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"Evaluation Of Apricot (*Prunus Armeniaca* L.) Extract-Enriched Foods For Chemical Health Risk Reduction: Antioxidant And Anthelmintic Potentials"

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Abstract

Background:
Prunus armeniaca L. (apricot) is a nutritionally rich fruit containing bioactive phenolics, flavonoids, and fatty acid derivatives with potential roles in reducing oxidative stress and parasitic infections—two key chemical health risk factors.

Objectives:
This study aimed to evaluate the antioxidant and anthelmintic potentials of ethanolic extracts from apricot fruit and assess their incorporation into functional foods such as jam and ice cream to develop safer, health-promoting food products.

Methods:
The apricot ethanolic extract was analyzed by GC–MS, revealing the presence of fatty acids, esters, glycidyl derivatives, and flavonoid-like compounds contributing to bioactivity. Antioxidant capacity, assessed by the DPPH radical scavenging assay, demonstrated strong activity (82.83% inhibition at 60 µL), surpassing the Trolox standard (65.87%). Functional jam and ice cream retained 71.24% and 62.31% of antioxidant activity,

respectively. Anthelmintic efficacy against *Pheretima posthuma* showed dose-dependent activity, with paralysis and death times at 50 mg/mL comparable to albendazole and higher than piperazine citrate.

Results:
Incorporation of the extract into jam and ice cream resulted in functionally active, consumer-acceptable products. The matrix slightly reduced activity but retained significant potential for mitigating oxidative and parasitic risks associated with foodborne and lifestyle disorders.

Conclusion:
Apricot fruit ethanolic extract demonstrates strong antioxidant and anthelmintic potential, and its application in food matrices can serve as a preventive strategy against chemical health risks. The findings support the development of safe, plant-based functional foods with pharmacological and toxicological relevance.

Keywords: *Prunus armeniaca* L. (Apricot), Antioxidant, Anthelmintic, Chemical health risk, Functional foods, GC–MS, Bioactive compounds, Nutraceutical safety.

1. Introduction

Functional foods and plant derived bioactives are gaining global attention as part of preventive healthcare strategies, with increasing emphasis on natural interventions to address oxidative stress, microbial infections, inflammation and parasitic diseases. Approximately 80% of the world's population relies on traditional herbal remedies, which provide diverse phytochemicals such as flavonoids, phenolic acids, alkaloids, tannins, and carotenoids that modulate physiological and biochemical processes [1]. Within this context, *Prunus armeniaca* L. (apricot) has emerged a valuable fruit crop due to its rich phytochemical profile and wide ranging health promoting effects. Apricot fruits are notable for their high content of vitamins (A, C, E), dietary fiber, and minerals such as potassium and selenium, alongside bioactive compounds like gallic acid, rutin, quercetin-3-glucoside, chlorogenic acid, and other phenolic constituents [2-5]. These components confer robust antioxidant activity in vitro, effectively scavenging free radicals and protecting against oxidative damage [6]. Additionally, apricot extract possess antimicrobial activity, including action against *Mycobacterium* spp. and diverse bacterial and fungal strains [7].

Flavonoids such as apigenin and quercetin present in apricot have been associated with anti inflammatory and anticancer properties [4].

Beyond pharmacological applications, apricots contribute to dietary wellness through their prebiotic effects, potentially modulating gut microbiota and enhancing intestinal health [4].their phenolic rich matrix also supports cardiovascular protection by improving lipid profiles and lowering blood pressure in various animal models [8]. However, certain constituents particularly amygdalin found in bitter apricot kernels remain controversial. While amygdalin has been investigated for anticancer potential, concerns over cyanogenic toxicity persist [9, 10]. Incorporating apricot based bioactives into functional foods aligns with the global shift towards plant based therapeutics; however, standardized comparative analysis of phytochemical diversity between sweet and bitter apricots in food applications remains sparse, justifying the scope of this investigation [11].

Evidence for anthelminitic activity from apricot fruit extracts is scarce. Most screening studies have employed earthworms (*Pheretima posthuma)* as a surrogate model [12], and while previous plant based investigations have demonstrated dose dependent worm paralysis and death, direct validation for apricot extracts is lacking [13].

At the same time, apricot products—such as jams, purées, juices, dried fruits, and confectionaries—are widely consumed for their nutritional and antioxidant value [14]. This overlap between traditional health applications and commercial food use presents an opportunity to develop functional products that retain bioactive efficacy.

