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Okra Gum: A brief review of its antibacterial activity against otitis media infections

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Abstract

An infection caused by bacteria in the central part of the ear is called otitis media. Children are most commonly affected, though it can affect people of all ages. The defining feature of chronic otitis media with effusion (COME) is an accumulation of viscous-like fluid in the middle ear without an infection. In contrast, acute otitis media (AOM) is a sudden and excruciating sickness. Haemophilus influenzae, Moraxella catarrhalis, and Streptococcus pneumoniae are common bacteria that create issues. But because Abelmoschus esculentus can fight against germs and other microbes, it's a great way to combat this sickness. Normally, this article deals with the global issue of otitis media, which can cause hearing loss. There are several ways to deal with this, including allopathic therapy; nevertheless, further research into various Abelmoschus esculentus plant preparations shows promise as an antibacterial infection treatment.

Keywords- Inflammation, Chronic, okra gum, *Abelmoschus esculentus*, Otitis.

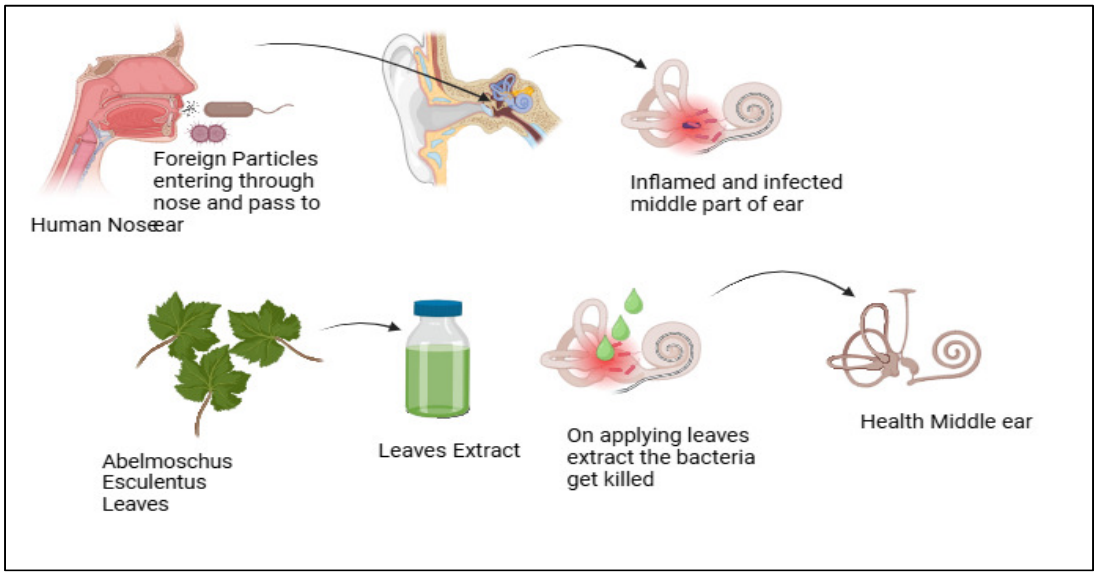

Figure: The Graphical Abstract

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Introduction

Plants that grow naturally are essential to maintaining human health. Man has been familiar with plants since the beginning of time and has used them in various capacities. Plants are employed in traditional medicine, medicines, nutraceuticals, and dietary supplements. They are also necessary for the manufacturing of pharmaceuticals prescribed for allopathic medicine. Using natural and plant-based products instead of synthetic ones is becoming more popular [1]. Okra seeds are an excellent source of protein, and humans need to consume a balanced diet of proteins [2]. Examining the fundamental problem resulting in hearing loss and other related issues, "Otitis media" is defined as middle ear inflammation produced by Streptococcus pneumonia, Moraxella catarrhalis, and Haemophilus influenza [3]. Hearing loss, observed in AOM, may impact speech, language, and cognitive development [4].

Otitis media with chronic suppurative, effusion with otitis media, recurrent acute otitis media, and acute otitis media are the five basic categories into which this bacterial illness is divided. Tympanic membrane (TM) bulging and accompanying erythema, together with unexpected middle ear inflammation, ear discomfort, or impulsive discharge, are the hallmarks of AOM. Two types of infections are mentioned above chronic inflammation of the middle ear and mastoid mucosa with a ventilation tube or TM perforation and persistent ear discharge, and fluid in these structures without any indications of infection or TM perforation for three months or longer [5].

