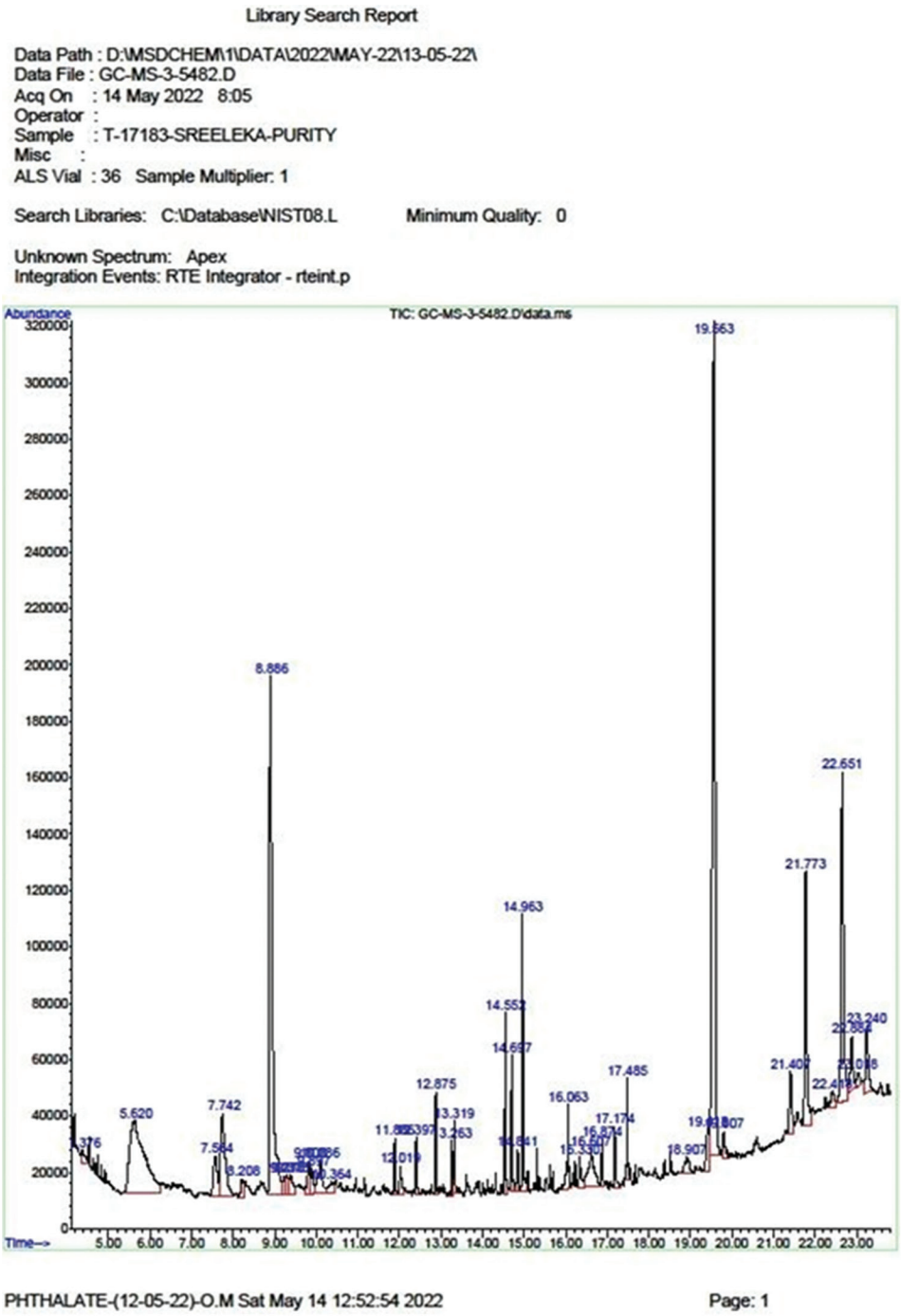

Table 1: **Phytochemical analysis of aqueous extract of *Averrhoa carambola* leaves**

