

Formulation And Evaluation of Black Salt–Based Herbal Toothpaste Containing *Achyranthes Aspera* Extract

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ABSTRACT:

The present study focuses on the preparation, formulation, and evaluation of a herbal toothpaste incorporating traditionally prepared black salt and ethanolic extract of *Achyranthes aspera* L. Black salt was produced using indigenous earthen kiln methods involving white nugget salt and herbal additives subjected to high-temperature processing in sealed mud pots. The aerial parts of *Achyranthes aspera* were shade-dried, powdered, and extracted using Soxhlet extraction with ethanol. Three toothpaste formulations (F1, F2, and F3) were developed using varying excipient compositions. The prepared formulations were evaluated for physicochemical parameters including pH, spreadability, abrasiveness, foamability, viscosity, homogeneity, stability, moisture content, and tube extrudability. Mineral estimation of black salt showed sodium (33.29%), iron (0.0746%; 746 ppm), and magnesium (0.58%; 5798 ppm). UV–Visible and FTIR spectroscopic analyses confirmed the presence of phenolic compounds, carbonate, sulphate, and metal–oxygen functional groups. Antimicrobial activity demonstrated effectiveness against *Candida albicans*, *Staphylococcus aureus*, and *Escherichia coli*. Among the formulations, F3 exhibited superior foamability and spreadability, while F1 showed stronger antifungal activity. The study concludes that black salt combined with *Achyranthes aspera* extract can serve as a promising herbal dentifrice with antimicrobial and cleansing properties.

KEYWORDS:

Black salt, Herbal toothpaste, *Achyranthes aspera*, Soxhlet extraction, Mineral analysis, UV spectroscopy, FTIR analysis, Antimicrobial activity, Oral hygiene, Herbal formulation.

I. INTRODUCTION:

Toothpastes have been used since the ancient past. Are one of the main irreplaceable components of oral health care. The design of toothpaste formulations began in China and India, as of 300–500 BC. During that period, squashed bone, pulverized egg, and clam shells were utilized as abrasives as a part of tooth cleaning. Modern Toothpaste formulations were developed in the 19th century. Later on, chalk and soap were incorporated to those formulations. After 1945, several formulations Advancements in different detergents had begun; sodium lauryl sulfate had been used as an emulsifying agent. In recent years, the focus has shifted towards the release of active ingredients during formulation_development to prevent and/or treat oral illness Toothpaste is a dentifrice used to clean, maintain and improve the health of teeth. Toothpaste is mainly used to promote oral cleanliness and also acts as an abrasive that helps to prevent dental plaque and food particles from the teeth, aiding in the removing and/or veiling of halitosis, and releases active ingredients such as fluoride to aid in preventing tooth and gum disease. Toothpastes are complex mixtures of abrasives and surfactants; anti-caries, such as fluoride; and tartar. control ingredients; pH buffers; humectants (to prevent dry-out and increase the pleasant mouth feel); binders (to provide consistency and shape).

II. PLANT PROFILE:

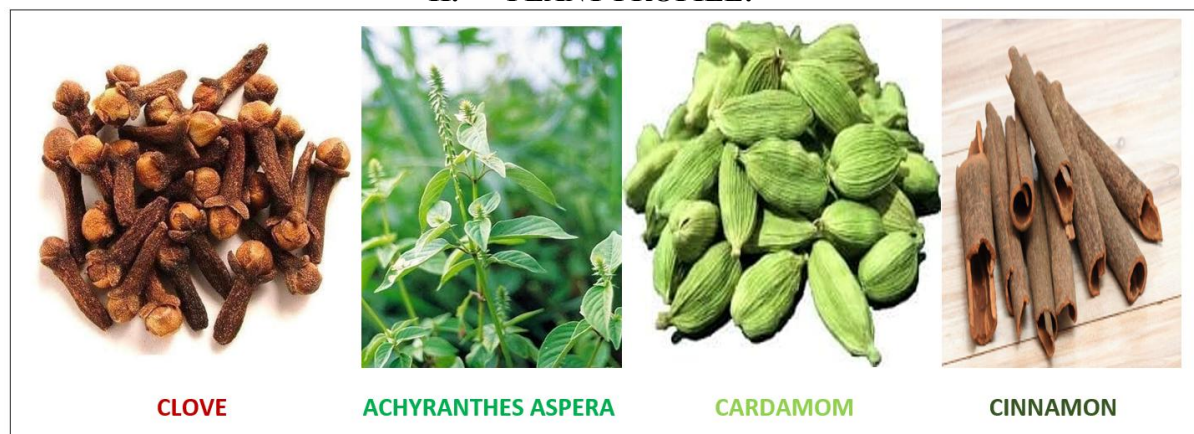


Fig: 1 Plant Image

2.1 SYZYGIIUM AROMATICUM:

- **Kingdom:** Plantae
- **Order:** Myrtales
- **Family:** Myrtaceae
- **Genus:** Syzygium
- **Species:** Aromaticum (L.)
- **Class:** Magnoliopsida

