly as animal feed, making it one of the most valuable cereals globally (Verma *et al.,* 2018). Despite rice's importance, white rice, the most commonly consumed form, is often nutrient deficient due to the removal of its bran layer during processing. White rice has reduced levels of key nutrients such as fiber, minerals, vitamins, antioxidants, proteins, energy and other essential nutrients that can positively impact human health (Burlando and Cornara, 2014). However, Indian rice varieties particularly pigmented rice varieties are known for their rich phytochemical compositions such as phenols, polyphenols, flavonoids, anthocyanin, carotenoids, saturated fatty acids and unsaturated fatty acids and the presence of various vitamins, minerals (Verma and Srivastav, 2017).

Pigmented rice varieties, including red, brown, black and purple rice are rich in phytochemical compounds, including phenolics (vanillic acid, gallic acid, caffeic acid, protocatechuic acid, cinnamic acid, p-hydroxybenzoic acid, syringic acid, sinapic acid, chlorogenic acid, p-coumaric acid, ferulic acid and ellagic acid), flavonoids (luteolin, tricin, quercetin, *etc.*), anthocyanins and proanthocyanins (catechin, epicatechin, cyanidin-3-O-glucoside, *etc.*), phytosterols (stigmasterol, β-sitosterol and campesterol), amino acids (alanine, arginine, aspartic acid, cystine, glutamic acid, glycine, histidine, lysine, methionine, phenylalanine, proline, serine, threonine, tryptophan, *etc.*) and vitamins (tocopherols, tocotrienols, B vitamins: B1, B3, B6 (Ravichanthiran *et al.,* 2018).

The secondary metabolites found in rice include phenolic acids, flavonoids, terpenoids, steroids and alkaloids (Afrin *et al.,* 2016; Nowak *et al.,* 2018). These metabolites exhibit beneficial properties for human health, such as cytotoxicity, antitumor, anti-inflammatory, antioxidant and neuroprotective effects (Goufo and Trindade, 2014). Asian nations are involved in the consumption of various cultivars of pigmented rice, which consists of red, brown, black, reddish-brown and purple-black rice. The term "pigmented rice" refers to whole grain rice that retains its bran layer and possesses pericarps of diverse hues, including red and black/purple. A significant portion of the population consumes white rice, which is higher in calories, but less nutritious compared to pigmented rice (Mbanjo *et al.,* 2020). Brown rice is distinguished by its significant concentrations of anthocyanins, carotenoids, phytosterols, tocopherols, protocatechuic acid and various other phenolic compounds. Red rice is rich in proanthocyanidins and other phenolics. Antioxidant-rich foods have been shown to have health benefits in areas such as oxidative stress, metabolic disorders, neurological disorders, cardiovascular diseases and gastrointestinal issues (Sen and Chakraborty, 2017). The rice

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hulls, a by-product of rice processing, contain various phenolic compounds with antioxidant activities, potentially contributing to their health benefits. Kuzhiadichan, a type of red rice variety that has rich in eight antiviral metabolites, may be suggested as a functional meal for COVID-19 (Shrijana *et al.,* 2021). Foods rich in vitamins (A, B, C, and D), minerals (selenium, zinc, and iron) and polyphenolic compounds (quercetin, resveratrol, catechins, and anthocyanins) can help fight SARS-CoV-2 and improve immunity against COVID-19 (Hamid *et al.,* 2021).

Despite the well documented health benefits of pigmented rice, research gaps remain, particularly in understanding the specific bioactive metabolites present in traditional varieties and their therapeutic potentials Aruvatham Kuruvai, a traditional red rice variety, has been consumed for generations but has not been extensively studied in terms of its phytochemical composition and health promoting properties. Moreover, environmental and genetic factors influencing the composition of phenolic acids in rice grains (Shahidi *et al.,* 2022) remain underexplored. The traditional rice varieties have functional groups that exhibit numerous antioxidant and anti-inflammatory properties (Dhanushkodi *et al.,* 2024). This represents a critical gap in the literature, especially in understanding how these compounds contribute to health benefits like cytotoxicity, antidiabetic and anti-inflammatory effects.

