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Extraction and identification of anti-oxidants, anti-inflammatory, anti-cancerous and cosmetic compounds from the mucus of a slug Laevicaulisalte

Suja P.S [1,4], Nija.C [*2,4], Navinchandran.M[3,4]

[1] Reg. No. 23113152192006, ORCID ID 0009-0002-4200-3827 Department of Zoology, S.T.Hindu College, Nagercoil, Tamil Nadu – 629002.

*[2]Associate Professor and Head of the Department of Zoology, Women's Christian College, Nagercoil, Tamil Nadu – 629001 ORCID ID 0009-0003-0280-3325.

[3]Assistant Professor, Department of Zoology, S.T.Hindu College, Nagercoil, Tamil Nadu – 629002.

[4]Affiliated to Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, INDIA.

*** Corresponding author.**

Email ID : address:nijadhas08@gmail.com

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ABSTRACT

India is the birthplace of new indigenous medical systems like Siddha, Ayurveda, and Unani. Natural materials have been a major source of pharmaceuticals since ancient times; currently, about half of the most potent medications originate from natural sources. Ancient Greeks were interested in snail and slug mucus trails because it had anti-inflammatory and antioxidant properties (Ekin et al., 2018). In Kanyakumari District, the land slug *Laevicaulisalte* is frequently observed. Its mucus is a stretchy, sticky substance that has lubricating and adhesive qualities. The bioactive elements of slug crude mucus have been evaluated by GC-MS analysis; these compounds exhibit antibacterial, anti-oxidant, anti-inflammatory, and anti-cancer activities. Five antioxidant, four anti-inflammatory, and three anti-cancerous compounds were isolated. Tetrapentacontane (39.510), 1-Heptacosanol (39.414), and 2-hydroxyl-1-(hydroxymethyl) ethyl ester (41.227) all have long retention times. It is well recognized that the chemicals found have therapeutic benefits.

Keywords: Anti-oxidant, Anti-inflammatory,Anti-cancerous,Slug, Laevicaulisalte, Bioactive compounds.

1. INTRODUCTION

The World Health Organization (WHO) estimates that 80% of people worldwide receive the majority of their primary medical treatment from traditional medicine (Ravelo et al., 2004). Consuming natural products, whether they are simple or more complex, has been shown to provide protection against a variety of human diseases (Gayathri et al., 2017).

Natural remedies are growing more and more popular, in addition to recent lab research on the pharmacological properties of bioactive compounds and their potential to treat a variety of diseases (Smita, 2021). Numerous natural products, including terrestrial plants, terrestrial microorganisms, marine animals, terrestrial vertebrates, and terrestrial invertebrates, are used to make the drugs and new bioactive compounds (Newman et al., 2003; Andrejko et al., 2009; Badiu et al., 2008; Coates et al., 2014; Dang et al., 2015).

Slugs and snails are belonging to the class Gastropoda and phylum Mollusca. In contrast to snails, which have hard, calcareous shells covering their bodies, slugs are categorized as snails without a shell (Barker, 2002; Ramzy, 2009). Slugs and snails may stick tenaciously to a variety of surfaces because of the an elastic, sticky fluid known as mucus or slime with lubricating and adhesive qualities. Mucus also shields mollusks from dehydration and deters predators from capturing snails and slugs (Hamalalnen et al., 2012; South et al., 1992).

The diversified family of mollusks known as gastropods, which includes slugs and snails, has long piqued scientific interest due to its unusual adaptations and fascinating biological activity (Sadjadi, 2018). According to Mcdermott et al. (2021) and Cilia et al. (2017), the most significant slug species is typically *Arion subfuscus*, while the most representative biological species of snails are *Helix aspersa*, also referred to as a garden snail, *Helix pomatia*, *Archachatina marginata*, *Achatina fulica*, *Hexaplex trunculus*, *Conus magus*, *Bolinusbrandaris*, and *Ereminadesertorum*. In Kanyakumari district of TamilNadu, India a terrestrial slug *Laevicaulisalte* has been found commonly.

These creatures are characterized by being able to generate slime, a mucus-like secretion with a complicated makeup. The slime of snails and slugs is comprised of 90–99.7% water by weight, with the remaining 0.3–10% consisting of proteoglycans such as achacin, hyaluronic acid, glycosaminoglycans, enzymes, antimicrobial peptides, copper peptides, and metal ions. In addition, snail slime contains glycolic acid, collagen, elastin, and allantoin; the Helix aspersa mucus also contains the enzymes glutathione-S-transferase (GST) and superoxide dismutase (SOD). Metal ions like copper, iron, manganese, and zinc are also present in considerable amounts in the slime of the slug Arion subfuscus. These ions are necessary for the gel to form when the slime is secreted (Cilia et al., 2017).