- **Subclass:** Rosidae
- **Division:** Magnoliopsida
- **Sub division:** Spermatophyta
- **Synonym:** Clove

2.2 ELETARIA CARDAMOMUM:

- **Kingdom:** Plantae
- **Order:** Zingiberates
- **Family:** Zingiberaceae
- **Genus:** Eletaria
- **Species:** Ellettaria cardamomum
- **Class:** Megnoliopsida
- **Division:** Tracheophyta
- **Synonym:** Cardamom, green cardamom, ceylon cardamom

2.3 ACHYRANTHES ASPERA:

- **Kingdom:** Plantae
- **Subkingdom:** Trachiobinota
- **Family:** Amarathaceae
- **Order:** Caryophyllales
- **Class:** Mangoliopsida
- **Subclass:** Caryophyllidae
- **Genus:** Achyranthes
- **Species:** Aspera
- **Synonym:** Apamarga, Devil's horsewhip

2.4 CINNAMON:

- **Kingdom:** Plantae
- **Family:** Lauraceae
- **Order:** Laurales
- **Class:** Magnoliopsida
- **Genus:** Cinnamomum
- **Species:** Zeylanicum
- **Synonym:** Cinnamomum, cinnamomum zeylanicum

III. MATERIALS AND METHODS:

3.1 EQUIPMENTS & RAW MATERIALS FOR BLACK SALT PRODUCTION:

Earthen pot is the basic indigenous equipment required for black salt production; white nugget salt, Clove powder, cinnamon bark powder, and cardamom powder, all these ingredient should be mixed properly in a specified ratio. Horizontal kiln in the earth are used for black salt production .In horizontally kiln; there are several unite operations are involved for black salt manufacturing. These unit operations are listed below

1. Mud pots manufacturing unit
2. Preparation of kiln for specific size and capacity
3. Firing materials (Coal)
4. Mixing of salt and other ingredients
5. Heating of white nugget salt into mud pot at higher temperature
6. Breaking the fired black Salt pot and categorized the black salt accordingly
7. Black salt packaging and storage.