Oxidative stress and parasitic infections remain major contributors to chemical health risks in food and public health sectors. Reactive oxygen species and parasitic toxins can initiate cellular damage, inflammation, and metabolic disorders. Therefore, dietary inclusion of natural antioxidants and antiparasitic compounds offers a preventive approach for chemical risk reduction. Considering this, evaluating apricot bioactives in safe, consumer-accepted food matrices aligns with the goals of sustainable nutraceutical development and public health protection.

We hypothesized that extracts from sweet and bitter apricots differ in their antioxidant and anthelmintic activities, and that their incorporation into functional foods can preserve these bioactivities. To address this gap, the present study evaluates the comparative pharmacological potential of sweet and bitter apricot fruits and explores their integration into value-added products such as jams and ice creams. Preliminary findings indicate that bitter apricot extracts may exhibit stronger bioactivity, supporting their potential for functional food innovation.

2. Materials and methods

2.1 Plant material:

Fresh fruits of *Prunus armeniaca* L. were procured from the local market of Shimoga, Karnataka, India. Botanical authentication was performed at National Pharmacy College, Shimoga, Karnataka. Fruits were washed under running potable water to remove surface contaminants, blanched at 85 °C for 3 min to inactivate enzymes, and manually deseeded and peeled before further processing [15].

2.2 Preparation of ethanolic apricot extract:

Approximately 1 kg of fresh apricot fruits was shade dried at 30±2°C and 45% relative humidity for 15 days. The dried fruits were chopped using a stainless steel knife and homogenized into smaller fragments (final weight: ~600 g). The material was macerated in 80% ethanol (1:1.67 w/v; 1000ml solvent per 600 g fruit) in amber coloured glass bottles for 15 days at ambient temperature with occasional shaking. Filtration was performed through muslin cloth, and the filtrate was concentrated on a water bath at 40°C to obtain the crude extract. The extraction yield was calculated as:

$$yield\ (\%) = \frac{weight\ of\ extract\ (g)}{weight\ of\ dried\ fruit\ (g)} \times 100$$

The yield obtained was 38% w/w [16,17].

2.3 Gas chromatography-mass spectrometry (GC-MS) analysis:

GC-MS analysis of the ethanolic extract was performed using a GCMS-QP2010SE system equipped with a fused silica capillary column (30 m x 0.25 mm ID, 0.26µm film thickness; DB-1 coating0. The oven temperature was programmed to 300°C. Helium served as the carrier gas at a constant pressure of 100 kPa and flow rate of 20 mL/min. The electron ionization mode was set at 70 eV. Methanol-dissolved samples were injected, and spectra were recorded over an m/z range of 60-550 amu. Identification of compounds was carried out by matching mass spectra with the NIST 107 spectral library.

2.4 Preparation of functional apricot jam:

Fresh apricot pulp (500 g) was mixed with granulated sugar (400 g) and heated in a stainless steel vessel at 70-80°C with continuous stirring until complete dissolution of sugar. High methoxyl pectin (10 g; 1% w/w of fruit pulp) was pre-dispersed in warm water and added gradually to prevent clumping [18].When the total soluble solids (TSS) reached 60-65°brix (measured using a handheld refractometer), ethanolic apricot extract (50 g; 10% w/w of pulp) was added. The mixture was further heated for 5-7 min at 90°C to ensure uniform dispersion. Citric acid (3 g) was added to adjust pH to 3.2-3.5, facilitating gel formation and improving microbial stability [17].

Hot jam (~85°C) was filled into pre sterilized glass jars, sealed immediately, inverted for 5 min to form a vacuum, and cooled to room temperature. Samples were stored at 4° until further analysis [19, 20].

2.5 Preparation of apricot ice cream:

The ice cream mix was formulated per liter as follows: full milk cream (500ml), fresh cream(25% fat,200 ml), skim milk powder (100 g), sucrose (120 g), and stabilizer (carboxymethyl cellulose, 0.3% w/w). all ingredients expect pulp and extract were blended and pasteurized at 85°C for 15 min, then cooled to 4°C for maturation (minimum 4h)[21, 22].Apricot pulp (100 g) and ethanolic extract (50 g; 5% w/w of mix) were added to the matured mix and homogenized at 120 bar (two stage homogenizer) to ensure uniform distribution[23].