Among invertebrates, mollusks are a major source of products of biomedical value (Shenoy A.S., 1988). Many wild animals and their secretions have been used in traditional medicine. The African giant snail, or Archachatina marginata, is one of the most important minor forest products in West Africa, and Nigeria in particular (Babalola et al., 2011).

Ahmad et al. (2018) checked all of the listed in vitro, in vivo, and human clinical studies that reported the antioxidant and anti-inflammatory qualities of molluscan natural substances in order to identify a potential outcome. Ibrahim et al., (2022) evaluated the anti-inflammatory and antioxidant properties of Ereminadesertorum mucus in connection to intestinal inflammation induced by carbon tetrachloride (CCl4) and evaluated damage in male albino mice.

Mucus extracts from *H. aspersa* and *E. desertorum* showed albumin denaturation, proteinase inhibition, and membrane stabilization of human red blood cells when tested for anti-inflammatory qualities and contrasted with aspirin's effects (El-Zawawy et al., 2021). The mucus of *Achatina fulica* also inhibited the growth of *Staphylococcus aureus* and *Staphylococcus epidermidis* germs when administered to a mouse model using wound dressing films (De La Secrecion, 2012).

Additionally, snail mucus may be used to improve cardiovascular protection and treat cognitive impairment because of its strong antioxidant qualities (Odeleye et al., 2019). The mucin and acharan sulphate motifs that were isolated from *A. marginata* shown consistent blood glucose reducing effects (Adikwn M.U., 2005) and anti-tumor activity (Cooling V, 2005), respectively, according to previous biological study.

A different study found that Helix aspersa slime inhibited the growth of IGR 39 and SK-MEL-28 melanoma cells by increasing the expression of the cytokine Tumor Necrosis Factor (TNF-α) and blocking the transcription process by blockingNuclear factor kappa light chain enhancer of activated B cells (NF-κB), which has been linked to the progression of cancer when properly regulated (Dominguez et al., 2020).

Andrus et al. (2020) pointed out that the beauty and cosmetics sector has taken advantage of gastropod slime's possible advantages. Slime extracts are used in a variety of cosmetic products because of the compounds, like hyaluronic acid and glycoproteins, that are thought to have moisturizing and skin-smoothing properties.

Extraction from living organisms or chemical synthesis are the two ways to create tiny bioactive compounds. Many species produce a vast array of natural products, ranging from small peptides to chemical compounds, some of which have biological functions. Alaish et al. (1996) claim that natural bioactive chemicals are produced as chemical cues to control normal physiological processes including differentiation and growth.

This study used GC-MS techniques to assess the bioactive components of the terrestrial slug *Laevicaulisalte*. The separation and identification of bioactive compounds from the mucus of the terrestrial slug *Laevicaulisalte* is the main goal of this study. A review of the literature showed that not much research has been done on *Laevicaulisalte.* Therefore, *Laevicaulisalte* was selected for the current investigation, which has specific executable goals: to determine the bioactive substances found in the crude mucus of the terrestrial slug *Laevicaulisalte.*

2. MATERIALS AND METHODS

2.1 Collection of Species

Laevicaulisalte specimens were transported from the Kanyakumari district to the laboratory.

2.2 Mucus Collection

The slugs were cleansed with distilled water before being placed in a sterile petri plate to collect mucus. Mucus was collected using a 2% citric acid solution, which encourages slugs to produce more mucus. The mucus was collected on the petri plates, scraped up with a spatula, and then placed in the refrigerator.

2.3 Gas Chromatography-Mass Spectrometry (GC-MS) analysis

A Shimadzu GC-MS-QP2010 gas chromatograph mass spectrometer equipped with a Rtx-5 fused silica capillary column (30 X0.25 mm, with 1 cm film thickness) and interfaced with a Turbo Mass quadrupole mass spectrometer was utilized to perform the GC-MS analysis of the material. The oven was set to rise from 1000°C to 3200°C at a rate of 1000°C per minute, with a 10-minute hold in between. At a flow rate of 1.0 mL/min, helium was employed as the carrier gas. The split ratio was 1:10, the injector temperature was 2500C, and the injection size was 1 µL neat. The mass spectra were obtained at 70eV with

a mass scan range of 40-700 amu (atomic mass unit), while the interface and MS ion source were kept at 3200C and 2000C, respectively. Data handling was done using GC-MS solution software.

