

Climate Research for Development (CR4D) End of Grant Workshop

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Impact of weather variability on aeroallergens and allergic diseases; implication on public health in Nigeria and adaptation

Dr Dimphna N. Ezikanyi

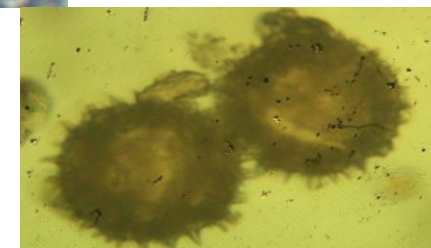
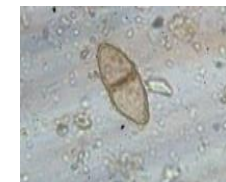
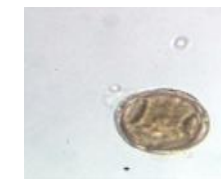
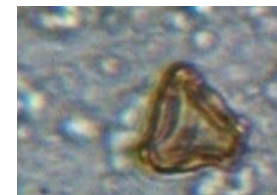
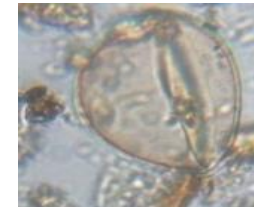
Ebonyi State University, Abakaliki, Nigeria

Lecturer

Introduction

Background of the study and Statement of the problem

- Aeroallergens are airborne organic entities majorly dispersed from plants and fungi.
- They are microscopic, ubiquitous and have high aerodynamism.
- They enter the interior through inhalation and deposition in nasal and bronchial airways.
- They are responsible for allergic diseases such as asthma, conjunctivitis, rhinitis/hay fever etc.
- Their spatial distribution and abundance are influenced by biological activities and weather.
- There is lack of information on impact of weather on seasonal variations of aeroallergens in Nigeria. Prevalence of asthma is higher in recent decade.



Aim and objectives of the study

The aim of the study was to ascertain the impact of weather variability on the spatial distribution of aeroallergens and allergic diseases with the view of formulating adaptive strategies.

OBJECTIVES;

1. To assess weather variability in coastal, equatorial and arid regions of Nigeria for the past three decades and current impact of weather variables on aeroallergens and allergic diseases.
2. To determine the spatial distribution of aeroallergens in coastal, equatorial and arid regions of Nigeria and use the data to produce aeroallergen calendar which will reveal their risk periods.
3. To evaluate the allergenic potential of aeroallergens, which will inform climate policy in selection of non allergenic plants in tree planting mitigation approach , in view of projected increase in Co₂ level.
4. To evaluate the prophylactic and curative potentials of a Fabaceae seed and *Euphorbia hirta* in attenuating or suppressing allergies.

Materials and Methods

- Secondary data on weather variability were obtained from Nigerian Meteorological Agency (NIMET)
- Secondary data on allergic diseases were obtained from hospital in the study locations
- Aeroallergens were recovered from the atmosphere using modified Tauber-like pollen traps. Samples were collected monthly across 14 studied locations.
- Allergenicity study followed the procedure of Barral *et al.*, 2006
- Experiment on prophylactic and curative potentials of Fabaceae plant and *Euphorbia hirta* were carried out using animal model (mice) following the procedure of Yang *et al.*, 2013