The homogenized mix was frozen in a batch type freezer at -5°C (overrun: 60-80%), packed into airtight containers, and hardened at -20°C for 24h before storage at -18°C[24].

2.6 Bioactivity evaluation:

Samples tested

The following samples were evaluated for both antioxidant and antihelmintic activities:

- Apricot ethanol extract (80% ethanol)
- Functional apricot jam enriched with extract
- Functional apricot ice cream enriched with extract

1. **Antioxidant activity**

The antioxidant activity of the fruit extract was evaluated at concentrations of 20,40,60 and 80 µg/ml, using trolox as the standard. Freshly prepared DPPH solution (0.1mM in methanol) was added to each test sample and incubated in the dark for 30 min at room temperature. A DPPH solution without sample served as control, and ethanol served as blank. The absorbance was measured ussing an Enspire multimode plate reader. Free radical scavenging activity (%) was calculated as:

$$inhibition\% = \frac{A_c - A_s}{A_c} \times 100$$

Where A_c is absorbance of control and A_s is absorbance of sample [25].

2. Anthelmintic activity

Adult Indian earthworms (*Pheretima postuhuma),* 3-5 cm in length and 0.1-0.2 cm in width, were collected from moist soil and washed with normal saline to remove fecal matter. The species was authenticated by the agricultural collage shimoga,India. The physiological and anatomical characteristics of the worms closely resemble those of human intestinal roundworms.

The animals were divided into six groups (n=5 per group).the extract was suspended in 1% gum acacia, and the volume adjusted with normal saline. Each group was treated as follows;

- Group 1: vehicle control (1% gum acacia in normal saline)
- Group 2: albendazole (20 mg/ml)
- Group 4-6: apricot extract at 10, 25, and 50 mg/ml in 1% gum acacia solution.

The time to paralysis and death was recorded for each worm. Paralysis was defined as the absence of movement except upon vigorous shaking. Death was confirmed by loss of motility and fading of body color [26].

2.7 Statistical analysis:

Data were analyzed using SPSS (version 20.0, IBM Corp., Armonk, NY<USA). Results were expressed as mean± SD. Differences between groups were assessed by one way ANOVA followed by Tukey's post-hoc test, with $p<0.05$,$p<0.01$, and $p>0.001$ considered statistically significant.

2.8 Sensory evaluation:

Sensory evaluation of the jam and ice cream were conducted using 10 members panel randomly selected from the university community. The jam sample was packaged in a trasparent jam bottles, ice cream was presented in cups made of polysterene and presented in a coded manner. The sensory quality attributes of the samples were colour, taste, aroma and sweetness. In the questionnaire presented to the panelists, they were requested to observe and taste each sample as coded with bread provided and grade them based on a 9-point hedonic scale, where 1- disliked extremely, 5- neither liked nor disliked and 9- extremely liked. For each panelist water bottle was provided for rinsing.

3. Results and discussion

3.1 Gas Chromatography And Mass Sprectroscopy (GCMS):

The GC–MS analysis of apricot extract revealed the presence of fatty acids, esters, glycidyl derivatives, alcohols, and aromatic compounds. Among these, glycidyl palmitoleate 10.77%, glycidyl palmitate 9.98%, oleic acid 7.34%, 9-octadecenoic acid derivatives 4.55–5.82%, and hexadecanoic acid esters up to 3.28% were the major constituents. Fatty acids and esters (oleic acid, palmitic acid, methyl esters) are known for antioxidant, anti-inflammatory, antimicrobial, and hypocholesterolemic activities. Butylated Hydroxytoluene (BHT) is a well-known synthetic antioxidant, possibly indicating strong radical scavenging potential. Glycidyl esters are linked with antioxidant and anticancer activity. Lanceolatin B and indole derivatives represent flavonoid-like and alkaloid compounds with potential pharmacological roles.