2.4 Identification of the components

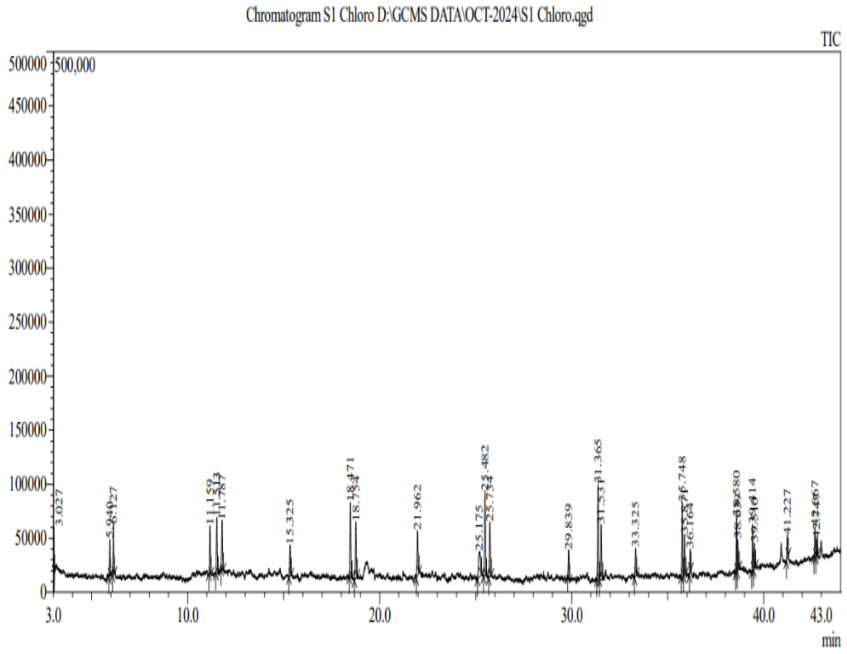
The National Institute of Standards and Technology (NIST) database, which has over 62,000 patterns, was used to interpret the mass spectrum. Unknown components' fragmentation pattern spectra were contrasted with those of known components that were kept in the NIST library. Each bio-component's relative percentage amount was determined by comparing its average peak area to the total area. The components of the test materials were identified by name, molecular weight, and structure.