Plate 1: Modified Tauber pollen sampler



Results and Discussions

Meteorological data: Mean inter annual temperature(oC) in three decades

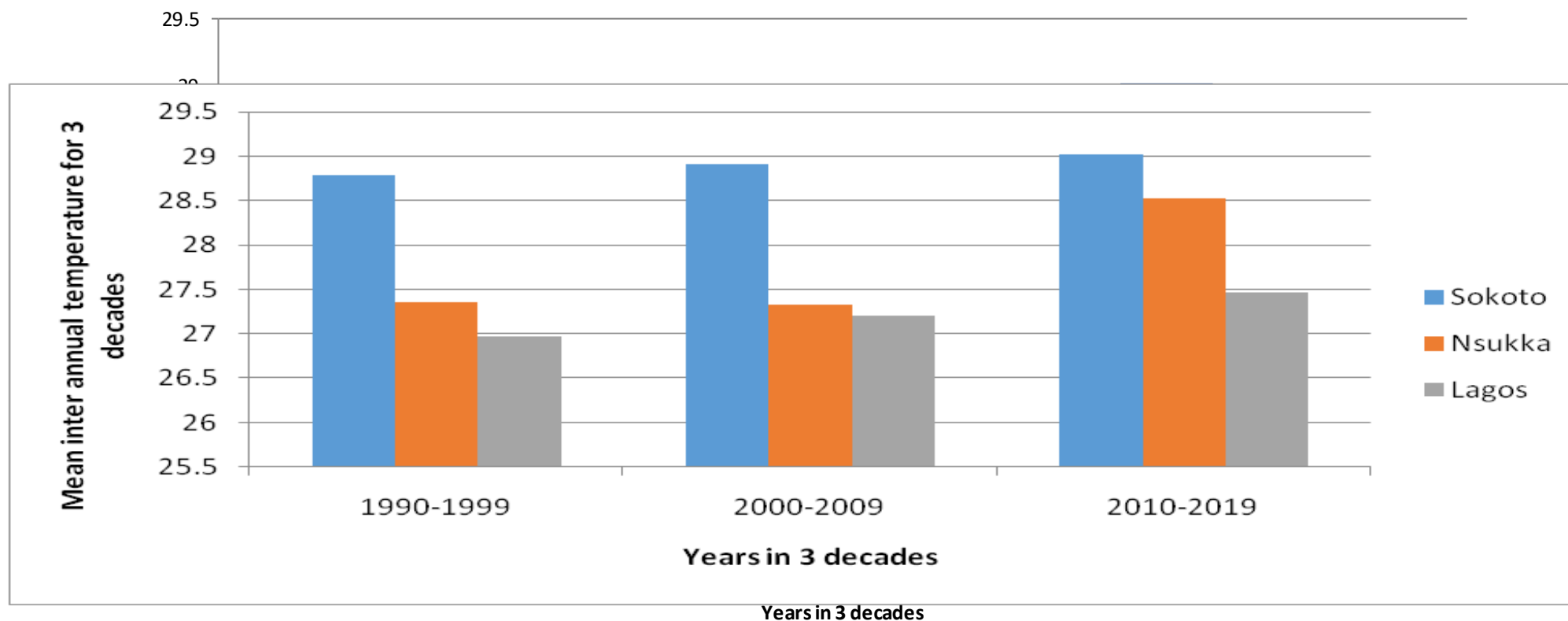


Fig 1: Mean inter annual temperature (oC)variations in 3 climate regions of Nigeria for three decades

Results and Discussions

Meteorological data: Mean inter annual rainfall (mm)

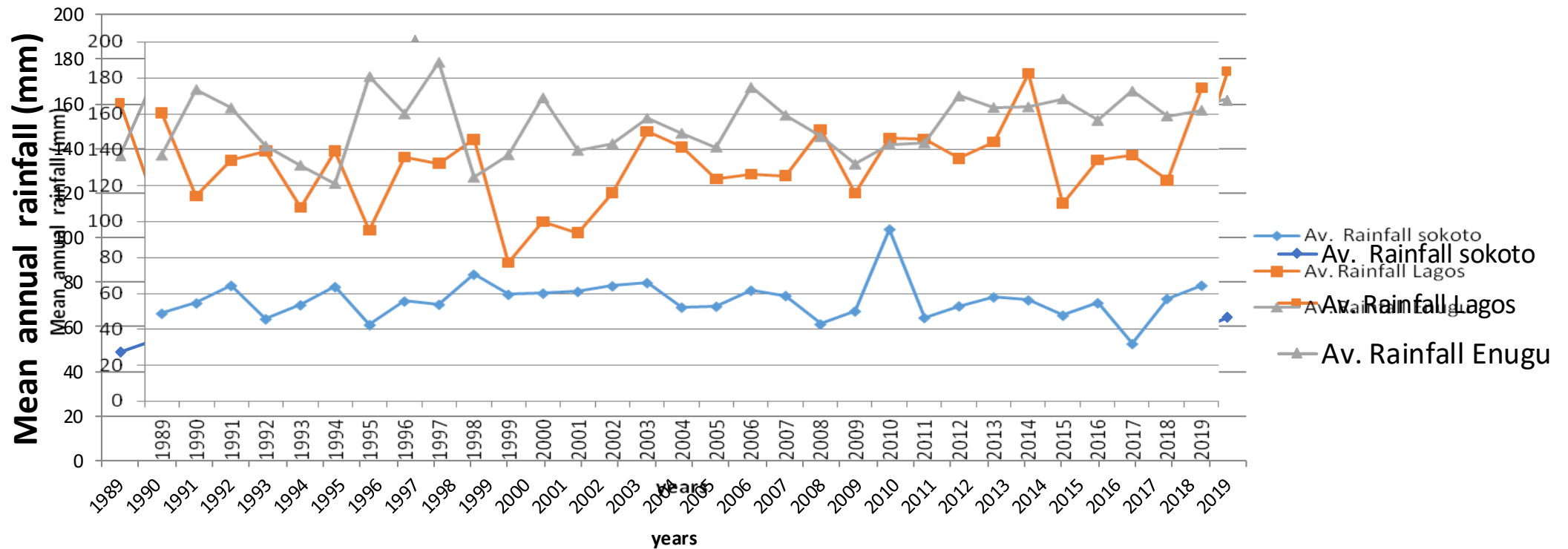


Fig . 2 : Rainfall variability in arid, coastal and equatorial of Nigeria regions for 30 years