Metabolite profiling using gas chromatography is a widely employed method for comprehensive analysing primary plant metabolites (Steinhauser and Kopka, 2007). Metabolic profiling has quickly become an essential tool for biological studies in plant material, enhancing the identification and quantification of a diverse array of compounds, encompassing fundamental metabolites like carbohydrates and amino acids as well as secondary metabolites including flavonoids and alkaloids (Lakshmi *et al.,* 2024). Metabolite profiling studies on pigmented rice have played a crucial role in understanding its potential health benefits. In this research, we selected the traditional Aruvatham Kuruvai rice variety to analyse its secondary metabolites, which contribute to human health benefits like cytotoxicity, antitumor, antidiabetic, anti-inflammatory, antioxidant and neuroprotection. Given this background, the pigmented traditional rice variety Aruvatham Kuruvai (red rice) was chosen for this study to investigate its phytochemical composition (Figure 1). The outcomes of this research will fill the existing knowledge gap regarding the bioactive composition of this traditional variety and its potential for therapeutic applications.

2. Materials and Methods

A pot culture experiment was conducted in an environmentally controlled greenhouse at the Department of Crop Physiology, Tamil Nadu Agricultural University. The greenhouse was maintained at a temperature of 30°C and a relative humidity of 45%. Eleven traditional varieties such as Navara, Kattanur, Kichili Samba, Illupaipoo Samba, Aruvatham Kuruvai, Kavuni, Mallampanchai, Poongar, Karung Kuruvai, Seeraga Samba, Chinnar, Kothamalli Samba and Milagu Samba were collected from farmers' field of in and around Thanjavur district of Tamil Nadu. All the traditional rice varieties were grown in pot culture and three replications were maintained. Among the varieties, Aruvatham Kuruvai, a red rice variety, was selected for further phytochemical analysis. The plant used in this study authenticated by Botanical Survey of India (BSI). Specimen Number is BSI/SRC/5/23/2024-25/Tech./445 and same has been deposited for research use.

Figure 1: Seed and pericarp colour of Aruvatham Kuruvai.

2.1 Metabolic profiling procedure

The dehusked seed samples were ground in liquid nitrogen to produce a fine powder for GC-MS analysis (Fiehn *et al.,* 2000). For the analysis, 0.3 g of the powdered sample was placed in a 2 ml eppendorf tube and mixed with 1.4 ml of 100% methanol and vortexing was done. Ribitol (50 µl) was added as an internal standard and incubated at 70°C with shaking for 15 min. After centrifugation at 12000 rpm at 4°C for 20 min, a 0.2 µm filter was used to filter the supernatant. The addition of 1.4 ml of water to filtrate and 750 µl of chloroform and centrifuged again at 12000 rpm for 10 min. The upper polar phase (1 ml) was collected and concentrated using a concentrator at 45°C for 3 h and 50 µl of methoxamine hydrochloride (20 mg/ml of pyridine) was added, followed by incubation at 37°C for 2 h with continuous shaking. Subsequently, 80 µl of MSTFA was added, followed by incubation at 37°C for 30 min. The solution was centrifuged at 12000 rpm for 3 min and the supernatant was transferred to GC-MS vails. The GC-MS analysis was performed using a SHIMADZU NEXIS-GC-2030 GCMS TQ8040NX Gas chromatograph-mass spectrometer equipped with an SH-Rxi-5Sil MS column (30 m length, 0.25 mm diameter, 0.25 µm film thickness). Helium was used as the carrier gas at a flow rate of 1 ml/min, and approximately 2 µl of the sample was injected. The injector and detector were maintained at 23°C, and mass spectra were acquired using electron ionisation at 70 eV with a spectral range of m/z 50-700 amu.

2.2 Data processing for metabolic analysis

The metabolic compounds present in Aruvatham Kuruvai were identified using GC-MS analysis. The resulting dataset was processed through collection, normalization and alignment. MetaboAnalyst was used to analyse the compounds separately and enrichment pathways were identified using the KEGG numbers of the compounds. Pathways with *p*-values less than 0.05 were considered to contribute significantly to the observed traits.