Symptoms of Otitis Media

Otitis media symptoms can include otorrhea, fever, upper respiratory infection, enlarged tympanic membrane, incorrect tympanometry, opacity, redness, or yellowness of the tympanic membrane, and in rare cases, vomiting or lethargy [6–7]. in children who have recently developed otorrhea unrelated to otitis externa or whose tympanic membrane bulges moderately to severely [8]. Any liquid, whether it is blood, pus, exudate, or transudate, is always pathogenic in the middle ear, an air cavity. Any acute clinical symptoms caused by the presence of fluid are referred to as Otitis Media in acute conditions [9]. If sudden clinical symptoms, otitis media are not observed is considered as secretory effusion otitis media. A bilateral effusion lasting more than three months is referred to as persistent effusion in otitis media. If a unilateral effusion persists longer than six months to be classified as chronic. There are two situations in which persistent otitis media can be discussed:

- On initial symptoms like fever and headache if antibiotic treatment persists for more than 48 to 72 hours (therapeutic failure).

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- Chronic AOM, is the recurrence of an acute episode within 14 days of the previous episode's last antibiotic therapy.

If a newborn encounters more than three acute otitis media symptoms in less than six months, or four in fewer than twelve months, with the most recent occurrence taking place in the six months prior, they are diagnosed with acute recurrent otitis media [10]. Usually, this article addresses the worldwide problem of otitis media, which can result in hearing loss. Many approaches are available to deal with this, including allopathic medicine; nevertheless, more investigation into different preparations of the plant Abelmoschus esculentus exhibits potential as an antibacterial infection treatment. The below figure 1 depicts the different symptoms involved in Otitis Media.

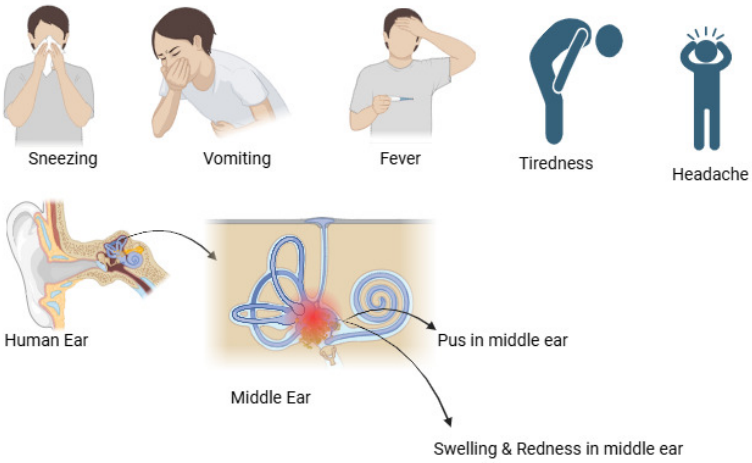

Figure 1. The Symptoms of Otitis Media

Pathogenesis

The early onset of acute otitis media infection, the development of an acute inflammatory cycle in the middle ear due to ongoing exposure to infectious agents, such as viral infections, the persistence of bacteria in the middle ear through the formation of biofilms, the thick and delayed colonialism of the nasal passages by bacteria, and, lastly, severe chronic ear disease are the first stages in the pathogenesis of OM. Nasopharyngeal and Eustachian tube mucosal congestion can be caused by infections of the upper airway tract [11]. As a result, the tube of Eustachian cannot open correctly and the mid part of the ear is affected by homeostatic pressure. Middle ear aspiration may occur from inhaling nasopharyngeal bacteria [12]. In this pyogenic infection with inflammation are buildup in the middle ear, which worsens clinical symptoms of acute otitis media. An erythematous

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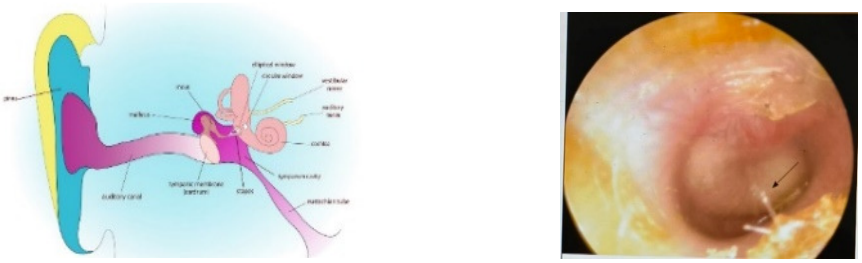
or protruding tympanic membrane and purulent middle ear fluid serve as empirical evidence of this. During an otic examination, it must be differentiated from chronic serous otitis media, which manifests as thick, amber-coloured fluid in the middle ear area and a retracting tympanic membrane [13]. The eustachian tube's architecture (A) and acute otitis media condition of the image are shown in the image below Figure 2 (B) [14]. Figure 3. The pathophysiology of otitis media.