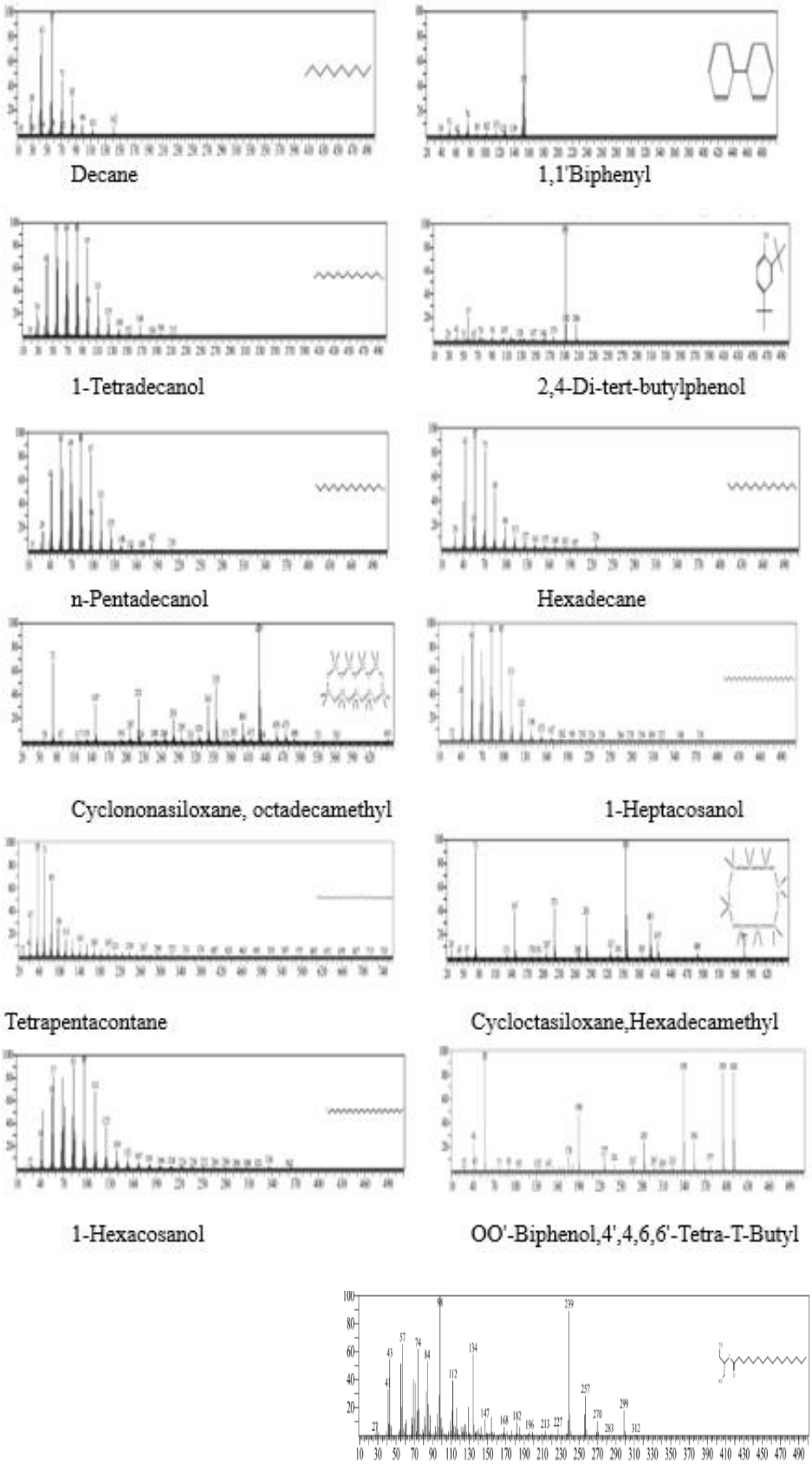
3. RESULTS

3.2 Bioactive compounds from slug crude mucus

Literature on the chemical constituents of *Laevicaulis alte* mucus is scarce. The bioactive substances in *Laevicaulis alte* crude mucus were found and verified by GC-MS analysis. The gas chromatogram displays the relative concentrations of the several eluted chemicals as a function of retention time. The peak heights indicate the relative concentrations of each component in the mucus. A chloroform extract of crude mucus was taken in order to analyze the active components in *Laevicaulis alte* using GC-MS. The crude mucus consisted of 22 bioactive components (Figure 1).The mass spectrum and structure of each distinct chemical are shown in Figure 2.

Figure 1. GC-MS chromatogram of *Laevicaulis alte* crude mucus





Hexadecanoic acid,2-hydroxyl-1-(hydroxymethyl) ethyl ester

Figure 2. Mass fragmentation of the active compounds identified in the *Laevicaulisalte* crude mucus

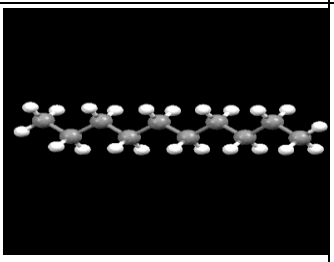
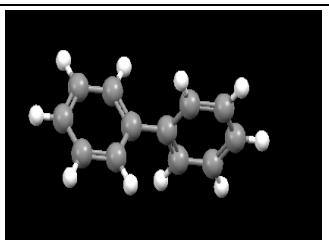
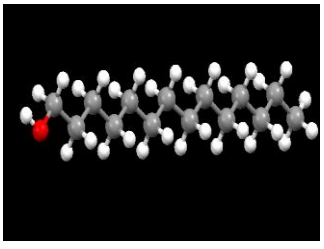
A total of 13 bioactive compounds with anti-oxidant (5 compounds), anti-inflammatory (4 compounds), anti-cancerous (2compounds), cosmetic (2 compounds) and other biological activities (5compounds) like narcotic effect, bone and collagen formation, anthelmintic, anti-HIV, insecticidal, larvicidal, neurotoxic effects has been isolated from the crude mucus of *Laevicaulisalte.*