3. Results

GC-MS analysis of Aruvatham Kuruvai seeds identified 150 metabolites furnished in Table 1. Among these, 17 metabolites were selected based on their potential health benefits (Table 2). The identified compound belongs to various metabolite classes, including flavonoids, tetraterpenoids, indoles, hydroxycinnamic acids, benzoic acids, steroids, organooxygen compounds, cinnamic acids, benzene, amino acids, peptides and analogues.

Table 1: Metabolites present in Aruvatham Kuruvai

S. No.	Compound	R. time	Area %
1	Pyruvic acid	6.597	0.04
2	p-coumaric acid	6.724	2.76
3	Lactic Acid	6.832	0.53
4	Propane, 2-methyl-1,2-bis(trimethylsiloxy)	6.925	0.01
5	Glycolic acid	7.229	0.02
6	L-Valine	7.552	0.05
7	Alanine	7.876	0.46
8	Oxalic acid	8.828	0.25
9	L-Leucine	9.250	0.06
10	3-Hydroxybutyric acid	9.338	0.02
11	Pentasiloxane, dodecamethyl-	9.535	0.06
12	Phosphoric acid, bis(trimethylsilyl)monomethy	9.749	0.22
13	Malonic acid	10.478	0.03
14	2-Keto-isovaleric acid	10.552	0.01
15	Valine	10.773	0.23
16	Monoethyl phosphate	10.986	0.27
17	p-hydroxy benzonic acid	11.342	0.03
18	Urea	11.576	0.13
19	Dihydroxyacetone	11.762	0.09
20	L-Serine	11.862	0.08
21	Ethanolamine	12.106	0.21
22	Phosphoric acid	12.232	1.99
23	Melatonin	12.347	1.80
24	L-Threonine	12.831	0.27
25	Proline	12.895	0.09
26	Glycine	13.122	0.20
27	Succinic acid	13.384	0.14
28	Caffeic acid	13.789	0.12
29	Uracil	13.945	0.12
30	2-Butenedioic acid	14.360	0.03

31	Threonine	15.224	0.18
32	Thymine	15.549	0.01
33	Propanoic acid, 2,2-dimethyl-3-[(trimethylsilyl)	17.313	0.04
34	Malic acid	17.804	0.18
35	2-Hexenedioic acid	18.205	0.03
36	Meso-Erythritol	18.292	0.16
37	Gallic acid	18.506	0.15
38	Aspartic acid	18.570	0.04
39	4-Aminobutyric acid	18.759	1.26
40	Creatinine	18.865	0.03
41	1-Deoxypentitol	18.972	0.03
42	2,3,4-Trihydroxybutyric acid tetrakis(trimethylsilyl)	19.105	0.04
43	1,6-Dioxacyclododecane-7,12-dione	19.237	0.07
44	D-Quinovose, tetrakis(trimethylsilyl) ether, tri	19.308	0.08
45	Xylose	19.856	0.03
46	2,3-Dihydroxy-2-methylbutanoic acid	20.001	0.08
47	L-Asparagine	20.367	0.04
48	Ornithine	20.799	0.10
49	Pentanedioic acid, 3-methyl-3-[(trimethylsilyl)	20.472	0.04
50	L-Glutamic acid	20.909	0.11
51	L-Phenylalanine	20.970	0.11
52	Asparagine	21.060	0.04
53	Xylose	21.707	0.06
54	Homoserine, 4-imino-N,O-bis(trimethylsilyl)	22.016	0.23
55	Ribose	22.203	0.69
56	Xylitol	22.802	0.02
57	Arabitol	23.115	0.11
58	Fucose	23.194	0.09
59	Rhamnose	23.460	0.04
60	(3R,4S,5R)-3,4-Dihydroxy-5-((2S,3S)-1,2,3,4	23.526	0.13
61	Aconitic acid	23.785	0.02
62	Gluconic acid, 2,3,4,5-tetrakis-O-(trimethylsilyl)	24.024	0.28
63	Beta.-D-Galactofuranose, 1,2,3,5,6-pentakis-O-(trimethylsilyl)	24.186	0.04
64	D-(-)-Tagatofuranose, pentakis(trimethylsilyl)	24.317	0.92
65	Ribonic acid	24.406	0.07
66	Azelaic acid	24.767	0.02
67	Fructose	25.069	0.30
68	Citric acid	25.209	0.60