S. No	Contents	Aqueous extract of *Averrhoa carambola* leaves
1.	Tannins	+
2.	Saponin	+
3.	Flavonoids	+
4.	Alkaloids	+
5.	Proteins	+
6.	Steroid	-
7.	Quinones	-
8.	Terpenoid	-
9.	Cardiac Glycosides	-
10.	Phenol	+

(+) positive (–) negative

Table 2 : **Hydroxyl radical scavenging assay**

Blank-0.45					
Concentration(µg)	100	200	300	400	500
Standard OD	0.31	0.25	0.19	0.15	0.11
%inhibition	31.1	44.4	57.7	66.6	75.5
Blank: 0.43					
Sample/Concentration (µg)	100	200	300	400	500
Aqueous extract OD	0.35	0.32	0.29	0.27	0.25
% of inhibition	18.6	25.5	32.5	37.2	41.8

Phytoconstituents of the *A. carambola* aqueous extract of leaves were analyzed qualitatively. Our results showed the presence of tannin, saponin, flavonoid, protein, alkaloid, and phenol in the aqueous extracts [9]. These secondary metabolites could be the source of the therapeutic effects. Pal *et al.* (2019) revealed that the preliminary phytochemical screening of

Table 3 : Reducing power assay

Concentration(µg)	100	200	300	400	500
Standard OD	0.40	0.75	1.21	1.60	1.97
Sample/concentration (µg)	100	200	300	400	500
Aqueous extract OD	0.49	0.53	0.57	0.62	0.66
Amount of reducing powder (µg)	120	130	145	155	165

Table 4: Cytotoxicity activity of *Averrhoa carambola* leaves extract against VERO cell

S. No	Concentration µg/mL	Absorbance 540 nm	% cell viability
1	1000	0.35	26.3
2	500	0.51	38.3
3	250	0.72	54.1
4	125	1.03	77.4
5	62.5	1.28	96.2
6	31.2	1.33	100
7	DMSO	1.33	100
8	Control cells	1.33	100

the *A. carambola* aqueous extract contains tannins, flavonoids, phenols, terpenoids, sterols, fats, fixed oils, etc. [10]. Our results showed that the analysis of antioxidant properties in *A. carambola* aqueous extract of leaves exhibited IC_{50} values at 500 µg for DPPH scavenging analysis and reducing power assay showed 165 µg/mL.

Determining the antimicrobial properties of plant extracts can be of great importance in therapeutic cures. Antibacterial susceptibility tests are used in ethnopharmacological research to evaluate the potential antibacterial activity of biological extracts against various pathogenic pathogens. By establishing the MIC, these assays are used to screen plant extracts for antimicrobial properties as well as to determine the effectiveness of antimicrobial medicines in treating illnesses. *Staphylococcus aureus*, *Enterococcus faecalis*, and *Klebsiella pneumonia* showed more antibacterial activity in *A. carambola* ethanol extract of leaf (Silva *et al*., 2021). Our results showed more antimicrobial activity in *Escherichia coli* (250 µg) and *Candida albicans* (250 µg) compared with other microbes [11].

Hydroxyl radical property can be formed by the Fenton reaction in the presence of reduced transition metals (such as Fe2+). Scavenging of hydroxyl radical is an important antioxidant activity because of the very high reactivity of the OH radical, enabling it to react with a wide range of molecules found in living cells, such as sugars, amino acids, lipids, and nucleotides Thus, removing OH- is very important for the protection of living systems. As a result of the hydroxyl scavenging assay, the activity was found to be 41.8% in the aqueous extract of *A. carambola* leaves. Kandhasamy *et al*. (2013) investigated the hydroxyl radical scavenging potential of various solvent extracts of *Bauhinia vahlii* leaves such as petroleum ether, acetone, hot water, chloroform, and methanol. The methanol extract (84.4%) showed the highest activity compared with other extracts [12].