No.	RT (min)	Name of the Compound	Molecular Formula	Mol. Wt.	Peak Area %
1	2.201	2-Propanone, 1-hydroxy-	C3H6O2	74	0.46
2	4.925	Ethanimidic acid, ethyl ester	C4H9NO	87	0.90
5	13.249	Butylated Hydroxytoluene (BHT)	C15H24O	220	0.89
9	17.377	(Z)-Ethyl 3-(4-methoxyphenyl)acrylate	C12H14O3	206	1.24
10	18.245	2-Undecanone, 6,10-dimethyl-	C13H26O	198	1.43
11	18.390	Cyclodecane	C10H20	140	1.57
14	18.689	Hexamethyl-diphenylcyclotetrasiloxane	C28H44O4Si4	548	2.74
16	18.802	Heptacosanoic acid, methyl ester	C28H56O2	424	2.21
19	19.081	Hexadecanoic acid, methyl ester	C17H34O2	270	2.09

21	19.505	n-Hexadecanoic acid (Palmitic acid)	C16H32O2	256	1.73
24	19.570	n-Hexadecanoic acid	C16H32O2	256	3.28
29	20.889	9-Octadecenoic acid, methyl ester (E)	C19H36O2	296	4.55
31	21.307	Oleic Acid	C18H34O2	282	7.34
37	22.751	Glycidyl palmitate	C19H36O3	312	9.98
40	24.892	Glycidyl palmitoleate	C19H34O3	310	10.77
43	25.368	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	C19H38O4	330	4.08
48	28.589	9-Octadecenoic acid, 1,2,3-propanetriyl ester (E,E,E)	C57H104O6	884	5.82

Table:1 (GCMS Analysis of ethanolic Apricot fruit extract)

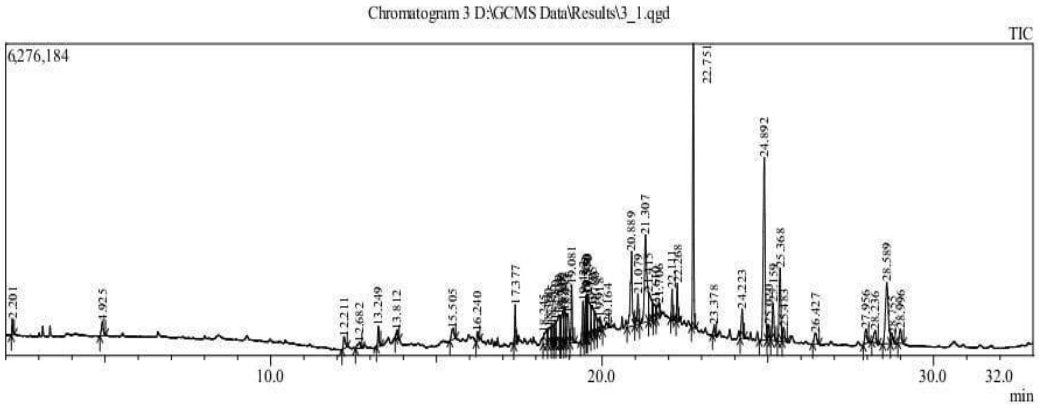

Figure: 1 (GCMS Analysis of ethanolic Apricot fruit extract)

3.2 Antioxidant activity

The antioxidant potential of apricot ethanolic extract, functional jam, and ice cream was evaluated by the DPPH radical scavenging assay and compared with Trolox as standard. At a

concentration of 60µl, the ethanolic extract of apricot exhibited the highest free radical scavenging activity 82.83%, which was significantly higher than the Trolox standard 65.87%. Functional apricot jam supplemented with 50mg/ml extract retained appreciable antioxidant potential, recording a scavenging activity of 71.24%, whereas ice cream enriched with the extract showed comparatively lower but still notable activity of 62.31%. The observed reduction in antioxidant activity in jam and ice cream compared to the pure extract can be attributed to processing effects such as thermal degradation of phenolic compounds in jam and fat protein interactions in ice cream. These findings indicate that incorporation of apricot extract into food matrices such as jam and ice cream can successfully retail substantial antioxidant activity, thereby enhancing their functional value.

Concentration of sample in µl/ml	**Percentage of DPPH in sample**	**Percentage of DPPH in standard (Trolox)**
20µl	45.86%	58.34%
40µl	77.38%	63.16%
60µl	82.83%	65.87%
80µl	84.5%	70.79%

Table: 2 (Antioxidant activity of ethanolic Apricot fruit extract)