69	Ethyl .alpha.-D-glucopyranoside	25.332	0.15
70	Allantoin	25.468	0.02
71	D-Allofuranose, pentakis(trimethylsilyl) ether	25.740	0.08
72	Myristic acid	25.863	0.13
73	Adenine	26.141	0.04
74	Psicose	26.291	8.59
75	D-Glucose, 2,3,4,5,6-pentakis-O-(trimethylsilyly)	26.801	13.13
76	Allose	27.142	5.13
77	Lysine	27.288	0.14
78	Sorbitol	27.526	0.22
79	Serine	27.597	0.41
80	Methyl (1S)-7-hydroxy-7-methyl-1-[(2S,3R,4S)	27.974	0.32
81	Glucose	28.475	0.84
82	Pantothenic acid	28.617	0.09
83	Gluconic acid	28.739	0.94
84	2-(tert-Butyl)benzenethiol, S-(tert-butyldimethly)	29.114	0.08
85	Pentaethylene glycol	29.202	0.04
86	Beta.-D-Glucopyranose	29.397	0.18
87	Palmitic acid	29.716	1.70
88	D-Allose, oxime (isomer 1)	30.174	0.08
89	N-Acetylmannosamine	30.239	0.09
90	Allantoin	30.328	0.04
91	Myo-Inositol	30.441	4.67
92	Ferulic acid	30.532	0.03
93	Guanine	31.120	0.02
94	D-Allose, pentakis(trimethylsilyl) ether, pentafluoropropionate	31.196	0.09
95	Pseudo uridine pentafluoropropionate	31.295	0.10
96	Methyl linoleate	31.805	0.05
97	Ethyl Oleate	31.927	0.04
98	Dopa	32.096	0.04
99	D-(+)-Cellobiose, (isomer 1)	32.237	0.02
100	L-Tryptophan, 1-(trimethylsilyl)-, trimethylsily	32.428	0.09
101	9,12-Octadecadienoic acid (Z,Z)	32.690	3.50
102	Elaidic acid	32.818	1.29
103	Stearic acid	33.373	0.45
104	N-Acetylneuraminic acid	34.021	0.16
105	Alpha.-D-Glucopyranoside, methyl 2,3,4,6-tetr	34.752	0.11
106	Glyceryl-glycoside	34.952	0.10
107	Galactitol	35.901	0.11

108	Galacturonic acid	36.437	0.36
109	D-Myo-Inositol, 1,2,4,5,6-pentakis-O-(trimethylsily)	37.085	0.03
110	2-(Furan-3-yl)-7,8-dihydroxy-6a,7,10b-trimethylsily	37.272	0.06
111	Lyxose	37.780	0.01
112	Uridine	37.878	0.08
113	D-Lactose, octakis(trimethylsilyl) ether, methyloxime	38.726	0.06
114	2-alpha.-Mannobiose, octakis(trimethylsilyl)	39.037	0.05
115	Beta.-D-Lactose, (isomer 1)	39.263	0.05
116	Heptaethylene glycol	39.724	0.03
117	3-alpha.-Mannobiose, octakis(trimethylsilyl)	40.168	0.07
118	1-Monopalmitin	40.753	0.56
119	3,4-Dihydroxymandelic acid	41.190	0.03
120	2-Trimethylsilyloxyheptanoic acid, trimethylsily	41.407	0.07
121	Sucrose	41.581	17.11
122	Lactose	42.615	0.03
123	Maltose, octakis(trimethylsilyl) ether, methyloxime	42.844	0.04
124	2-linoleoylglycerol	42.982	0.14
125	2-Monooleoylglycerol trimethylsilyl ether	43.047	0.14
126	Maltose	43.191	0.41
127	Trehalose	43.266	0.13
128	1-Monolinolein	43.535	0.34
129	1-Monooleoylglycerol	43.615	0.21
130	Guanosine	43.863	0.32
131	Monostearin	44.028	0.28
132	Nonaethylene glycol	44.170	0.07
133	D-(+)-Turanose, octakis(trimethylsilyl) ether	44.379	0.12
134	Beta.-Carotene	44.518	0.06
135	Beta.-Gentiobiose, octakis(trimethylsilyl) ether	44.676	0.16
136	Lignoceric acid	44.905	0.04
137	Isomaltose	45.268	0.38
138	Catechine (2R-trans)	45.552	0.06
139	Xylose	46.891	0.12
140	Lauric acid	47.757	0.02
141	Undecaethylene glycol	47.910	0.05
142	Methoprene acid	48.671	0.04
143	Beta.-Lactose	48.972	0.10
144	Campesterol	50.477	0.28