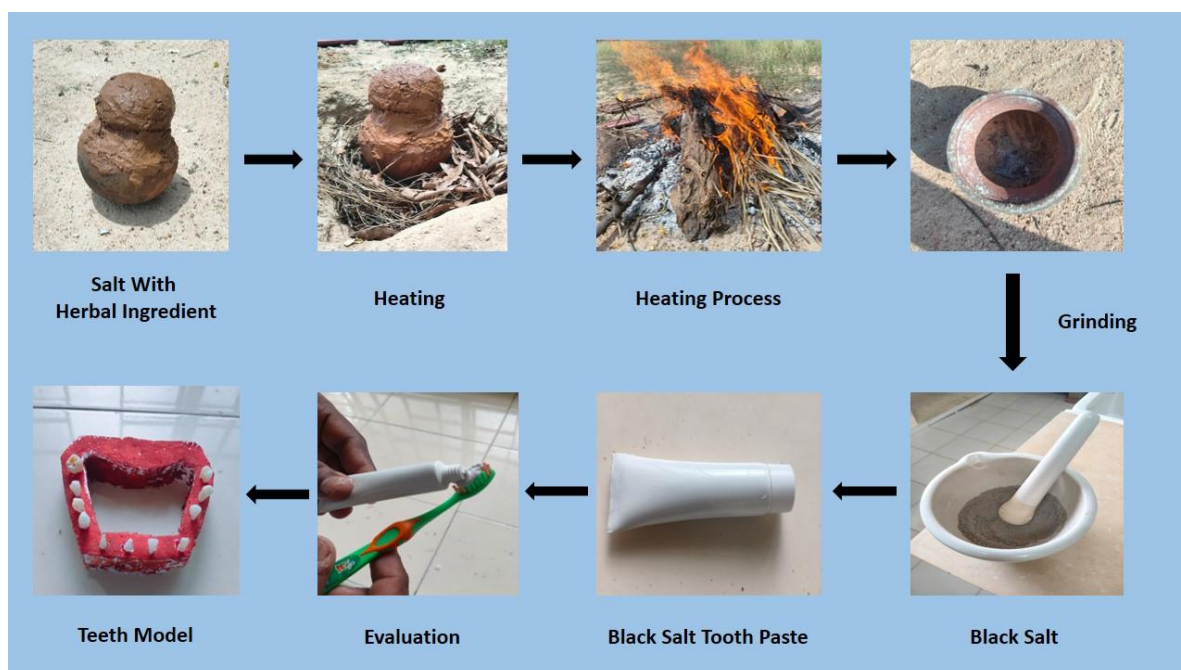


Fig: 2 Black Salt Preparation

3.2 PREPARATION OF EXTRACT:

The Freshly collected Aerial parts of *Achyranthes aspera* L are dried in shade. About 550 grams of dry powder obtained from *Achyranthes aspera* L Aerial parts are taken. The powdered Aerial parts are extracted with acetone to remove chlorophyll and

then continuous hot solvent extraction was done using a Soxhlet apparatus for 24 h at 50 °C using solvent: drug ratio of 10:1 (mL/g). The Ethanolic extract is concentrated by vacuum distillation, cooled and placed in desiccators to remove the excessive moisture.

3.3 FORMULATION OF TOOTH PASTE:

FORMULATION 1

S.NO	INGREDIENTS	QUANTITY
1	Extract	5ml
2	Black salt	5g
3	Carboxy methyl cellulose	3g
4	Calcium carbonate	20g
5	Glycerin	5ml
6	Methyl paraben	0.5g
7	Propyl paraben	0.25g
8	Sodium Lauryl Sulphate	1g
9	Mint oil	1ml
10	Demineralized water	30ml

Table: 1 Formulation - I

Procedure: Carboxymethyl cellulose was triturated with methyl paraben and propyl paraben by using mortar and pestle. Sodium Lauryl Sulphate was dissolved in 30 ml of demineralized water and added sufficiently along with 5ml of glycerin. The mixture

was triturated well. Finally, calcium carbonate and ethanolic extract of *Achyranthes aspera* have added to the mixture and triturated to form a paste. Lastly, few drops of mint oil were added to mask the taste.

FORMULATION 2

S.NO	INGREDIENTS	QUANTITY
1	Extract	5ml
2	Black salt	5g
3	Sodium Lauryl Sulphate	0.15g
4	Sodium benzoate	0.1g
5	Sodium saccharine	0.2g
6	Glycerin	40ml
7	Calcium carbonate	50g
8	Pepper mint oil	1ml
9	Distilled water	20ml

Table: 2 Formulation - II

Procedure: The solid ingredients calcium carbonate, sodium lauryl sulphate, glycerine, sodium benzoate, sodium saccharine, Black salt were weighed accurately as mentioned in the formula and sieved with sieve no.80 so as to maintain the particle size.

These ingredients were also mixed in a mortar and pestle, then triturated with precisely weighed glycerine until a semisolid substance was created. Addition of ethanolic extract of *Achyranthes aspera*. At the end, peppermint oil was added as a flavour

FORMULATION 3

S.NO	INGREDIENTS	QUANTITY
1	Extract	5ml
2	Black salt	5g
3	Gum Tragacanth	2g
4	Calcium carbonate	20g
5	Methyl paraben	0.5g
6	Sodium lauryl sulphate	2.5g
7	Titanium Dioxide	1g
8	Distilled water	25ml
9	Mint oil	2ml

Table: 3 Formulation – III

Procedure: The solid ingredients black salt, Gum tragacanth, calcium carbonate, Methyl paraben, sodium lauryl sulphate and Titanium dioxide were weighed accurately and Dissolved in 25ml of water along with 5ml ethanolic extract of *Achyranthes aspera*. These ingredients were triturated very well in the mortar and pestle until a semisolid homogeneous mixture was created. At the end mint oil was added as a flavour.

- Physical Examination (Colour, Odour, Taste, Smoothness, And Relative Density)
- Abrasiveness
- Spreadability
- pH Calculation
- Homogeneity
- Foaming
- Stability
- Moisture And Volatile Matter Determination
- Estimation Of Mineral Content
- UV-Visible Spectroscopic Analysis
- FTIR (Infrared) Spectroscopic Analysis

3.4 EVALUATION OF TOOTH PASTE:

- Chemical Test

IV. RESULTS AND DISCUSSION:

4.1 EVALUATION OF TOOTH PASTE:

S.NO	EVALUATION	F1	F2	F3
1	Color	White	White	White
2	Odor	Heavy Aromatic	Aromatic	Aromatic