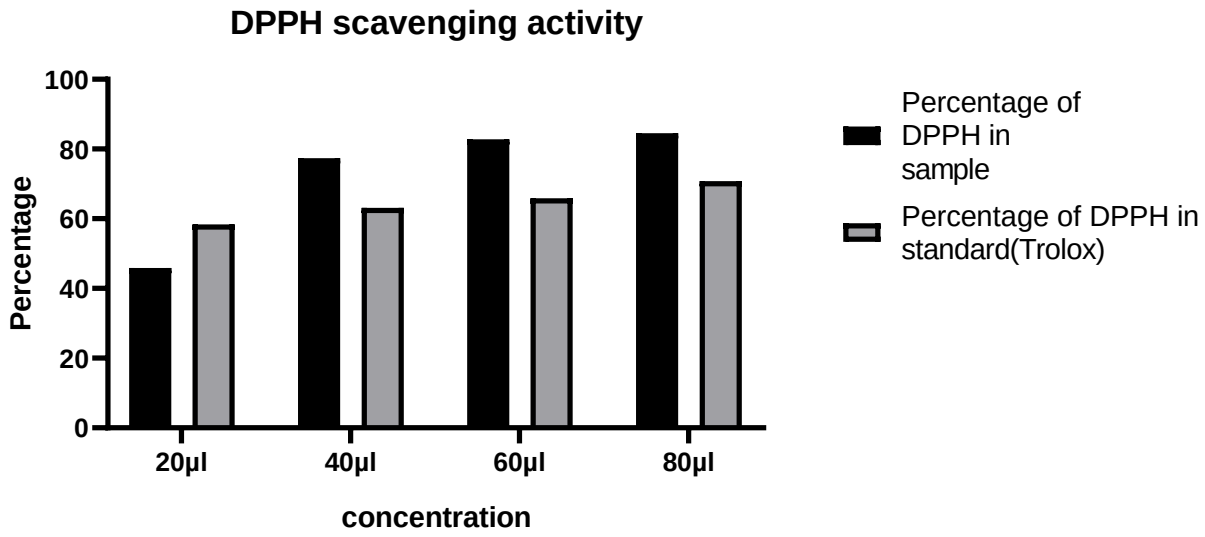

Figure: 2 (Antioxidant activity of ethanolic Apricot fruit extract)

Sample	DPPH Scavenging activity (%)
Apricot extract	82.83
Functional jam	71.24
Functional ice cream	62.31
Trolox (standard)	65.87

Table: 3 (Antioxidant activity of ethanolic Apricot fruit extract, Functional jam, Functional ice cream, Trolox (standard)

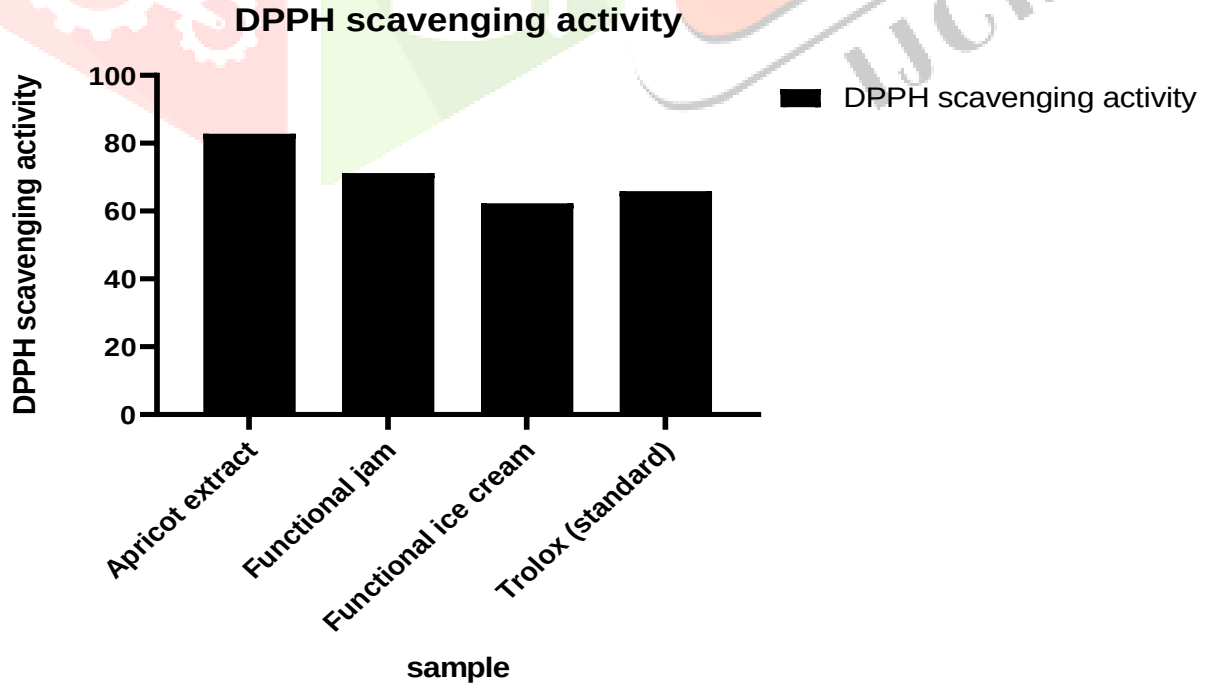

Figure: 3(Antioxidant activity of ethanolic Apricot fruit extract, Functional jam, Functional ice cream, Trolox (standard)