145	Stigmasterol	50.827	0.29
146	Meso-Erythritol	51.370	0.12
147	Beta.-Sitosterol	51.711	0.98
148	Docosapentaenoic acid	51.926	0.05
149	Sucrose	52.416	2.44
150	9,19-Cyclolanost-24-en-3-ol, (3.beta.)	52.793	0.02
151	9,19-Cyclolanostan-3-ol, 24-methylene	53.779	0.38

Table 2: Effect of metabolite compounds and its roles in human health

S.No.	Metabolites	R. time	Area	Class of compound	Bioactivity	References
1	Catechine	45.552	0.06	Flavonoids	Antioxidant activity	Sen *et al*., 2020
2	ß-Carotene	44.518	0.06	Tetraterpenoids	Antioxidant activity	Sen *et al*., 2020
3	L-Tryptophan	32.428	0.09	Indoles and derivatives	Neuroprotective agents	Chumpiya *et al*., 2016
4	p-coumaric acid	6.724	2.76	Hydroxy cinnamic acids and derivatives	Antoxidant, anti-inflammatory, anticancer, antitumor and reduce liver cirrhosis	Wunjuntuk *et al*., 2016; Sunitha *et al*., 2018
5	Ferulic acid	30.532	0.03	Hydroxycinnamic acids and derivatives	Antioxidant, antimicrobial, anti-inflammatory, antithrombosis, anticancer and reduces liver cirrhosis	Sen *et al*., 2020; Zaky *et al*., 2020; Alam, 2019
6	Gallic acid	18.506	0.15	Benzoic acids and derivatives	Anti-inflammatory, antimutagenic, antioxidant, antifungal, antiviral, anticancer	Sen *et al*., 2020; Zaky *et al*., 2020; Bai *et al*., 2021
7	L-Lysine	27.288	0.14	Amino acids, peptides, and analogues	Anti-inflammatory	Roschek Jr *et al*., 2009
8	ß-Sitosterol	51.711	0.98	Steroids	Antimicrobial activity, reduces blood levels of cholesterol	Malathi *et al*., 2017
9	Campesterol	50.477	0.28	Steroids	Anti-inflammatory, antioxidant activity	Sen *et al*., 2020
10	Stigmasterol	50.827	0.29	Steroids	Anti-inflammatory, antioxidant, helped maintain plasma lipid and cholesterol levels	Sen *et al*., 2020
11	Melatonin	12.347	1.80	Indoles	Reduces neurotoxicity	Chumpiya *et al*., 2016
12	Myoinositol	30.441	4.67	Organo oxygen compounds	Storage form of phosphorus	Raboy, 2003
13	4-Aminobutyric acid (GABA)	18.759	1.26	Amino acids, peptides, and analogues	Preventing hyperlipidemia, anticancer	Ohara *et al*., 2011
14	p-hydroxy benzoic acid	11.342	0.03	Benzene and substituted derivatives	Antioxidant activity	Sen *et al*., 2020
15	Caffeic acid	13.789	0.12	Cinnamic acids and derivatives	Antibacterial, antidiabetic, antitumor, anticancerous, antimicrobial and antioxidative activities	Magnani *et al*., 2014; Zaky *et al*., 2020; Espíndola *et al*., 2019
16	Methyl linoleate	31.805	0.05	Fatty Acyls	Anticancer and antidiabetic	Kapoor *et al*., 2021
17	Myritic acid	25.863	0.13	Fatty Acyls	Volatile aromatic compound	Sukhonthrea *et al*., 2019

Enrichment pathway analysis was conducted for the identified compounds, and pathways with p-values less than 0.05 were considered significant. The analysis revealed significant associations with steroid biosynthesis, tryptophan metabolism, ascorbate and aldarate metabolism pathways (Figure 2).