(A) (B)

Fig.2 Depicts the anatomy of ear and otitis media with an acute condition.

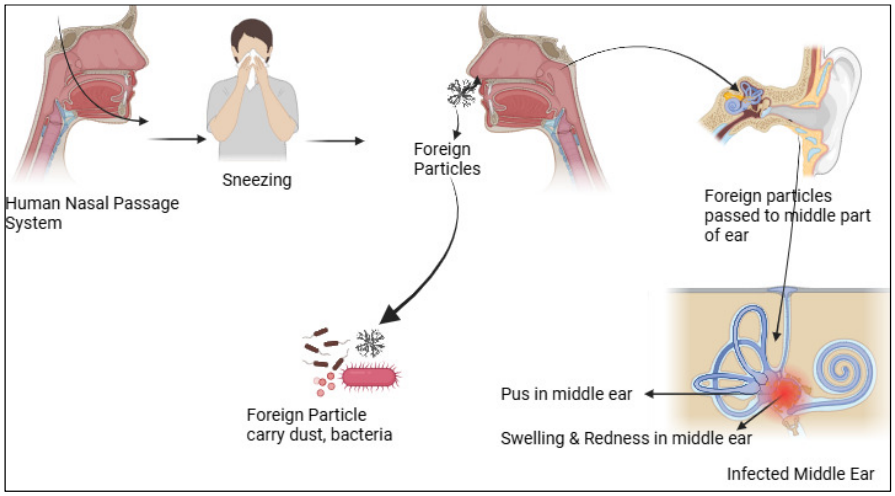


Figure 3. The Pathogenesis of Otitis Media

Epidemiology of Otitis Media Cases

In this study. 384 children who visited paediatric sections of three national referral hospitals in Mogadishu, Somalia, participated in the study between July 2022 and November 2022. Participants in the study ranged in age from 0 to 59 months. 51.3% were between the ages of 0 and 12 months, while the remaining 33.1% and 15.6% were between the ages of 57 and 59 months and 13 and 36 months, respectively. There were 50.8% male children overall [15]. In Eastern European studies, the incidence of AOM was found to be 160.7 occurrences per 1000 person-years. There are currently no statistics on the disease's prevalence in

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Indonesia [16]. Based on estimates from the World Health Organization (WHO), between 75 to 140 million individuals in Southeast Asia and 250 million people (4.2%) globally will suffer from acute otitis media with corresponding hearing loss in 2023. There are 278 million people with hearing loss worldwide. Approximately two-thirds of cases occur in developing countries. The number of people with hearing loss increased to 360 million globally in 2014, or around 5% of people suffering in the world's population [17]. The epidemiology of otitis media by age is displayed in percentage form in Table 1 below.

Table 1. Epidemiology of Otitis Media

S.no	Age Range	Percentage
1.	0-12 Months	51.3%
2.	13-36 Months 57-59	33.1%-15.6%
3.	15-25	34.1%

Advanced Approach for Diagnosing Otitis Media

As to the official national criteria, an AOM diagnosis can only be provided if all the subsequent conditions are satisfied simultaneously: (3) MEE presence, which can manifest as otorrhoea or TM bulging, or is strongly suspected based on significantly reduced/absent eardrum mobility; (1) Unexpectedly developing ear pain or, in preverbal kids, symptoms such gripping, pulling, or grasping the ear, with or without fever; and (2) signs of tympanic membrane oedema, including serious redness and discoloration of the auditory [18,19, 20]. Both ear-specific symptoms and systemic indicators are not sensitive enough or specific enough to diagnose AOM. Ostalgia may not exist in 50% of infants under two and 35% of older children [21]. Parents could misinterpret what their baby is doing [22]. The usual method for evaluating TM inflammation, swelling, or perforation is to utilize a traditional way to check the ear diaphragm with the help of an otoscope, Consequently, this ocular device cannot assess eardrum movement or determine the origin of acute otitis media because it can only offer a two-dimensional view of the ear canal [23]. Other diagnostic techniques including the measurement of the tympanic membrane, photo-microscopy, and pneumatic otoscopy were used less often [24]. The benchmark technique was judged to be pneumatic otoscopy [25].