3.3 Anthelmintic activity

The ethanolic extract of apricot fruit exhibited dose dependent anthelmintic activity against *Pheretima posthuma*. At 50 mg/ml, the extract produced paralysis and death times of 55.06 min and 69.24 min, respectively, indicating strong potency comparable to the standard drug albendazole 26.48 min and 50.35 min and superior to piperazine citrate 13.30 min and 28.45 min. when incorporated into functional foods, apricot jam supplemented with 50 mg/ml extract retained appreciable activity, with paralysis at 60.83min and death at 77.18 min, whereas ice cream enriched with the extract showed slightly delayed effects, producing paralysis at 67.20 min and death at 82.64 min. the reduction in activity observed in jam and ice cream compared to the pure extract may be attributed to interactions with food matrices, such as sugar-pectin complexes in jam and fat-protien binding in ice cream, which can slow the release of active phytochemicals.

Treatment	Time taken for paralysis. (min)	Time taken for death.(min)
Vehicle (1% gum acacia)	-	-
Albendazole (25 mg/ml)	26.48±0.43	50.35±0.40
Piperazine citrate (25mg/ml)	13.30±0.23	28.45±0.56
Ethanolic fruit extract; 10 mg/ml 25 mg/ml 50 mg/ml	 123.83±0.43 80.16±0.68 55.06±0.56	 150.01±0.53 95.08±0.36 69.24±0.49

Table: 4 (Antihelmintic activity of Vehicle(1% gum acacia), Albendazole, Piperazine citrate and Ethanolic fruit extract)