3	Taste	Spicy, Bitter, and subtly sweet	Spicy and subtly sweet	Spicy and subtly sweet
4	Consistency	Good	Good	Good
5	Smoothness	Smooth	Smooth	Moderate Smooth
6	Abrasiveness	Good Abarasive	Good Abarasive	Good Abarasive
7	PH	7.4	7.6	7.2
8	Foamability	61 (100%)	66 (100%)	71 (100%)
9	Moisture Content	35 %	38 %	34 %
10	Spreadability	6 cm/sec	6.5 cm/sec	7 cm/sec
11	Homogeneity	Good	Good	Good
12	Stability	Stable	Stable	Stable
13	Finess	Fine	Fine	Fine
14	Viscosity (CPS)	38541.7cps	35854.5cps	39543.6cps
15	Tube excludability	Good	Good	Good

Table: 4 Evaluation Of Tooth Paste



Fig: 3 Toothpaste

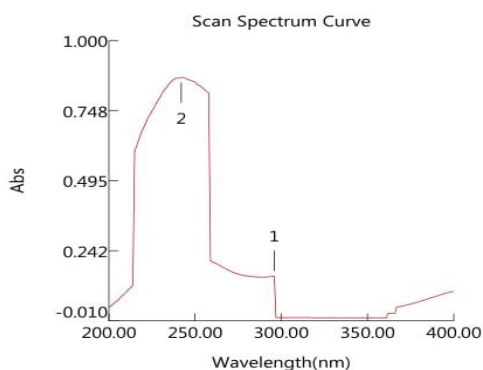


Fig: 4 Black Salt & Toothpaste



Fig: 5 Prepared Toothpaste

4.2 UV SPECTRUM ANALYSIS:

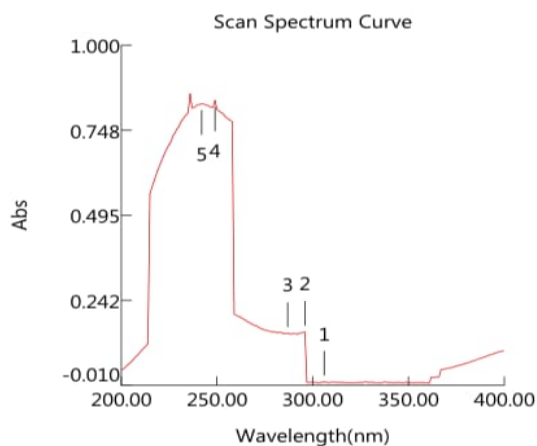


- **Instrument Performance**
 Model : TU-1810DASPC
 Number : 24-1885-01-0056
 Spectral Bandwidth : 2.00 nm
- **Scan Spectrum Performance**
 Scan Range : 200.00 to 400.00 nm
 Measure Mode : Abs
 Interval : 1.00 nm
 Speed : Medium
 Data File : formulation 1 wavelength.spd
 Create Date/Time : Friday, June 27, 2025 10:48:45 AM

Data Type : Original
 Method File:

- **Analyse Note**
 Analyser : Administrator

Fig: 6 UV Spectrum (Ethanolic Extract Of Achyranthes Aspera L)



- **Instrument Performance**
 Model : TU-1810DASPC
 Number : 24-1885-01-0056
 Spectral Bandwidth : 2.00 nm
- **Scan Spectrum Performance**
 Scan Range : 200.00 to 400.00 nm
 Measure Mode : Abs
 Interval : 1.00 nm
 Speed : Medium
 Data File : formulation 3 wavelength.spd
 Create Date/Time : Friday, June 27, 2025 10:59:08 AM

Data Type : Original
 Method File:

- **Analyse Note**
 Analyser : Administrator

Fig: 7 UV Spectrum (Black Salt)