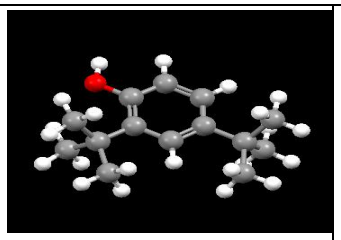
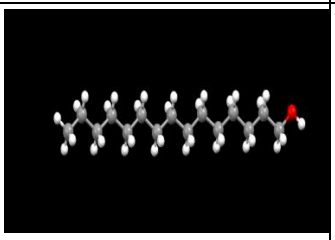
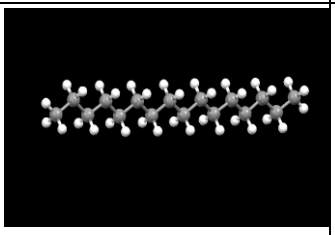
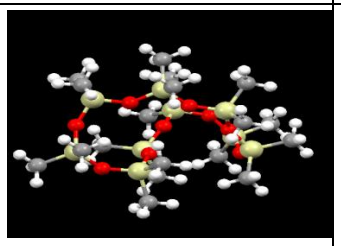
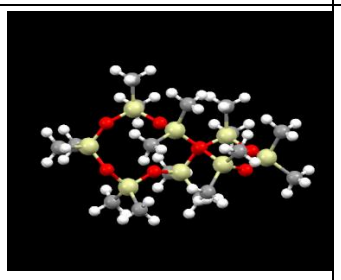
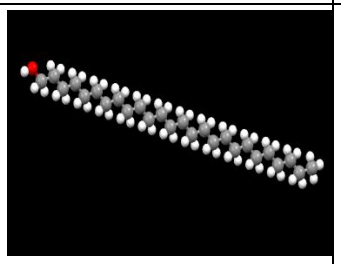
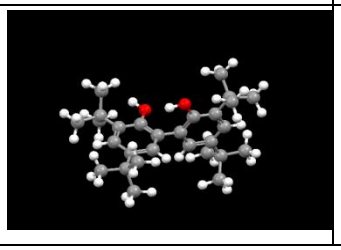
Table 1 shows the three-dimensional chemical structure and biological activity of the crude mucus. *Laevicaulisalte* crude mucus was subjected to a GC-MS analysis, which revealed a number of biologically active compounds with potential therapeutic uses. A linear chain of 10 carbon atoms, each covalently bound to a hydrogen atom, makes up decane, which has narcotic properties.Two benzene rings joined by a single bond define the structure of 1,1'-biphenyl, which exhibits anti-inflammatory, anti-cancer, and anti-HIV properties. A saturated fatty alcohol with a straight 14-carbon chain, 1tetradecanol has antibacterial, anti-inflammatory, and cosmetic properties. Two tertiary butyl groups joined at the ortho and para locations of the phenol molecule in 2,4-Di-tert-butylphenol exhibit antibacterial and anticancer properties.

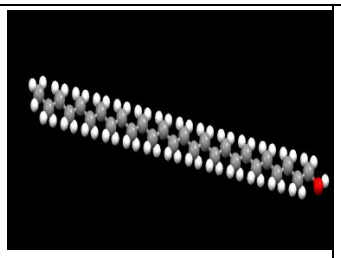
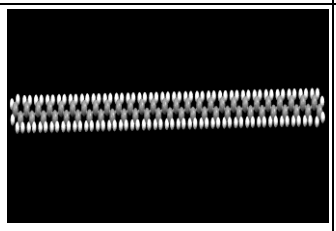
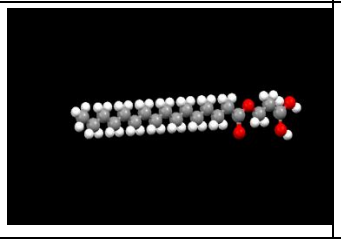
n-Pentadecanol is a 15-carbon long-chain fatty alcohol that has antimicrobial and cosmetic properties. Hexadecane, a 16-carbon straight-chain alkane, has antioxidant and antibacterial properties. The nine-membered ring structure of cyclic frames with alternating silicon and oxygen atoms makes up cyclononasiloxane, octadecamethyl, which has antibacterial and antioxidant properties. Cyclooctasiloxane, hexadecamethyl, is associated with the synthesis of collagen and bone because of its cyclic structure, which is made up of four silicon and four oxygen atoms organized alternately in an eight-membered ring. 1-Hexacosanol is a long-chain fatty alcohol with 26 carbons that exhibits antibacterial, anticancer, neurotoxic, and insecticidal properties. With hydroxyl groups on both of its benzene rings joined by a single bond, O O'-Biphenol,4,4',6,6'-Tetra-T-Butyl is a biphenol that exhibits antibacterial and anti-inflammatory properties.

1-Heptacosanol is also a long-chain fatty alcohol, but with 27 carbon atoms displays antimicrobial and antioxidant activities. Tetrapentacontane is a straight-chain alkane with 54 carbon atoms shows antimicrobial and antioxidant properties. The straight-chain compound hexadecanoic acid, 2-hydroxyl-1-(hydroxymethyl) ethyl ester, has 19 carbon atoms exhibits antioxidant, anti-inflammatory, anthelmintic activities.