Results and Discussions

Aeroallergens spatial distribution in arid (Sokoto) Nigeria

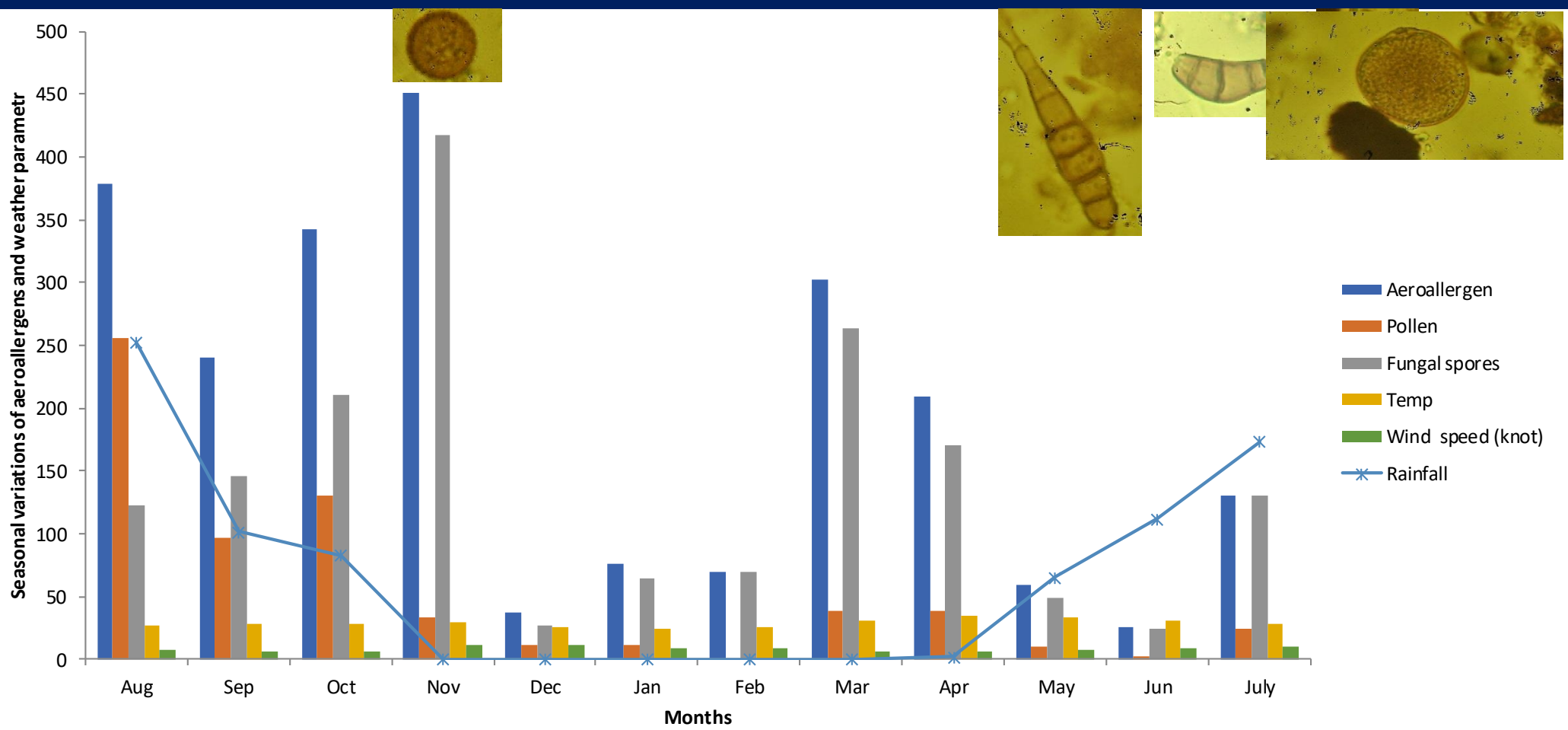


Fig 3: Seasonal variations of aeroallergens and weather parameter in arid region

Results and Discussions

Aeroallergens spatial distribution in equatorial (Enugu) Nigeria