4.3 FT-IR SPECTRUM ANALYSIS:

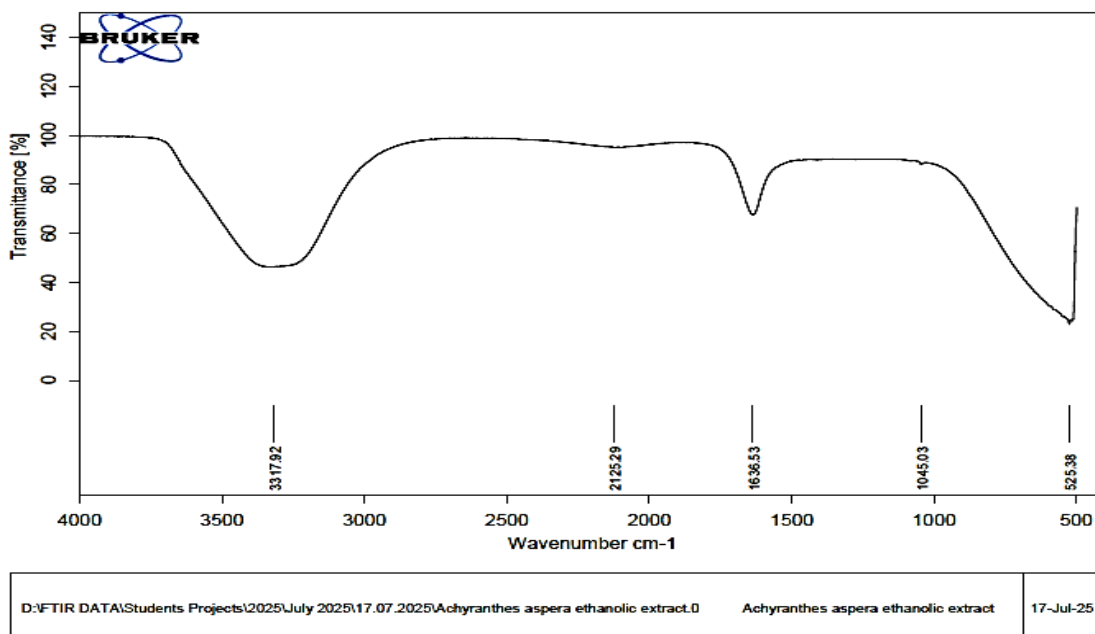


Fig: 11 FT-IR Spectrum (Ethanolic Extract Of Achyranthes Aspera L)