Table 1. 3D Structure and bioactivity of compounds in the crude mucus

S.No	Compound name	Structure	Biological activity	References
1	Decane		Narcotic effect	Clough,2014
2	1,1'Biphenyl		Anti-inflammatory, anti-cancer,anti-HIV	Sloboda et al.,1980, Prota et al.,2013, Yuan Lei et al.,2020
3	1-Tetradecanol		Anti-inflammatory, Cosmetics,antibacterial	medchemexpress.com, Thermofisher.com

4	2,4-Di-tert-butylphenol		Antibacterial, antifungal, anticancer	Vinatiorganics.com , Kai Fan et al.,2024, Sathuvan et al.,2012
5	n-Pentadecanol		Antibacterial, cosmetics	Kubo et al.,1995 Shell Global,2019
6	Hexadecane		Antibacterial, anti-oxidant	Yogeswari et al.,2012
7	Cyclononasiloxane,octadecamethyl		Antibacterial, anti-oxidant	Humaira Rizwana et al 2019, Kadri et al.,2011
8	Cycloctasiloxane,Hexadecamethyl		Bone and collagen formation	National Library Science of Medicine
9	1-Hexacosanol		Insecticidal,larvicidal,neurotoxic effect, antibacterial,anti-fungal, anti cancer	medchemexpress.com, Sriramya et al.,2017,Han et al.,2009, Wei&Bin, 2011
10	OO'Biphenol,4, 4',6,6'Tetra-T-Butyl		Antibacterial, Anti-fungal,anti-inflammatory	Poonam et al.,2021, Kai Fan et al., 2023,Irshad et al.,2021

11	1-Heptacosanol		Antibacterial, Anti-fungal,anti-oxidant	Mostafa et al.,2024, Eva Sanchez et al.,2021, Imada ,2005
12	Tetrapentacontane		Antibacterial, anti-fungal,anti-oxidant	Mahima et al.,2022, Abuzer et al.,2021, Zuhair et al.,2022
13	Hexadecanoic acid,2-hydroxyl-1-(hydroxymethyl) ethyl ester		Anti-oxidant, anti-inflammatory,anthelmintic	Sheela& Uthayakumari,2013 , Alma et al.,2020, Kalpesh et al.,2020

The antioxidant compounds found in the crude mucus of slugs are listed in Table 2. Alkanes include hexadecane and tetrapentacontane; siloxane compounds include cyclononasiloxaneand octadecamethyl; fatty alcohols include 1-heptacosanol; and fatty acid compounds include hexadecanoic acid and 2-hydroxyl-1-(hydroxymethyl) ethyl ester. Tetrapentacontane's molecular weight ranges from 758 g/mol to 226 g/mol, indicating a range of chemical structures that may contribute to its antioxidant properties.

Table.2Anti-oxidant compounds from slug crude mucus

S. No	Retention time	Area %	Compound name	Compound nature	Molecular formula	Molecular Weight
1	18.754	5.18	Hexadecane	Alkane	$C_{16}H_{34}$	226
2	25.175	4.89	Cyclononasiloxane,octadecamethyl	Siloxane	$C_{18}H_{54}O_9Si_9$	666
3	39.414	3.08	1-Heptacosanol	Fatty alcohol	$C_{27}H_{56}O$	396
4	39.510	1.77	Tetrapentacontane	Alkane	$C_{54}H_{11O}$	758
5	41.227	1.80	Hexadecanoic acid,2-hydroxyl-1-(hydroxymethyl) ethyl ester	Fatty acid	$C_{19}H_{38}O_4$	330

Slug crude mucus contains anti-inflammatory compounds, which are listed in Table 3. These molecules include fatty alcohols, such as 1-Tetradecanol, fatty acids, hexadecanoic acid, 2-hydroxyl-1-(hydroxymethyl) ethyl ester, and aromatic compounds, such as 1,1'-Biphenyl and O O'-Biphenol, 4,4',6,6'-Tetra-T-Butyl. The molecular weights of these compounds range from 154 g/mol for 1,1'-Biphenyl to 410 g/mol for O O'-Biphenol, 4,4',6,6'-Tetra-T-Butyl, indicating a variety of chemical structures that may contribute to their anti-inflammatory properties.

Table .3 Anti-inflammatory compounds from slug crude mucus

S.No	Retention time	Area%	Compound name	Compound nature	Molecular formula	Molecular weight
1	11.159	3.77	1,1'Biphenyl	Aromatic	$C_{12}H_{10}$	154
2	11.513	4.28	1-Tetradecanol	Fatty alcohol	$C_{14}H_{30}O$	214
3	38.580	3.89	OO'-Biphenol,4,4',6,6'-Tetra-T-Butyl	Aromatic	$C_{28}H_{42}O_2$	410
4	41.227	1.80	Hexadecanoic acid,2-hydroxyl-1-(hydroxymethyl) ethyl ester	Fatty acid	$C_{19}H_{38}O_4$	330

The anti-cancerous chemicals that were extracted from slug crude mucus given in table 4. Two compounds were found: 2,4-Di-tert-butylphenol, a phenol with an area percentage of 2.54%, and 1,1'-Biphenyl, an aromatic compound with an area percentage of 3.77%. These substances, which have molecular weights of 154 and 206, respectively, suggest that the mucus contains bioactive substances that may have anti-cancer effects.