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Treatment of Otitis Media Septicity

The inner ear cavity and auditory canals were frequently used for local injections of dexamethasone solution. Cytokines that promote inflammation include interleukins-1-β and tumour necrosis-α which dexamethasone inhibits to provide anti-inflammatory, anti-exudative, and anti-allergic actions [26]. Pneumo-massaging the tympanic membranes and using decongestants, very effective COX inhibitors, and antihistamines to blow the auditory canals without causing inflamed changes in the cavities of the nose and nasopharynx [27]. Since they reduce the oedema of the mucus in the inner ear membrane brought on by vasoconstriction, antagonists of α1-(phenylephrine) or α2-(indanazolamine, xylometazoline, naphazoline, oxymetazoline, tetrazolinone) -adrenergic receptors are used as decongestants. Other writers, however, call attention to adverse effects that can worsen the development of ESP, such as mucous membrane dryness caused by decongestant treatment [28,29]. Amoxicillin/clavulanate (Augmentin) should be the first line of treatment for a kid who has swollen conjunctivitis or who has taken amoxicillin for acute otitis media infection within the last 30 days. For isolated cases of AOM, a single injectable injection of ceftriaxone works equitably as amoxicillin. However, since there are few options available in the case that treatment is ineffective, ceftriaxone shouldn't be used as a first-line treatment [30].

About *Abelmoschus esculentus*

Okra is among the most popular delicious veggies found in the Arab, North America, West Africa, and South Asia. Moreover, it has some new well-known names, such as Bamya in Iraq, and Father of Musk in some Arabic countries [31]. The gel-like substance of okra, an edible veggie vital for human wellness, is being explored as an eventual compostable food container [34] and also used in industry to reduce cloudiness from wastewater [32, 33], Okra fruits are highly hygroscopic, are rich in nutrients, and are a great source of vitamins and minerals. The majority of okra's carbohydrates are contained in its mucilage, which has several industrial and therapeutic uses. Okra's fruits, seeds, and leaves are useful because of their composition and characteristics. Numerous research have questioned the rheological characteristics and bioactive potential of okra mucilage; the results of these investigations are currently included in literature surveys [35–37]. A detailed summary of plant taxonomy is shown in Table 2 below [38].

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Table 2 The Botanical Description of Plant		
S.no	**Scientific Class**	**Name**
1.	Biological Name	Hibiscus esculentus, Abelmoschus esculentus [38]
2.	Kingdom	Plantae
3.	Division	Magnoliophyta
4.	Class	Magnoliopsida
5.	Order	Malvales
6.	Genus	*Abelmoschus* [39]
7.	Species	*A.Esculentus* [60]
8.	Binomial Name	*Abelmoschus Esculentus*
9.	Family	Malvaceae [61]

Physical Characteristics of*, Abelmoschus esculentus.*

This herb grows to a maximum height of two meters each year. The leaves are around 10 to 20 cm long, broad, and rough, with five to seven lobes on a palmate lobed leaf form. This plant produces solitary, axillary blooms that are 4–8 cm in diameter and have five white–yellow petals with a reddish-purple spot at the base of each petal [42].

***Abelmoschus esculentus* Biochemistry**

The biochemistry of *Abelmoschus esculentus* includes Water (88.6 grams), energy (144.00 kJ, 36 kcal), protein (2.10 grams), carbohydrate (8.20 grams), fat (0.20 grams), fibre (1.70 grams), calcium (84.00 mg), potassium[K] (90.00 mg), iron (1.20 mg), Vitamin A (185.00 µg), Vitamin B2 (0.08 mg), Vitamin B1 (0.04 mg), Vitamin B3 (0.60 mg), and Vitamin C (47.0 mg) are all present in 100 grams of the edible portion of okra pods. Okra is rich in vitamin C, protein, and carbs [43]. The following nutrients are present in 100 g of edible okra leaves: This meal contains the following ingredients: 81.50 grams of water, 4.40 grams of protein, 0.60 grams of fat, 11.30 grams of carbs, 2.10 grams of fibre, 532.00 mg of calcium, 70.00 mg of phosphorus, 0.70 grams of iron, 59.00 mg of ascorbic acid, 385.00 grams of beta-carotene, and 0.25 mg of thiamine [44]. It has been determined and studied whether quercetin has antidiabetic potential [45]. Table 3 depicts the different extract's composition of nutrients as follows.

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Table 3 Chemical Composition of Okra			
S.no	**Nutrients**	**Okra Pods**	**Okra Leaves**
1.	Water	88.6gm	81.50gm
2.	Proteins	2.10gm	4.40gm
3.	Carbohydrates	8.20gm	11.30gm
4.	Fats	0.60gm	0.20gm
5.	Fiber	1.70gm	2.10gm
6.	Calcium	84mg	532mg
7.	Potassium	90mg	-
8.	Phosphorus	-	70mg
9.	Iron	1.20mg	0.70gm
10.	Vitamin A	185microgram	385gm
11.	Vitamin B2	0.08mg	-
12.	Vitamin B1	0.04mg	0.25mg
13	Vitamin B3	0.0mg	-
14.	Vitamin C	47mg	59mg

Other names of *Abelmoschus esculentus*

Below table 4 gives the other name of *Abelmoschus esculentus* in detail are as follows.