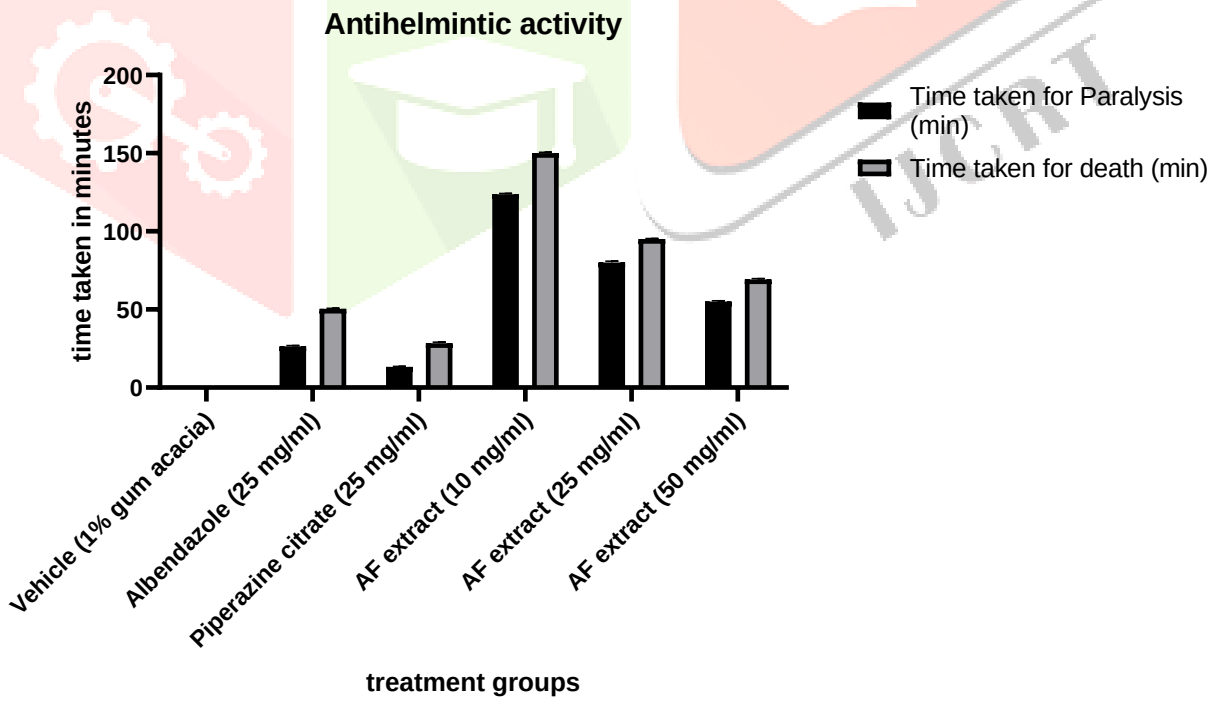

Figure: 4(Antihelmintic activity of Vehicle(1% gum acacia), Albendazole, Piperazine citrate and Ethanolic fruit extract)

Treatment	Concentration (mg/ml)	Time taken for paralysis (min)	Time taken for death (min)
Albendazole	25	26.48±0.43	50.35±0.40
Piperazine citrate	25	13.30±0.23	28.45±0.56
Ethanolic extract of fruit	50	55.06±0.56	69.24±0.49
Functional apricot jam	50	60.83±0.52	77.18±0.61
Functional apricot ice cream	50	67.20±0.48	82.64±0.57

Table: 5 (Antihelmintic activity of Albendazole, Piperazine citrate and Ethanolic fruit extract, Functional apricot jam and Functional apricot ice cream)

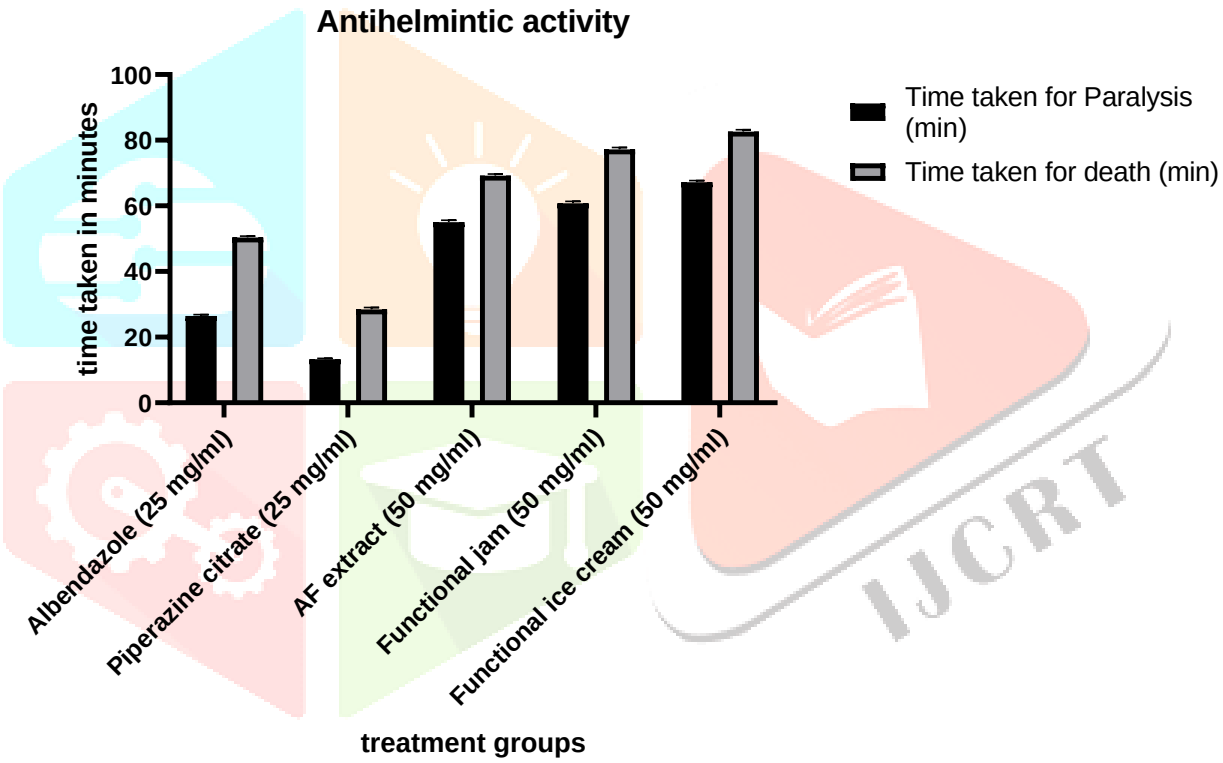

Figure: 5 (Antihelmintic activity of Albendazole, Piperazine citrate and Ethanolic fruit extract, Functional apricot jam and Functional apricot ice cream)