Shu *et al*. (2014) revealed that the most abundant fatty acids were a-linolenic acid (62.04%) for leaf extracts and oleic acid (55.44%) for fruit extracts of *A. carambola*. The amount of total unsaturated fatty acids in leaves and fruits comprised more than 77% of total fatty acid by GCMS analysis. Nehal *et al*. (2020) also detected 24 volatile compounds in the fruit extract of *A. carambola*. In our results, 40 compounds were found for leaf extracts of *A. carambola* [13].

CONCLUSION

The current research has shown that natural sources have therapeutic properties without much toxicity. This potential of plants is due to the presence of secondary metabolites.

The results prove that *A. carambola* leaf extract has antioxidant, antibacterial, and antifungal activity. In addition to this, the present investigation revealed that *A. carambola* leaf extract can act as a potential drug for treating breast cancer. Toxicity and anticancerous activity of the sample were evaluated by VERO cell lines and cancer efficacy was found to be at a low concentration compared to cytotoxicity. Hence, the study has proven that it could be recommended for the pharmaceutical industry.

ACKNOWLEDGMENT

The author appreciates the Department of Biotechnology and Biochemistry. Plant authentication is done by the Department of Biotechnology laboratory, Faculty of Biochemistry, Annamalai University Chidambaram for synthesis, biological activities analysis in the Annamalai University, Department of Biotechnology and Biochemistry.

AUTHORS CONTRIBUTION

SJB – conceptualization, data curation; project administration; formal analysis design, and experimental works, original draft; software; OM – writing – review and editing; DA – data curation, validation, and manuscript review; HB – supervision, validation, manuscript review, and approval.

CONFLICTS OF INTERESTS

The author declares no conflicts of interest

REFERENCES

1. Vasconcelos CM, Araújo MS, Conde-Garcia EA. Electrophysiological effects of the aqueous extract of *Averrhoa carambola* L. Leaves on the guinea pig heart. Phyto Med 2006;13:501-8.
2. Wei SD, Chen H, Yan T, Lin YM, Zhou HC. Identification of antioxidant components and fatty acid profiles of the leaves and fruits from *Averrhoa carambola*. Food Sci Technol 2014;55:278-85.
3. Moresco HH, Queiroz GS, Pizzolatti MG, Brighente IM. Chemical constituents and evaluation of the toxic and antioxidant activities of *Averrhoa carambola* leaves. Braz J Pharmacogn 2012;22:319-24.
4. Ramadan NS, Wessjohann LA, Mocan A, Vodnar DC, El-Sayed NH, El-Toumy SA, *et al*. Nutrient and sensory metabolites profiling of *Averrhoa carambola* L. (starfruit) in the context of its origin and ripening stage by GC/MS and chemo metric analysis. *Molecules* 2020;25:2423.
5. Pal A, Chinnaiyan S, Mallik A, Bhattacharjee B. Anti ulcer activity of leaves of *Averrhoa carambola* Linn. Int J Pharmacol Res 2019;9:e5209.
6. Babu G, Jijitha TP. Identification, isolation and anticancer activity of bioactive constituents from fruit extract of *Averrhoa carambola* Linn. Int Res J Pharm 2016;7:84.
7. Ncube NS, Afolayan AJ, Okoh AI. Assessment techniques of antimicrobial properties of natural compounds of plant origin: Current methods and future trends. Afr J Biotechnol 2008;7:1797-806.

Author Queries???
AQ1: Kindly provide the history details
AQ2: Kindly provide the text part
AQ3: Kindly check the Reference citation
AQ4: Kindly check the author name does not match the reference list
AQ5: Kindly cite the Reference 4 in the text part
AQ6: Kindly cite tables 1-4 in the text part
AQ7: Kindly check the Table formation