Table 4. Other name of *Abelmoschus esculentus*		
S.no	Category	Others Name
1.	Scientific Epithet	*Hibiscus Esculentus* [46]
2.	Common Name	Lady Finger, [1], Green Ginseng, And Plant Viagra [47]
3.	Particular Name	Okra
4.	Name In Sanskrit	Tindisha, Pitali
5.	Name In Hindi	Bhindi
6.	English Name	Edible Hibiscus, Ockro
7.	Italian, French	Gombo

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Therapeutics Activity of *Abelmoschus esculentus*

Anti-bacterial Activity of *Abelmoschus esculentus*

Evaluated the antibacterial properties of A. esculentus pulp aqueous extract gold nanoparticles (Au NPs) by employing the agar diffusion method. The Au NPs solution (0.2 mg mL−1) showed exceptional antibacterial activity against the five studied bacterial strains: Bacillus subtilis, Bacillus cereus, Micrococcus luteus, Pseudomonas aeruginosa, and Escherichia coli, with inhibition zones of 26, 24, 35, 21, and 15 mm, respectively [48].

In the study, a variety of pathogens, including Gram-positive ones like *Bacillus subtilis*, *Staphylococcus aureus*, and *Streptococcus pyogenes*, as well as Gram-negative ones like *Klebsiella pneumoniae*, *Escherichia coli*, Pseudomonas aeruginosa, *Proteus vulgaris*, *Salmonella typhimurium*, and *Shigella sonnei*, were assessed for the antibacterial properties of Ag NPs derived from *A. esculentus*. The antibacterial activity against the selected bacterial strains was investigated using the agar well diffusion method. Testing the Ag NPs solution against every known Gram-positive and Gram-negative microbial pathogen revealed antibacterial properties. Conversely, Gram-negative bacteria demonstrated a higher degree of growth inhibition than Gram-positive bacteria. *P. vulgaris* (16 ± 1.0 mm) was the most suppressed bacteria at a 100 µl dose, followed by *K. pneumoniae* (14 ± 0.5 mm) and *S. sonnei* (14 ± 0.7 mm) [49]. In contrast, A. esculentus showed effectiveness against S. aureus, *Mycobacterium sp.*, *M. aurum*, X. Py2, and P. aeruginosa at low extract concentrations when both peeled and unpeeled were used. The range of MICs observed in these cases was 6.25 to 12.5% (v/v), or 6.4 to 12.8 mg/ml. It has been discovered that the MIC values of other plant extracts are comparable [50]. For cells that were at rest, the effects of the okra gum were evaluated 30 minutes after the extract was exposed. All studied bacterial strains were inhibited by the gum in terms of cell viability, except *R. erythropolis cells*. At the same concentration, the fresh extract performed better overall than the lyophilized okra extract. Additionally, because of the latter's poor solubility, dosages higher than 9.5 mg/mL could not be examined. Comparing the data obtained at fresh extract concentrations of 4.9 and 97.7 mg/mL, the results indicated that the loss in cell viability ranged from 34.7 to 46.8%. Furthermore, the growth of S. aureus and P. aeruginosa was completely inhibited by an okra extract concentration of 97.7 mg/ml. People with cystic fibrosis have been known to die from lung infections caused by *P. aeruginosa*, whereas *S.aureus* is the main cause of nosocomial infections worldwide. Meningitis, pneumonia, and skin infections are only a few of the illnesses that *S. aureus* can cause [51].

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The disc diffusion technique was used to screen for antibacterial activity. An in vitro antibacterial activity screen was performed using Muller Hinton Agar (MHA). The zone of inhibition for the test sample against *Salmonella typhi*, *Escherichia coli*, *Enterococcus faecalis*, and *Bacillus cereus* was as follows when compared to the standard drug chloramphenicol: 0 mm, 0 mm, 0 mm, and 0 mm for 20 mg/ml; 0 mm, 7 mm, 0 mm, and 9 mm for 30 mg/ml; 18 mm, 18 mm, 17 mm, and 17 mm for 40 mg/ml; 24 mm, 25 mm, 24 mm, and 26 mm for 50 mg/ml [52].