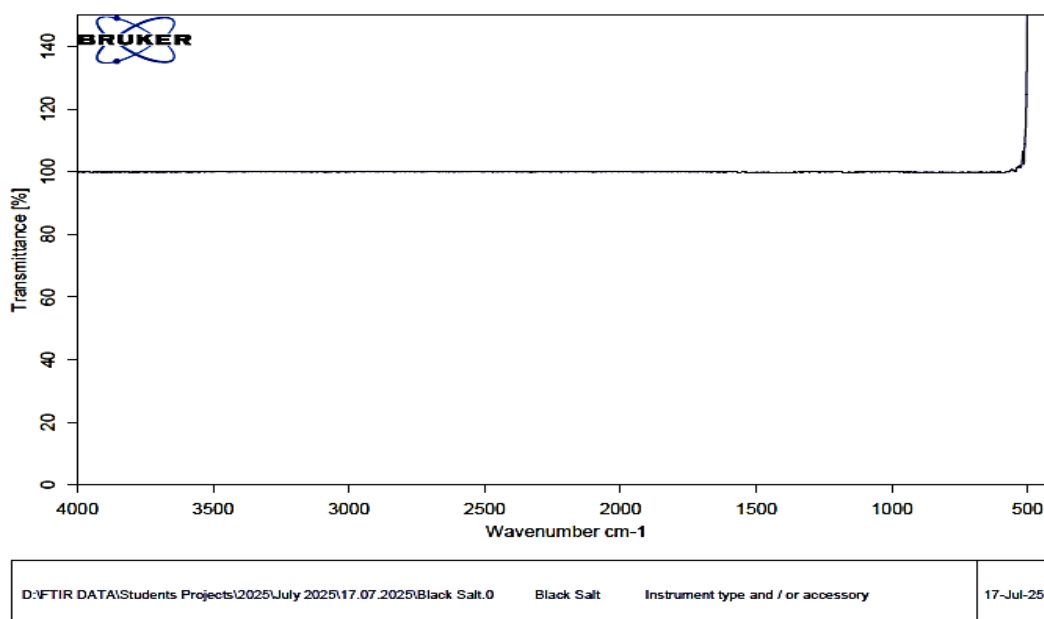
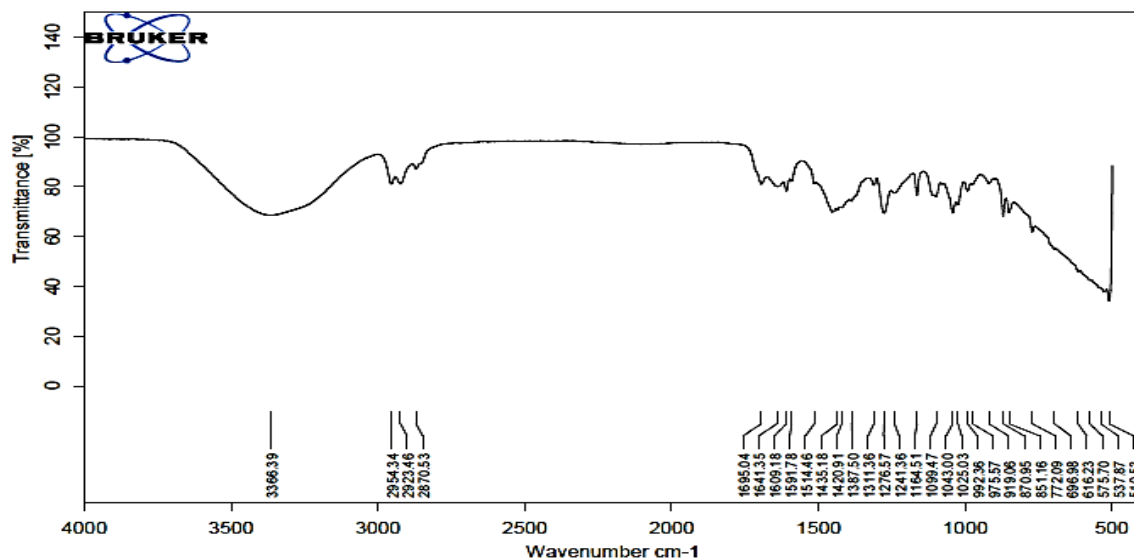
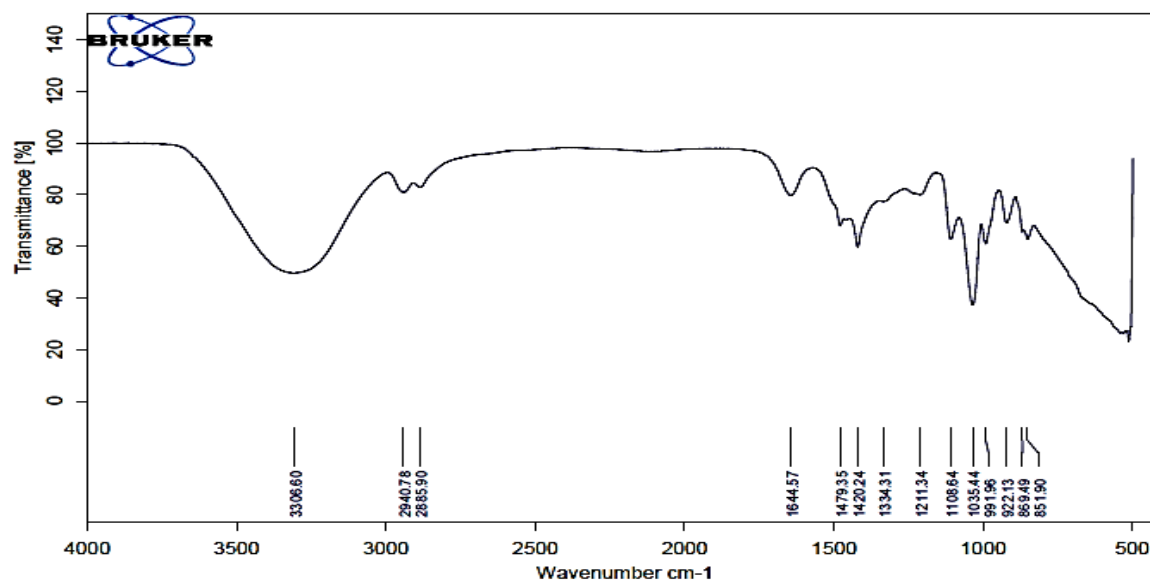


Fig: 12 FT-IR Spectrum (Black Salt)