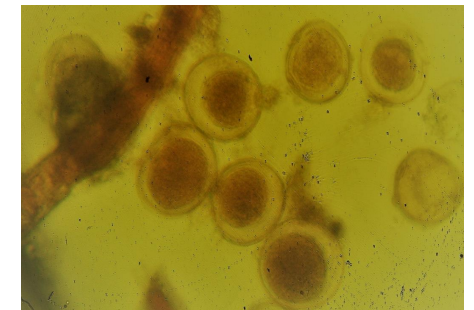
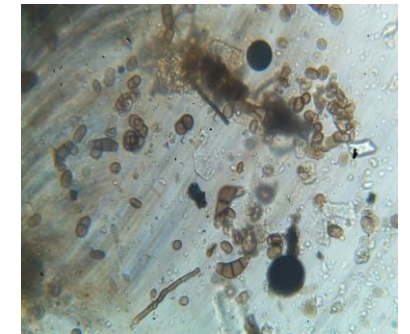
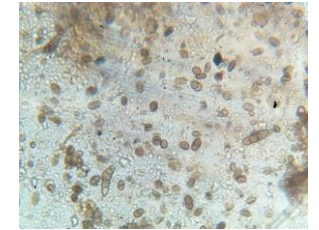
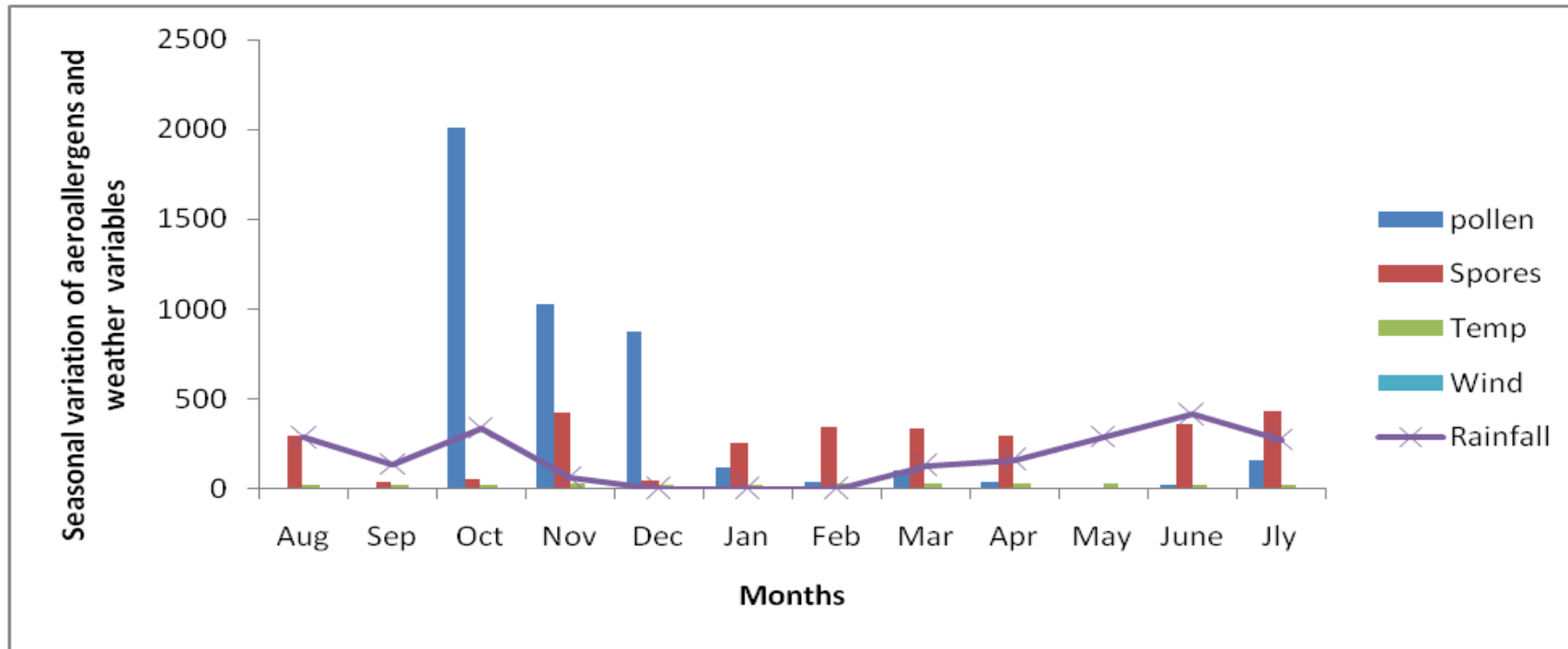
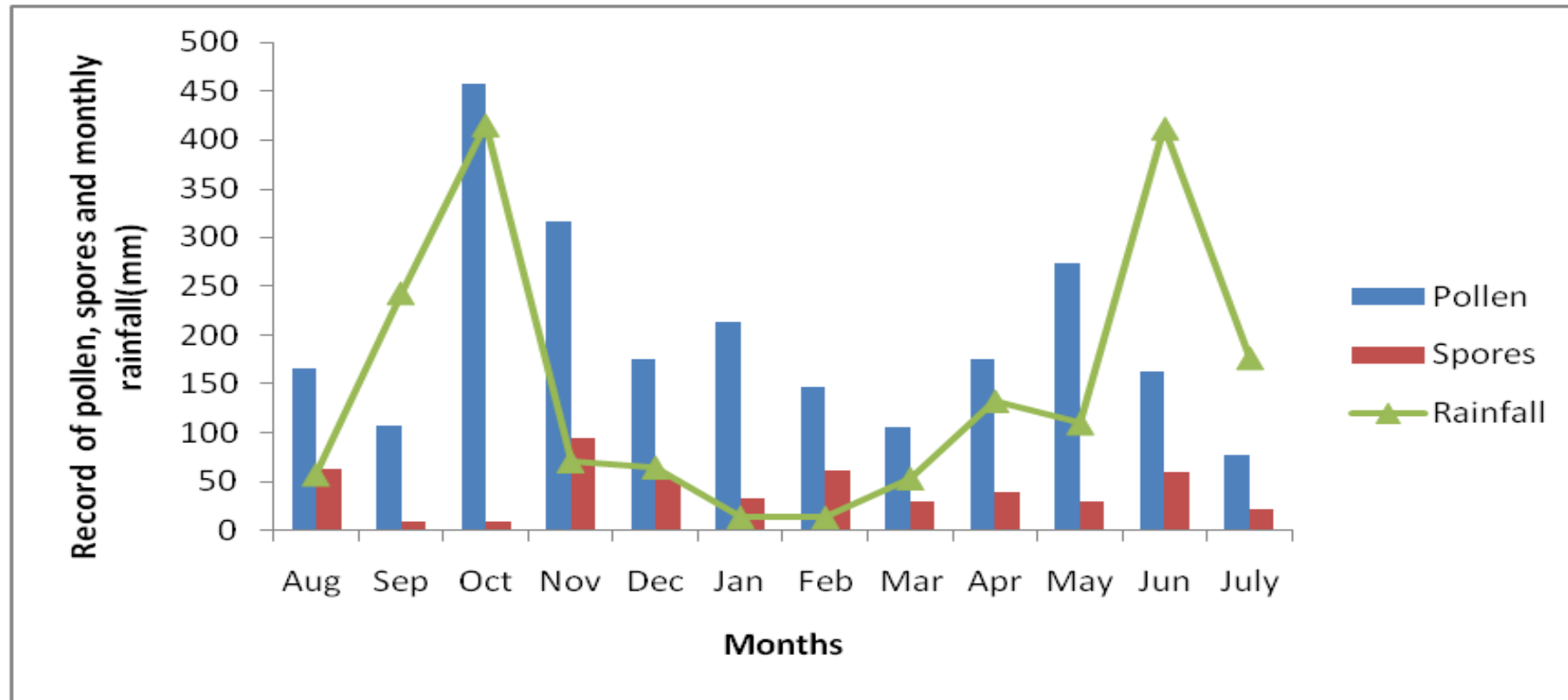


Fig 4 : Seasonal variations of aeroallergens and weather parameters in equatorial region