The demonstrated antioxidant and anthelmintic effects suggest that apricot extract can reduce oxidative and parasitic health risks linked to chemical stress and infection. The bioactive compounds identified—especially oleic acid, glycidyl esters, and flavonoids—are known to modulate cellular oxidative pathways, thereby contributing to health risk mitigation. This aligns with the journal's focus on bioactive safety, environmental health, and natural compound efficacy.

3.4 Sensory evaluation

Sensory evaluation score was based on colour, aroma, texture, sweetness of freshly prepared apricot jam and ice cream. Sensory evaluation is important to evaluate the quality or to improve quality and to provide input for decision making or product development. The panelists rated both jam and ice cream > 5 on 9-hedonic scale. Apricot jam scored significantly higher scores than ice cream. Apricot ice cream exhibited lowest colour, aroma, and texture.

samples	Colour	aroma	texture	sweetness
Functional Apricot jam	8.1±0.34	8.2±0.42	8.6±0.29	7.8±0.82
Functional Apricot ice cream	7.1±0.32	6.8±0.66	6.4±0.28	8.2±0.38

Table: 6 (Sensory analysis of functional Apricot jam and ice cream)

4. Conclusion

The present study demonstrates that ethanolic extracts of apricot fruits possess strong antioxidant and anthelmintic properties, thereby supporting their traditional medicinal relevance and highlighting their potential application in functional food development. The GC–MS profile revealed fatty acids, esters, glycidyl derivatives, and flavonoid-like compounds, many of which are known to exhibit antioxidant, antimicrobial, and anti-inflammatory activities. These findings are in agreement with earlier reports that attributed the radical scavenging properties of apricot to its phenolic and flavonoid content, particularly oleic acid, palmitic acid, and quercetin derivatives.The ethanolic extract exhibited a higher free radical scavenging activity than the standard antioxidant Trolox, indicating its superior efficiency in neutralizing reactive oxygen species. Similar results have been reported for phenolic-rich fruit extracts, suggesting that apricot may serve as a promising natural alternative to synthetic antioxidants. When incorporated into jam and ice cream, the extract retained substantial antioxidant activity, although a reduction was observed. This decline can be attributed to thermal degradation of bioactive compounds during jam preparation and fat–protein binding in ice cream. Comparable observations have been made in other functional foods where processing conditions partially compromised bioactive stability.

Anthelmintic evaluation revealed dose-dependent activity of apricot extract against *Pheretima posthuma*, with potency comparable to albendazole. The functional jam and ice cream retained notable efficacy, albeit with slightly prolonged paralysis and death times. This reduction is likely due to matrix interactions that modulate the release and absorption of active phytochemicals. These results are consistent with previous reports of plant extracts showing promising anthelmintic activity in earthworm models, which are considered reliable surrogates for intestinal roundworms.

From a practical standpoint, sensory evaluation confirmed consumer acceptability of both jam and ice cream, with jam receiving higher preference scores. This indicates that apricot extract can be successfully integrated into commonly consumed products without compromising palatability, thereby facilitating its adoption as a nutraceutical-rich ingredient.

The broader implications of this study suggest that apricot extract may serve as a sustainable source of natural antioxidants and anthelmintics, aligning with the growing demand for plant-based therapeutics and functional foods. However, certain limitations must be acknowledged. The present study employed in vitro antioxidant assays and an earthworm model for anthelmintic activity, which, while informative, may not fully represent

in vivo conditions. Additionally, potential variability in bioactive retention during large-scale food processing was not evaluated.

Future research should focus on in vivo animsal models and human trials to validate the pharmacological efficacy of apricot extract. Studies on bioavailability, stability under industrial processing, and optimization of formulation strategies are warranted to maximize functional benefits. Exploring synergistic effects of apricot extract with other natural bioactives may further enhance its therapeutic and nutritional value.

Overall, the incorporation of apricot extract into food systems not only enhances their nutritional and sensory profile but also represents a sustainable strategy for reducing oxidative and parasitic health risks. These results strengthen the link between dietary bioactives and chemical health safety, providing a scientific basis for risk-preventive functional food innovation.

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