Table .4 Anti-cancerous compounds from slug crude mucus

S.No	Retention time	Area%	Compound name	Compound nature	Molecular formula	Molecular Weight
1	11.159	3.77	1,1'Biphenyl	Aromatic	$C_{12}H_{10}$	154
2	15.325	2.54	2,4-Di-tert-butylphenol	Phenol	$C_{14}H_{22}O$	206

Cosmetic components found in slug crude mucus are highlighted in the table 5. Two fatty alcohols were found: n-Pentadecanol had the largest area percentage (6.60%) and 1-Tetradecanol had the lowest (4.28%). These substances appear to have emollient and moisturizing qualities, which makes them useful for cosmetic applications. Their molecular weights are 214 and 228 respectively.

Table .5 Cosmetics compounds from slug crude mucus

S.No	Retention time	Area%	Compound name	Compound nature	Molecular formula	Molecular weight
1	11.513	4.28	1-Tetradecanol	Fatty alcohol	$C_{14}H_{30}O$	214
2	18.471	6.60	n-Pentadecanol	Fatty alcohol	$C_{15}H_{32}O$	228

The biological functions of the chemicals found in slug crude mucus are summarized in table 6. While cycloctasiloxane and hexadecamethyl are linked to the formation of collagen and bone, decane acts as a narcotic. The anthelmintic effects of hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl) ethyl ester were established. 1-Hexacosanol exhibits insecticidal, larvicidal, and neurotoxic properties, while 1,1'-Biphenyl is noteworthy for its anti-HIV action. This variety of uses demonstrates the wide range of potential uses for slug crude mucus in biomedical domains.

Table .6 Compounds of other biological activities from slug crude mucus

S.No	Compound name	Activities
1	Decane	Narcotic compound
2	Cycloctasiloxane,Hexadecamethyl	Bone and collagen formation
3	Hexadecanoic acid,2-hydroxyl-1-(hydroxymethyl) ethyl ester	Anthelmintic
4	1,1'Biphenyl	Anti-HIV
5	1-Hexacosanol	Insecticidal, larvicidal, neurotoxic effects

4. DISCUSSION

For snails and slugs to survive and interact with their surroundings, their secretions are essential. Recent research has drawn notice to the diverse qualities of gastropod slime, generating a lot of curiosity from scientists. This material aids in these animals' adaptation to their environment and helps them avoid predators as a natural defence mechanism. Beyond its ecological function, scientists have found that it has antimicrobial and wound-healing properties, which makes it a viable option for developments in beauty and medicine. A growing number of cosmetic products use snail mucin because of its moisturizing and regenerating qualities (Rizzi et al., 2021).

In the past, Italy has used the mucus from ordinary garden slugs to cure skin disorders like acne, warts, dermatitis, calluses, and inflammations. Traditional medicines have frequently been derived from natural resources (Quave et al., 2008). Recent scientific research on the medicinal benefits of snail mucus, especially in oncology, is consistent with this traditional understanding. Studies have shown that *Helix aspersa* slime inhibits the growth of melanoma cells, which are among the most severe types of skin cancer.

Numerous investigations have shown that snail mucus has promising medicinal qualities. According to Ellijimi et al. (2018), melanoma cell lines IGR-39 and SK MEL-28 greatly decreased cell viability after being treated with 300 µg/mL slime for 72 hours. This was mainly due to apoptosis linked to Poly (ADP-ribose) polymerase (PARP) breakage. These results imply that snail mucus might be a useful option for treating cancer, especially when it comes to melanoma cells.

Similarly, slime derived from *Helix aspersa* was found to enhance fibroblast viability by favorably regulating the cell cycle and increasing the release of collagen 1 (Ricci et al., 2023), so confirming its potential for skin regeneration and wound healing. Apart from its dermatological advantages, Odeleye et al. (2019) emphasized the potent antioxidant properties of snail mucus, speculating that it might also help preserve the cardiovascular system and enhance cognitive function.

22 bioactive components were found in the chloroform extract of crude mucus from *Laevicaulisalte* according to GC-MS analysis in the current investigation. This conclusion is corroborated by the discovery of bioactive compounds in the hemolymph of the gigantic African snail (*Archachantina marginata*), from which 26 compounds were isolated (Lawal et al., 2015).