Lyophilized and freshwater extracts of the pods were found to inhibit the growth of *R. erythropolis*, *R. opacus*, *Mycobacterium sp.*, *Mycobacterium aurum*, *Staphylococcus aureus*, *Escherichia coli*, *Xanthobacter Py2*, and *Pseudomonas aeruginosa* (minimum inhibitory concentration: 12.5–80% v/v). Stearic, palmitic, and lipid fraction acids were believed to be accountable. In a recent research, gold nanoparticles made using pulp extract (10–500 µl) showed significant antibacterial activity against Escherichia coli, Bacillus subtilis, Bacillus aeruginosa, and Pseudomonas aeruginosa [53].

Gram-positive and gram-negative bacteria that are amenable to the disc diffusion method include *E. Coli* and Salmonella species. Ciprofloxacin was considered standard. The bacterial cultures were cultivated on an agar medium at 37°C. Each microbe was cultivated for six hours before being added to the muller-Hinton agar plates at a concentration of 106 cells/ml. Next, filter paper discs (6 mm in diameter) soaked with extract (100µg) were placed on the surface of each infected plate. The plates were incubated at 37 °C for 24 hours. The zone of inhibition was recognized by one. Abelmoschus Ezekiel After being extracted with water, the antibacterial activity of crushed okra seeds was assessed using the agar diffusion method [54]. *Xanthobacter Py2*, *Pseudomonas aeruginosa*, *Mycobacterium aurum*, *R. opacus*, and *R. erythropolis* have all been shown to be inhibited in their growth by the lipid content of lyophilized okra pod extracts, specifically the stearic and palmitic acids and their aqueous counterpart [55].

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Table 5. The list of Microorganism inhibited by *Abelmoschus esculentus*				
S.no	**Part of *Abelmoschus esculentus***	**Effective against Microorganism**	**Inhibitory Concentration**	**Zone of Inhibition**
1.	*Abelmoschus esculentus* pulp extract gold nanoparticles	*Bacillus.subtilis, Bacillus Cerus, Micrococcus luteus, Pseudomonas aeruginosa, Escherichia coli*	0.2 mg mL−1	26, 24, 35, 21, and 15 mm
2.	*Abelmoschus esculentus* peeled and unpeeled extract	*S.aureus, Mycobacterium sp, M.aurum, p.aeruginosa*	6.25%-12.5%(V/V), 6.4to 12.8 mg/ml	(*S.aureus*)294mm peeled, 297mm unpeeled, (*Mycobacterium. sp*) 200mm peeled, 198mm unpeeled, (*M.aurum*) peeled 343, unpeeled 347,(p.aeruginosa)peeled 357, unpeeled 352
3.	*Abelmoschus esculentus* extract	*S.aureus, P.aeruginosa*	97.7mg/ml	34.7-46.8mm
4.	*Abelmoschus esculentus* pod	*Rhodococcus. Erythropolis, Rhodococcus opacus, Mycobacterium aurum, Staphylococcus aureus, Escherichia coli,*	12.5– 80% v/v	12.6mm

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		Xanthobacter PY2, Pseudomonas aeruginosa		

Anti-Inflammatory Activity

Okra lectin at 0.01, 0.1, and 1 mg/kg (I.V. route) induced inflammation in mice (n = 6–10) [56]. An investigation conducted recently revealed that the okra ethanol extract (500, 250, or 100 mg/kg [p.o.]) decreased the Oedema response (scores) in Wistar rats (n = 7) that had acute stomach mucosal damage due to ethanol [57]. Flavonoids found in OPs have anti-inflammatory properties through their inhibition of arachidonic acid metabolism-related enzymes including lipoxygenase and cyclooxygenase [58].

Anti-Fungal Activity

20gm of potato, 20gm of dextrose, and 5ml of a concentrated plant extract (10% solution) were added to each petri dish, mixed, and allowed to solidify. To introduce the fungus into the Petri plate, use a cork borer to cut a 4 mm-diameter disc from a pure culture of *F. oxy-sporum*, falciparum, grown on potato dextrose agar. This was carried out with every extract as well as two controls: one included no plant extracts at all, and the other contained 5ml of Benzoyl mixed with PDA. The cultures were injected for nine days at 27ºC in an inoculation chamber. The inhibition's growth percentage was calculated [59].

Anti-Diabetic Activity

Numerous Research has demonstrated the effects that prevent diabetes of *A. esculentus* via a range of mechanisms, including inhibiting DPP-4 activity, downregulating pancreatic PPARs, reducing the expression of tumour Necrosis Factor and liver Insulin Degrading enzymes, lowering intestinal tract glucose absorption, and inhibiting α-glucosidase and α-amylase enzymes, in a different study, rats given a high-fat diet (HFD) for 30 days along with an injection of 35 mg/kg of streptozotocin (STZ) developed diabetes because okra powder alters the pancreatic islets and can change the expression of the PPAR-γ and PPAR-α genes in these rats' pancreas. Following a 30-day induction period, the rats' high levels of TG, TC, and FBS were greatly lowered, and the HOMA-IR index showed a modest drop. This was achieved using oral okra powder (200 mg/kg). Additionally, it decreased the increased expression of the PPAR-α and PPAR-γ genes in diabetic rats. The nucleus contains receptors known as PPAR-γ and PPAR-γ responsible for maintaining pancreatic glucose homeostasis [60].