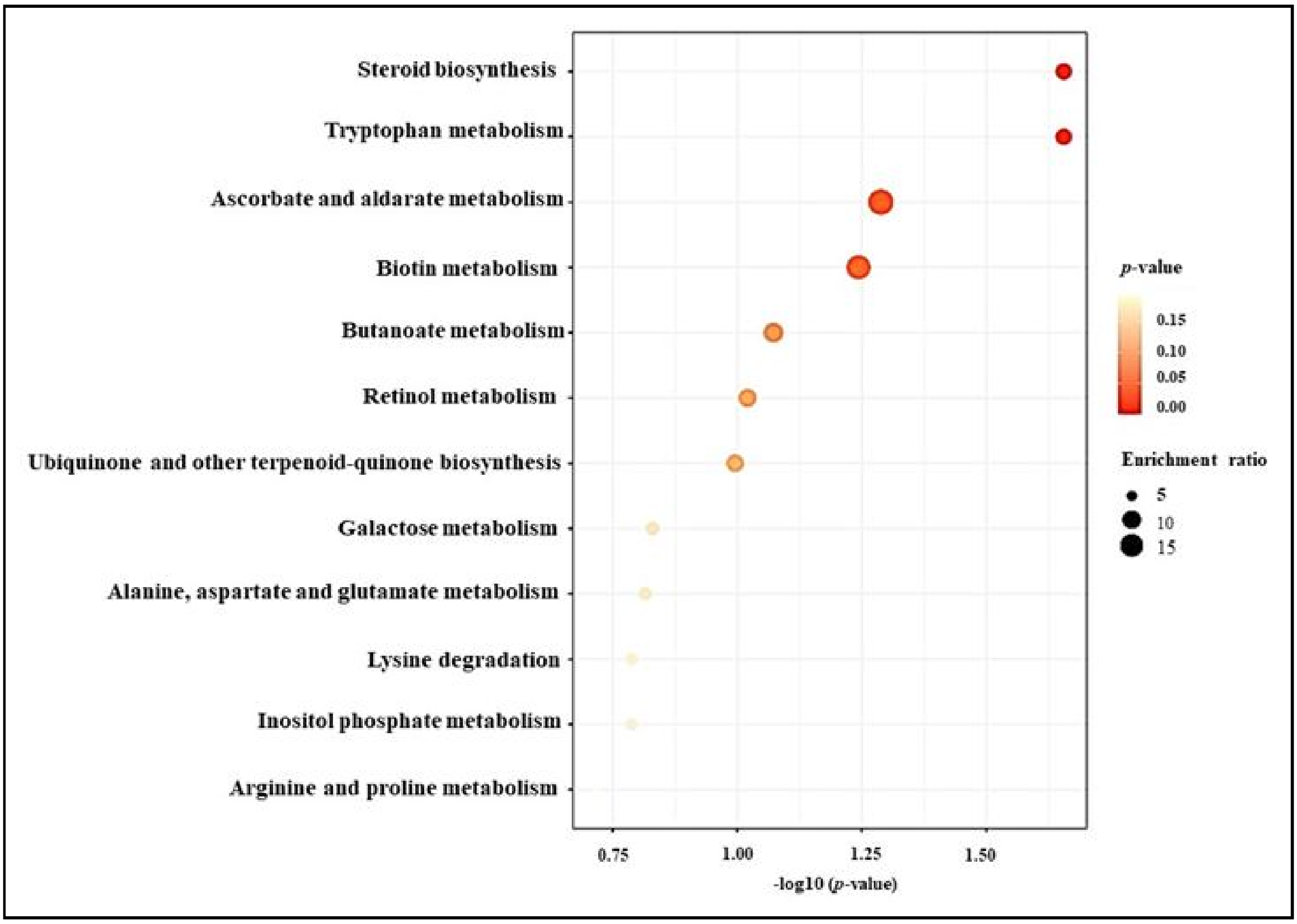

Figure 2: Overview of enrichment pathways.