Our study identified the presence of decant in slug mucus which has narcotic effect. Clough, 2014 observed that acute exposure to high doses of decane induces narcotic effects in both mice and rats.

1,1'-Biphenyl is a compound with a range of pharmacological activities, making it a valuable component in various therapeutic applications. Research has demonstrated its anti-inflammatory properties, as seen in studies where biphenyl derivatives have shown significant inhibition of inflammation(Sloboda et al.,1980). Addtionally, 1,1'-Biphenyl exhibits anti-cancer activity, particularly against breast cancer cell lines. Compounds derived from biphenyl have been found to induce apoptosis and cell cycle arrest in cancer cells, making them potent anti-cancer agents(Prota et al., 2013). Furthermore, 1,1'-Biphenyl has shown promise in the fight against HIV. Studies have indicated that biphenyl-substituted compounds can inhibit HIV-1 replication by targeting reverse transcriptase, a crucial enzyme in the virus's life cycle(Yuan Lei et al.,2020).

1-Tetradecanol, also known as myristyl alcohol, is a straight-chain saturated fatty alcohol with the molecular formula $C_{14}H_{30}O$. It is commonly used in cosmetics such as cold creams for its emollient properties, which help to hydrate and soothe the skin(thermofisher.in). Additionally, 1-Tetradecanol has antibacterial and anti-inflammatory properties, making it a valuable ingredient in various therapeutic applications(medchemexpress.com).The potential of 2,4-di-tert-butylphenol molecule to cure cancer is highlighted by the study of Sathuvan et al. (2012), which suggests that it can limit the growth of tumors.

n-pentadecanolincorporation into industrial chemicals and consumer goods, such as lotions and creams, as noted by Shell Global (2019), demonstrates its versatility and significance in diverse industries.The compound Hexadecane has been found to have significant antioxidant qualities, according to a study by Yogeswari et al. (2012).Antioxidant Properties noted by Kadri et al. (2011), cyclononasiloxane,octadecamethylextracts from *Laevicaulisalte*exhibit antioxidant properties. Antioxidants are crucial in neutralizing free radicals, which can cause oxidative stress and damage to cells.

Cycloctasiloxane, hexadecamethyl, a compound isolated from slug mucus, contains silicon, an essential trace element for the human body. Silicon plays a critical role in the production of collagen, a protein that provides structural support to skin, tendons, and connective tissues, as well as in the formation and maintenance of healthy bones(National Library Science of Medicine 2018).

1-Hexacosanol has neurotoxic, insecticidal, and larvicidal activities(medchemexpress.com). 1-Hexacosanol has neurotoxic, insecticidal, and larvicidal actions in addition to its promising anti-cancer activities. Its insecticidal and larvicidal properties also point to possible pest control applications. The bioactive compound extracted from*Laevicaulisaltehas* O O'-Biphenol, 4,4',6,6' 'Tetra-T-Butylwhich anti-inflammatory properties, resemble a similar study by Irshad et al. (2021).

1-heptacosanol antioxidant properties, hinting at additional health-related applicationsas studied by Imada (2005). Zuhair Radhi Addai et al. (2022) emphasize Tetrapentacontaneantioxidant activity, making it a multifaceted compound with significant potential in medical and pharmaceutical applications.

Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl) ethyl ester, derived from slug mucus, demonstrates a range of promising biological activities. Its antioxidant properties, as highlighted by Sheela and Uthayakumari (2013), suggest its potential in neutralizing free radicals and preventing oxidative stress-related damage. Furthermore, its anti-inflammatory effects, as reported by Alma M. Astudillo et al. (2020), indicate its utility in mitigating inflammation, which is a common underlying factor in various chronic diseases. Additionally, the compound's potential role in combating helminthiasis, as suggested by Kalpesh et al. (2020), opens avenues for its application in treating parasitic infections.

The anti-oxidant, anti-inflammatory, anti-cancerous, cosmetic, narcotic, bone and collagen production, anthelmintic, anti-HIV, insecticidal, larvicidal, and neurotoxic substances found in slug mucus are all confirmed by our research. These findings open up new avenues for the creation of natural remedies and lay the foundation for further research to fully comprehend and utilize these compounds' medicinal potential.

5. CONCLUSION

The current work has identified and confirmed the presence of bioactive components in the terrestrial slug *Laevicaulisalte* using GC-MS analysis. Consequently, it can be considered a valuable source of natural materials for human therapy and could be utilized in a number of different drugs. Future research requires the analysis of theextract andits bioactive components,to the application levels to various diseases. Additionally, this gave an entirely new viewpoint about how to create viable pharmaceutical and bioactive natural product candidates.

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