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Hypolipidemic Activity

When examining the low-cholesterolemia impact of A. esculentus extracts on hyperlipidaemic mice, simvastatin was utilized as the reference medication. Triglyceride and cholesterol levels in hyper-glycaemic rats dropped following a 24-hour dosage of dichloromethane and methanol extracts. A second research assessed the effects of okra mucilage water fractionation and water extract on fatty parameters in rodents given a high-fat diet. The extract and fraction reduced the Whole levels of cholesterol, triglycerides, LDL as well as VLDL, furthermore, mucilage increased the HDL levels in examined groups [61].

Antioxidant Activity

Okra fruit pods are very effective antioxidants, particularly the pectic polysaccharide portion. It can efficiently trap free radicals, preventing reactive oxygen species (ROS) from damaging cells. Additionally, by raising superoxide dismutase (SOD) levels, these polysaccharides can support the antioxidant process. Because OPs inhibit lipid peroxidation events, they can help prevent beta cell death [62,63].

Anti-Cancer Activity

The anticancer efficacy of OPs is intimately associated with its immunomodulatory action. OPs have anticancer qualities by either directly destroying tumour cells or by controlling the immune system to limit the development of tumours [64]. Increased spleen index, phagocytic activity, and splenocyte proliferation were seen in treatment groups receiving high doses of OPs, suggesting that OPs may stimulate the immunological response of certain immune components [65].

Flowability of Okra Polysaccharides

Their rheological traits significantly impact removing polysaccharides, their physical properties, molecular structure, and the production of new products during processing. OPs often exhibit shear-thinning propensity and viscoelastic properties. Pseudoplastic behaviours were indicated by Water-extractable substances' elastic properties OPs, which were influenced considerably by their concentrations [66,67,68]. There were three types of okra extract rheological traits were examined in distinct research in concentrated and diluted regimes, biopolymers were taken out by using different procedures. The fine structure of the chains and variations in the molecular weights of the samples were demonstrated to be responsible for the changes in rheological behaviour [69]. At different concentrations, POP's apparent viscosity grew as the concentration did, but it decreased as the shear rate increased. The POP behaved like a typical pseudoplastic fluid in terms of shear-thinning [70].

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Extraction of *Abelmoschus esculentus gum*

Okra Gum Extracted by Microwaves and Ultrasonic Techniques

OFG (okra fruit gum) was taken out and examined using microwaves and ultrasonic methods. In summary, A 2% v/v glacial acetic acid solution, 40 minutes of extraction time, 60 watts of ultrasonic power, and a water-to-raw material ratio of 44.98 ml/g were used to extract gum from a paste of cleansed and split A. esculentus fruits. The ultrasonic pre-treated mixture was microwaved at 600 watts for five minutes. The slurry was soaked on muslin fabric to remove the fibres. An excessive amount of acetone precipitated the gum. The precipitated gum was dried in a hot air oven at 55°C. Through lyophilization, OFG powder was produced after the use of the dialysis (10 kDa) technique [71].

Extracted by Ultrasonic Device

An ultrasonic instrument was utilized to extract Okra Fruit Gum (OFG) [72]. Slicing and washing fruits in 2% v/v glacial acetic acid solution formed a slurry. The gum was extracted using a 1000 ml beaker, by applying 65 watts of ultrasonic power, a 1:1 water to raw material ratio, and 45 minutes of extraction time at 65°C. After extraction, muslin cloth was used to filter the slurry and remove any remaining particles. Acetone was employed insufficiently to cause the gum to precipitate. At 50°C, the precipitates were finally dried in a vacuum oven. The OFG sample underwent dialysis to purify it further. Sophisticated lyophilized gum is used to make OFG gum powder. Weighing each OFG sample allowed us to calculate its yield [73]. As previously stated, An ultrasonic wave of radiation extractor was utilized to extract the easily soluble in water polysaccharide [74]. To get rid of colour and low-molecular components, fifty grams of powdered dried okra leaf were briefly spent an hour at 70°C immersed in 85% ethanol (1:10 w/v). The alcohol-insoluble residue was collected and dried at 50 °C for an hour after vacuum filtration. Following a 20-minute mechanical shake period and mixing with pH 6.0 distilled water, the dry residue was ultrasonically extracted for 30 minutes at 40°C (100 kHz, 600 W). By a Centrifugation method, gel-like substance mucilage is obtained in concentration 8000g in 30min. Three liters of 95% ethanol were then used to precipitate the liquid extract (mucilage) overnight at 4 ◦C. Following collection, dialyzing (3.5 kDa, 24 hours), freezing overnight (-80 0C), and three days of freeze-drying was done with the precipitated fraction (floats) above the ethanol. A tiny bit of drained gum was crushed and passed (to a size of 150 μm) to get natural okra leaf polysaccharide (OLP), which was the term used throughout this work. After three successive separations of the polysaccharide, The mean percentage ratio of dried polysaccharide powder (g) to the powdered okra leaf utilized was used to determine the extraction yield [75].