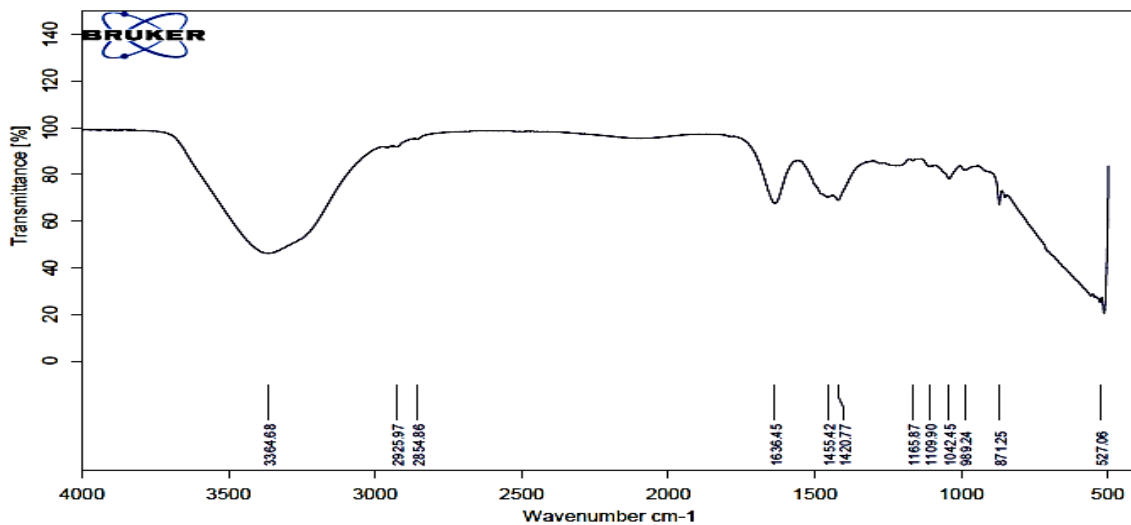
D:\FTIR DATA\Students Projects\2025\July 2025\17.07.2025\Ethanollic extract with blacksalt containing toothpaste-1.0	Ethanollic extract with b	17-Jul-25
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Fig: 13 FT-IR Spectrum (Formulation - I)



D:\FTIR DATA\Students Projects\2025\July 2025\17.07.2025\Ethanollic extract with blacksalt containing toothpaste-2.0	Ethanollic extract with b	17-Jul-25
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Fig: 14 FT-IR Spectrum (Formulation - II)



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Fig: 15 FT-IR Spectrum (Formulation - III)

4.4 ESTIMATION OF MINERAL ANALYSIS:

4.4.1 Estimation Of Sodium Content:

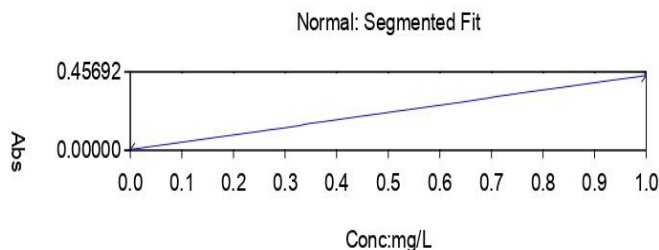
SOLAAR AA Report

Operator Name: PERSONAL
 Results File: C:\SOLAAR\MDATA\RESULTS.SLR

Report Date: 21-07-2025 12:40:17

Solution Results - Na

Min Curvature: 0%
 Max Curvature: 0%
 Characteristic Conc: 0.0101



Sample ID	Signal	Rsd	Conc	Corrected Conc
	Abs	%	mg/L	mg/L
Na Blank	0.000	>99	0.0000	
Na Standard 1	0.435	1.3	1.0000	
Na Black salt	0.365	0.5	0.8386	0.8386
Na BKT STD 1.0 ppm	0.446	1.8	1.0245 C	1.0245 C

CALCULATION SHEET FOR ASSAY

Name of the Product: Black salt Date: 09.07.2025

Ferrous ammonium
 Magnesium : Sodium chloride

22.99	58.44	99
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 %

STANDARD DILUTIONS: **Std Abs**

Sodium chloride

318.40	mg→	50
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 ml→

1

 mL→

50

 mL→

1

 mL→

50

 mL→

1

 mL→

1

0.435

SAMPLE DILUTIONS:

Sodium content in Black salt

312.55	mg→	50
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 ml→

1

 mL→

50

 mL→

1

 mL→

50

 mL→

1

 mL→

1

0.365

ASSAY:

S.No.	Std Abs	Sample Abs	Na content in %
1	0.435	0.365	33.291

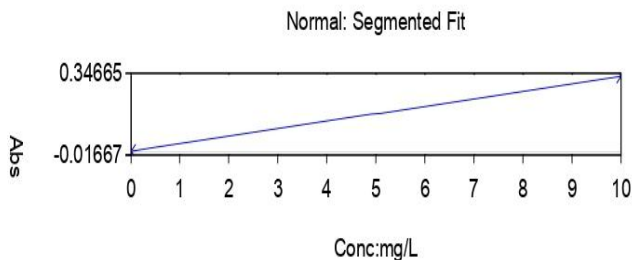
**4.4.2 Estimation Of Iron Content:
 SOLAAR AA Report**