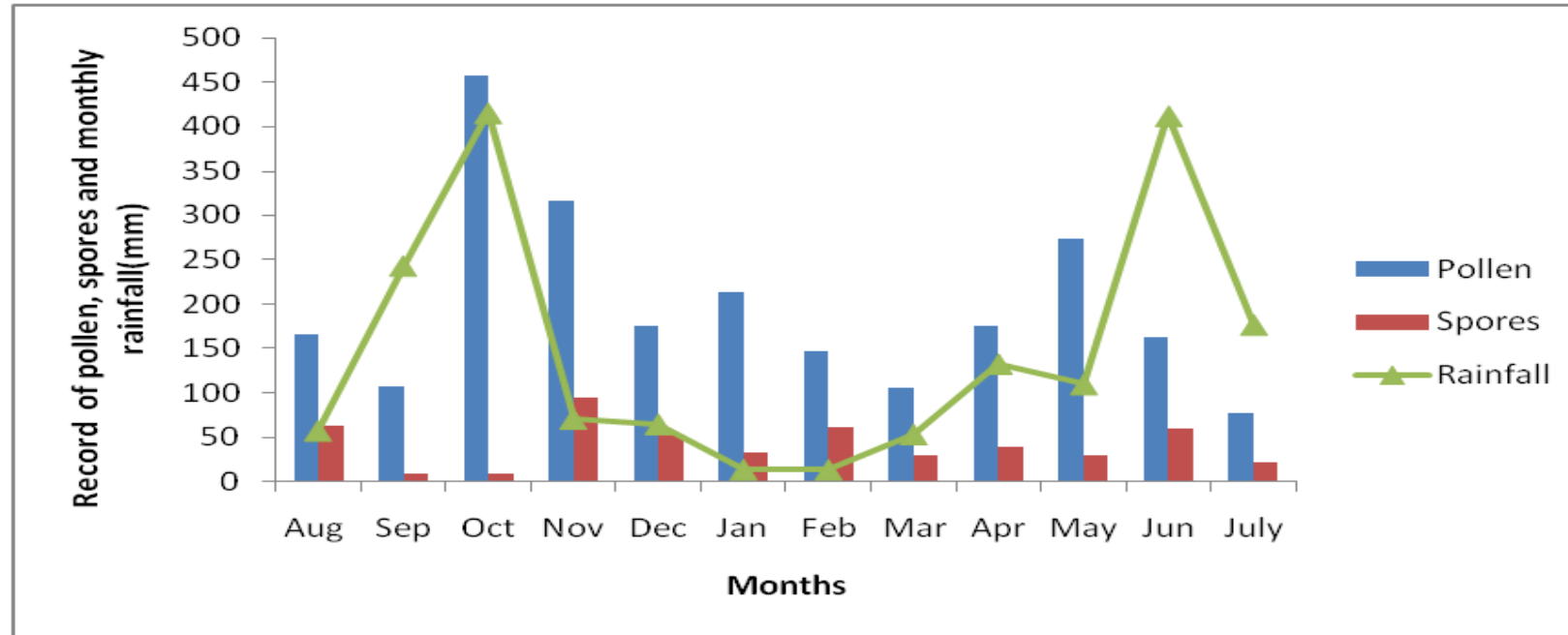
Results and Discussions

Aeroallergens spatial distribution in coastal (Lagos) Nigeria



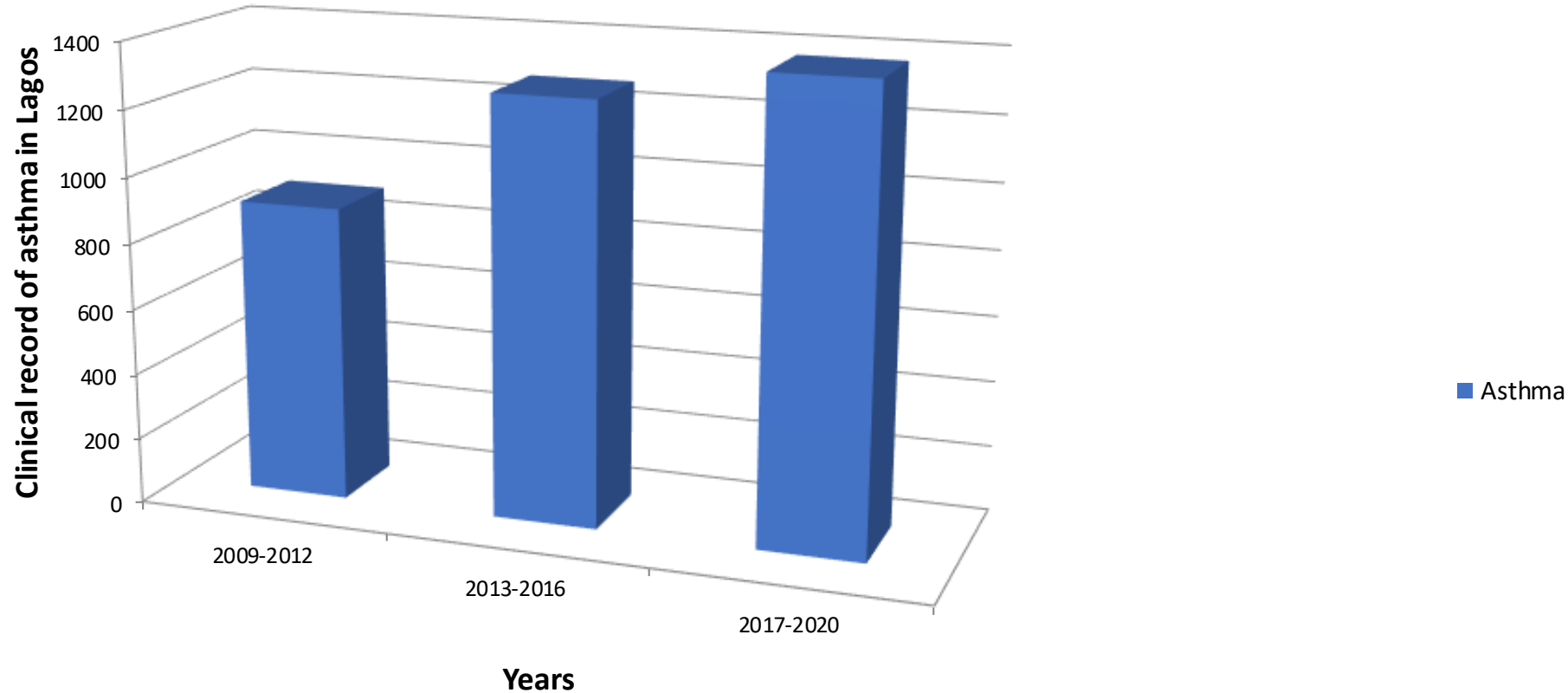
Results and Discussions

Aeroallergens spatial distribution in coastal (Lagos) Nigeria



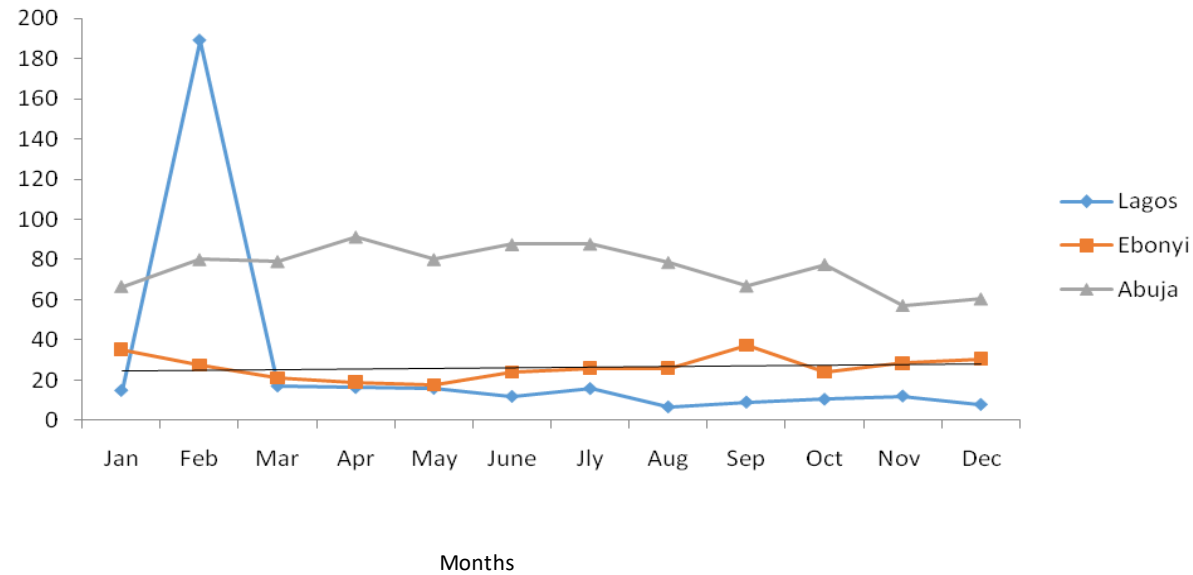
Results and Discussions

Aeroallergens spatial distribution in coastal (Lagos) Nigeria



Results and Discussions

Seasonal variation of conjunctivitis across climate regions in Nigeria



Results and Discussions

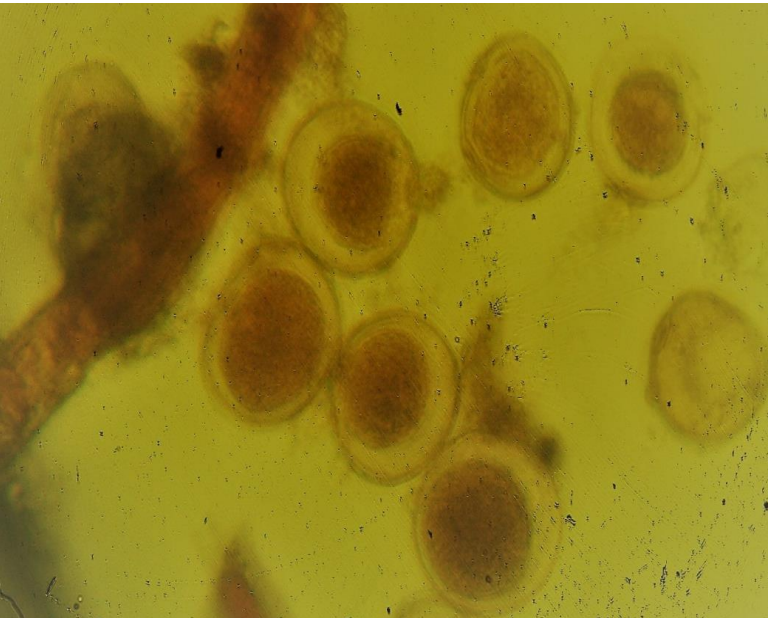
Allergenicity of pollen and spores

Table 1: Allergenicity of pollen and spores

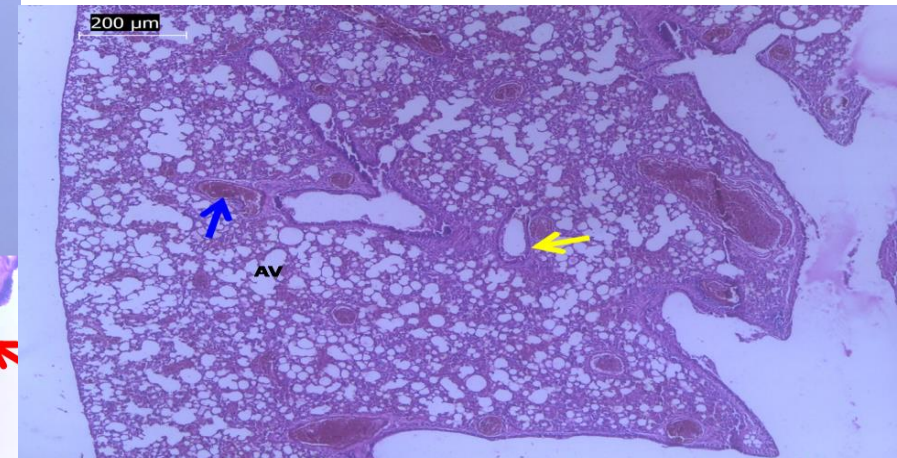
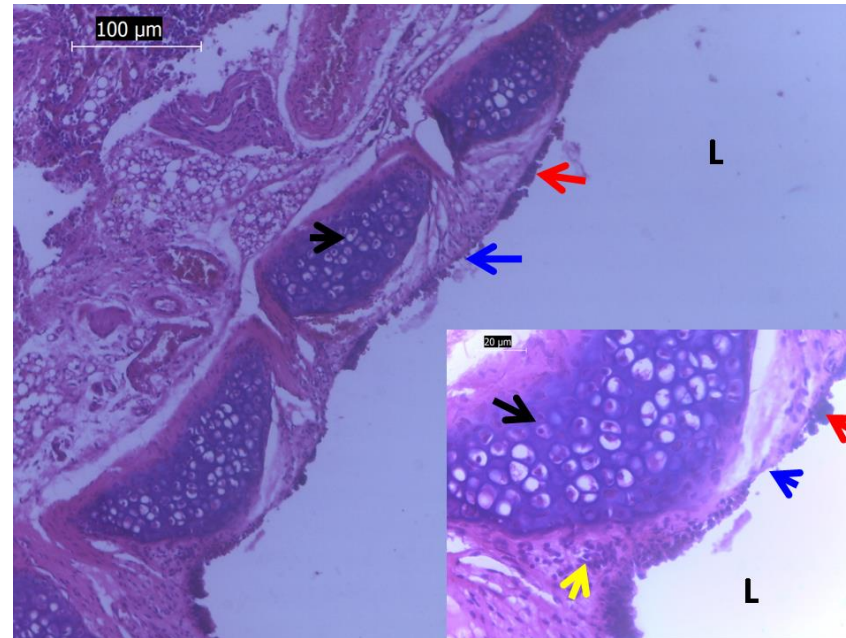
s/n	Pollen or Spores	Allergenic activities	Site of action	Plant kind
1	<i>Oreodoxa Oleraceae</i>	Dematophytic reactions and inflammation within the lung parenchyma.	Skin and lung	
2	<i>Pentaclethra macrophylla</i>	depletion of the epithelia lining of the trachea and clusters of inflammatory cells within the submucosal layer of the trachea.	Tracheae and lung	