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After chopping and deseeding the okra pods, they were allowed to soak in water at room temperature. After 12 hours, the liquid portion, or filtrate, was separated from the solid material using a cloth made from muslin. Three times the amount of ethanol was added to the filter. When the liquid was gently stirred by hand, the mucilage entirely precipitated. The mucilage was then allowed to ventilate in a furnace set to 30 °C for around 12 hours. The next stage was sifting once the drained mucilage powder had been evenly crushed in a grinder. Until additional analysis, the milled polymer was stored in polyethylene pouch bags in the darkness [76,77]. In a mortar, freshly mashed A. esculentus (L.) was first chopped. A 250ml beaker was filled with five grams of A. esculentus paste and 100ml of 70% ethanol. This mixture was brought to a boil in the microwave for one minute [78]. This process was kept up until the ethanol started to turn green. The filter paper was used to filter the mixture. It was then centrifuged at 7000 revolutions per minute. For future research, the end-product plant extract was kept at +4 °C [79].

Physical Chemical Properties of *Abelmoschus esculentus* gum

Molecular mass

The polysaccharide component of okra mucilage has molecular weights ranging from 2.76 3 103 to 4.20 3 103 kDa, whereas another part has molecular weights ranging from 0.11 3 103 to 0.9 3 103 kDa [80]. Typically, lower molecular weight polysaccharides and higher molecular weight polysaccharides are less active because the latter are more difficult to get through cell membranes [81].

Hygroscopic Nature

Okra gum's moisture content is around 14.83%, indicating the presence of moisture in the gum's bound form [82]. The ability of the polymer locations of adsorption to form hydrogen bonds with water is the cause of this. Massive interparticle attraction develops between the interacting molecules as a result of the water sorption interaction nearby. The bonded moisture may create a moisture layer on the particles when pressure is applied, which may affect the tablets' compressibility [83].

The thickness of an *Abelmoschus esculentus* gum

Okra gum's component acidic polysaccharides give it a thick, slimy texture. When these polysaccharides are extracted with water, a very viscous solution is produced [84,85,70]. It has been shown that adding water-soluble tends to make okra mucilage less viscous, whereas adding maltodextrins might make it more viscous [86]. Okra gum's primary polysaccharide, pectin, is recognized for giving the gum its sticky consistency [68].

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Properties of coatings and swell

At concentrations of around 1%–1.5% (w/v), OPs have strong film-forming qualities when paired with plasticizers. When mucilage is dried in an oven as opposed to a lyophilization process, there is more swelling (B20%). Also, the medication releases more slowly and gradually when the mucin is oven-dried [87-88]. These films can be used as a hydrophilic matrix for the gradual release of bioactive compounds and show notable swelling [89].

Future Perspective

Abelmoschus esculentus offers an incredible opportunity to develop a formulation with antibacterial activity against Streptococcus pneumoniae and other pathogens to treat Otitis media infection and prevent adverse effects. There may also be an anti-inflammatory impact to treat inflammation. This means that there will be more chances to research Abelmoschus esculentus, including gum extraction.

Conclusion

A bacterial infection or oedema of the middle portion of the ear, or otitis media typically comes on by bacteria or viruses such as Haemophilus influenzae, Moraxella catarrhalis, and Streptococcus pneumoniae. Children are more likely to be impacted than adults, while people of all ages can be. While there is a considerable chance that the herbal extract from Abelmoschus esculentus will not function as a cure for this condition, it is still possible.

Author Contribution

Under Naimish Nanda's instruction, Prince Kumar Jha is drafting the original content of this review paper. Dr. Sandip Prasad Tiwari provided the information for this journal idea, while Saurabh Sharma completed the official data analysis. Saloni Saw is the one who does the conceptualization.

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