Operator Name: PERSONAL
 Results File: C:\SOLAAR\DATA\RESULTS.SLR

Report Date: 21-07-2025 12:38:35

Solution Results - Fe

Min Curvature: 0%
 Max Curvature: 0%
 Characteristic Conc: 0.1332



Sample ID	Signal Abs	Rsd %	Conc mg/L	Corrected Conc mg/L
Fe Blank	-0.000	36.6	0.0000	
Fe Standard 1	0.330	2.0	10.0000	
Fe Black salt	0.247	0.5	7.4687	7.4687
Fe BKT STD 10.0 ppm	0.335	0.9	10.1341 C	10.1341 C

CALCULATION SHEET FOR ASSAY

Name of the Product: Black salt Date: 09.07.2025

Ferrous ammonium

Magnesium : Ferrous ammonium sulphate hexa hydrate 55.845 392.14 99 %

STANDARD DILUTIONS:

Ferrous ammonium sulphate hexa hydrate

709.87 mg → 100 ml → 2 ml → 200 ml → 1 ml → 1 ml → 1 ml → 1 ml → 0.330

Std Abs

SAMPLE DILUTIONS:

Iron content in Black salt

1004.24 mg → 100 ml → 1 ml → 1 ml → 1 ml → 1 ml → 1 ml → 1 ml → 0.247

ASSAY:

Iron content

S.No.	Std Abs	Sample Abs	Fe content in %	Fe content in ppm
1	0.330	0.247	0.0746	746

4.4.3 Estimation Of Magnesium Content: SOLAAR AA Report

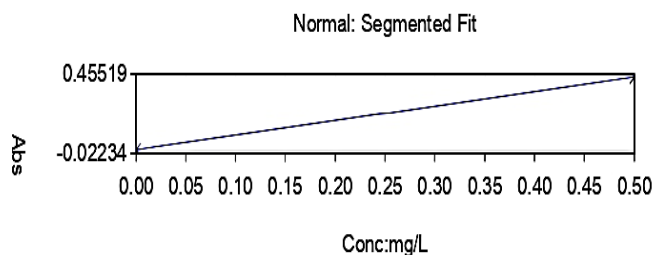
Operator Name: PERSONAL

Report Date: 21-07-2025 12:48:10

Results File: C:\SOLAAR\MDATA\RESULTS.SLR

Solution Results - Mg

Min Curvature: 0%
 Max Curvature: 0%
 Characteristic Conc: 0.0051



Sample ID	Signal Abs	Rsd %	Conc mg/L	Corrected Conc mg/L
Mg Blank	-0.001	22.4	0.0000	
Mg Standard 1	0.433	0.6	0.5000	
Mg Black salt	0.504	2.1	0.5808 C	0.5808 C
Mg BKT STD 0.5 ppm	0.431	1.0	0.4968	0.4968

CALCULATION SHEET FOR ASSAY

Name of the Product: Black salt Date: 09.07.2025

Ferrous ammonium

Magnesium : Magnesium sulphate hepta hydrate

24.301	246.48	99
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 %

STANDARD DILUTIONS:

Magnesium sulphate hepta hydrate

512.50	mg→	100	ml→	2	ml→	100	ml→	5	ml→	100	ml→	1	ml→	1
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0.433

Std Abs

SAMPLE DILUTIONS:

Magnesium content in Black salt

1004.24	mg→	100	ml→	1	ml→	100	ml→	1	ml→	1	ml→	1	ml→	1
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0.504

ASSAY:

Magnesium content

S.No.	Std Abs	Sample Abs	Mg content in %	Mg content in ppm
1	0.433	0.504	0.58	5798

4.5 TOOTH MODEL CLEANING TEST:



Before

After

Fig: 16 Tooth Model Cleaning Test

4.6 ANTI – MICROBIAL ACTIVITY:

S.NO	MICROORGANISAM	F1	F2	F3
1	C. albicans	+++	++	++
2	S. aureus	++	+	+
3	E. coli	+	+	+

Table: 5 Anti – Microbial Activity

- Highly active (+++):6-8mm
- Moderately active (++) :4-6mm
- Slightly active (+):3mm
- Inactive (-): less than 3mm

V. CONCLUSION:

The formulated black salt herbal toothpaste containing *Achyranthes aspera* extract demonstrated satisfactory physicochemical stability, appropriate pH, good spreadability, effective foaming, and promising antimicrobial activity. Mineral analysis confirmed significant sodium, magnesium, and iron content contributing to oral health benefits. Spectroscopic analysis validated the presence of active functional groups and mineral constituents. The study supports the potential development of black salt-based herbal dentifrice as a safe, economical, and effective alternative to synthetic toothpaste formulations.

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