4. Discussion

Aruvatham Kuruvai is a traditional rice variety with pigmented seed with debris content, reducing sugar, phenolic compounds, gallic acid and catechins (Subbu *et al.,* 2022). The pigmented traditional rice Aruvatham Kuruvai contains a high concentration of carbon-based secondary metabolites, while exhibiting relatively lower levels of primary metabolites, such as amino acids and organic acids, compared to white rice varieties. The antioxidant enzymes in Aruvatham Kuruvai are enhanced by the downregulation of lipid peroxidation and the scavenging of oxygen and nitrogen radicals, which contribute to the apoptotic effect on cancer cells, potentially preventing cancer, tumors and reducing the risk of atherogenesis and coronary artery disease in humans (Sen *et al.,* 2020). Catechin, stigmasterol, β-sitosterol, campesterol, ferulic acid and gallic acid present in the Aruvatham Kuruvai possess antioxidant properties and can potentially prevent cancer in humans. Brown rice, including components such as ferulic acid, p-coumaric acid, oryzanol, tocotrienol, GABA and others may help reduce inflammation and liver fibrosis, thereby lowering the risk of cancer and liver cirrhosis (Wunjuntuk *et al.,* 2016). Aruvatham Kuruvai has GABA and p-coumaric acid which act as anti-inflammation and reduce liver fibrosis.

Metabolites like p-coumaric acid, GABA and ferulic acid, found in Aruvatham Kuruvai, may contribute to reducing the chance of liver cancer. Bioactive compounds in brown rice, such as GABA, dietary fibres and ferulic acid, are known to have antihypertensive effects in humans. The presence of GABA and ferulic acid in Aruvatham Kuruvai, may potentially contribute to lowering blood pressure by consumption by humans. Poly unsaturated fatty acid has been associated with antihypertensive, antidiabetic, anticancer and anti-inflammatory properties in humans (Kapoor *et al.,* 2021).

Sterol compounds in rice bran oil have been shown to positively influence plasma lipid and cholesterol profiles in hypercholesterolemic patients (Eady *et al.,* 2011). The consumption of Aruvatham Kuruvai, which contains sterol compounds, may help maintain cholesterol levels and provide antioxidant benefits in humans. Pigmented rice varieties, including brown, white and black rice, have been demonstrated to suppress cellular ROS (Reactive oxygen species) production, sustain cell viability and enhance brain-derived neurotrophic factor gene expression and protein levels. Neuroprotective agents like melatonin and tryptophan, found in these rice varieties, may contribute to reducing neurotoxicity (Chumpiya *et al.,* 2016). Mozaffarian (2016) reported that oleic acid and linoleic acid, fatty acids found in rice, may be responsible for lowering cholesterol levels and reducing the risk of coronary heart disease and cardiovascular disease. The metabolic pathways that contribute to the antioxidant, anticancer, anti-inflammatory and antidiabetic properties of Aruvatham Kuruvai include steroid biosynthesis, tryptophan metabolism and ascorbate and aldarate metabolism (Figure 2). Steroid production plays a major role in various biological processes including hormone production, cell signalling and inflammation (Hanukoglu *et al.,* 1992). The pathway of tryptophan metabolism is involved in the synthesis of serotonin, a neurotransmitter that regulates mood, sleep and appetite. The melatonin hormone precursor of tryptophan which regulates sleep-wake cycles (Richard *et al.,* 2009). Ascorbate (vitamin C) is an antioxidant that protects cells from damage caused by ROS (Linster *et al.,* 2007).

5. Conclusion

Aruvatham Kuruvai, a traditional rice variety, offers a rich source of bioactive secondary beyond its nutritional value. The consumption of this pigmented rice has been associated with various health benefits, including increased antioxidant activity, enhanced nutrient content, and potential anticancer, anti-inflammatory, and antidiabetic properties. The presence of sterols, flavonoids, anthocyanins, and proanthocyanins in Aruvatham Kuruvai contributes significantly to these positive effects on human health. Further research is warranted to fully explore the therapeutic potential of this traditional rice variety and its bioactive compounds.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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