3	<i>Acacia sp</i>	Mild depletion of the epithelia lining of the trachea was observed	trachae	
4	<i>Spondias mombin</i>	Caused the depletion of the epithelia lining of the trachea,	trachae	
5	<i>Gmelina arborea</i>	Degeneration of the epithelia lining and chondrocytes of the trachea	trachae	
6	<i>Caesalpinaceae</i>	Higher magnification showed that the bronchioles were lined by a single layer of columnar shaped epithelia cells. The blood vessels were surrounded by a circularly oriented smooth without laceration and the interaveolar septa were relatively thin to enhance diffusion.	trachae	
7	<i>Jacaranda mimisifolia</i>	it caused severe thickness of the interaveolar septa.	lung	
8	<i>Aspergillus niger</i>	Inflammation around terminal bronchiole and hypertrophy of the mucuous gland.	bronchiole	
9	<i>Mariscus ligularis</i>	Pseudostratification of the epithelial layer of trachea	trachae	
10	<i>Sacciolepis africana</i>	Proliferation of sub epithelial mucuous gland.	trachae	
11	<i>Fusarium sp.</i>	Inflammation within the lung parenchyma	lung	
12	<i>Terminalia catappa</i>	Inflammation within the lung parenchyma	lung	
13	<i>Mangifera indica</i>	Inflammation within the lung parenchyma		

Results and Discussions

Allergenic effect of *Pentaclethra macrophylla*



Photomicrograph of histology of the trachea of Group 1 (inoculated with *Pentaclethra macrophylla* pollen allergen) at higher magnification showed the depletion of the epithelia lining of the trachea and clusters of inflammatory cells within the submucosal layer of the trachea (L: lumen, red arrow: epithelium, black arrow: hyaline cartilage, yellow arrow: inflammatory cells, blue arrow: depleted epithelia lining)



Photomicrograph of the histology of the lungs tissue group 2 (inoculated with *Pentaclethra macrophylla* pollen allergen) showed evidences of toxicological alterations within the cyto-architecture of the lungs. Severe congestion of blood vessel and thickening of the interalveolar septa were the alteration observed (yellow arrow: bronchioles, red arrow: interalveolar septa, blue arrow: blood vessel, AV: a alveolar sac).

Results and Discussions

Prophylactic potentials of Fabaceae plant and *Euphorbia hirta*

Table 2: Qualitative phytochemical analysis of Fabaceae plant

b	Saponin	Phenol	Flavonoid	Tannin	Reducing Sugar	Alkaloid	Steroid	Phlobatannin	Terpenoid
M	+	+	+	+	+	+	+	-	+

Table 3: Quantitative phytochemical analysis of Fabaceae plant

	Phenol (mg/100g)	Flavonoid (mg/100g)	Alkaloid (mg/100g)	Steroid (mg/100g)	Reducing Sugar (mg/100g)	Tannin (mg/100g)	Saponin (mg/100g)	Terpenoid (mg/100g)
Test 1	36.42	46.59	40.32	56.94	33.83	26.49	55.32	17.79
Test 2	36.81	49.41	43.59	57.30	33.69	26.77	55.98	17.46

Results and Discussions

Prophylactic potentials of Fabaceae plant and *Euphorbia hirta*

Table 4: Qualitative phytochemical analysis of *Euphorbia hirta*

b

	Saponin	Phenol	Tannin	Reducing Sugar	Alkaloid	Phlobatannin	Terpenoid	Steroid
Sample	+	+	+	+	+	-	+	+

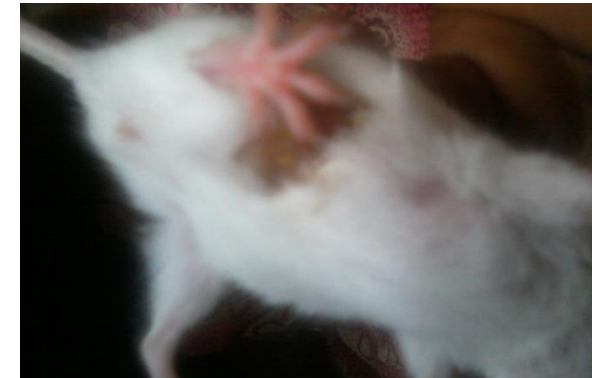
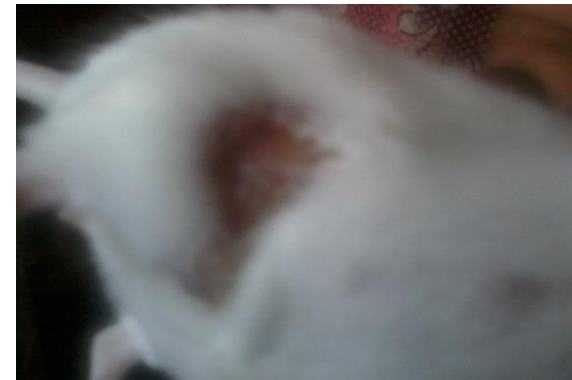
Table 5: Quantitative phytochemical analysis of *Euphorbia hirta*

	Phenol(mg/100)	Flavonoid(mg/100)	Alkaloid(mg/100)	Steroid(mg/100)	Reducing Sugar(mg/100)	Tannin(mg/100)	Saponin(mg/100)	Terpenoid(mg/100)
Test 1	62.14	23.34	68.70	39.01	26.97	45.20	42.58	46.24
Test 2	61.75	22.34	67.64	38.66	26.73	44.92	43.50	45.74

Results and Discussions

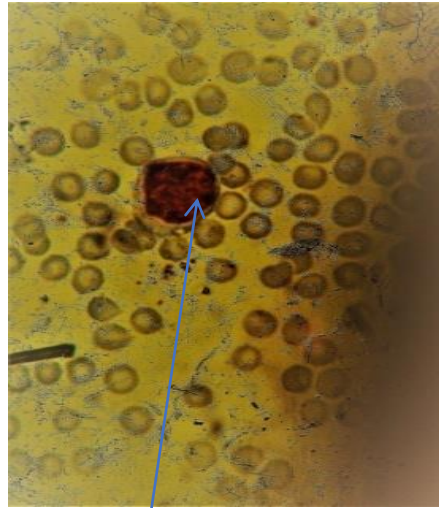
Prophylactic potentials of Fabaceae plant and *Euphorbia hirta*

Physical features of allergy
in unprotected group

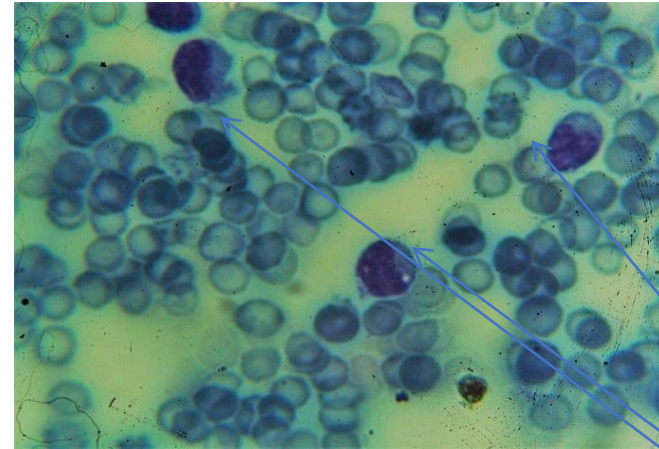


Results and Discussions

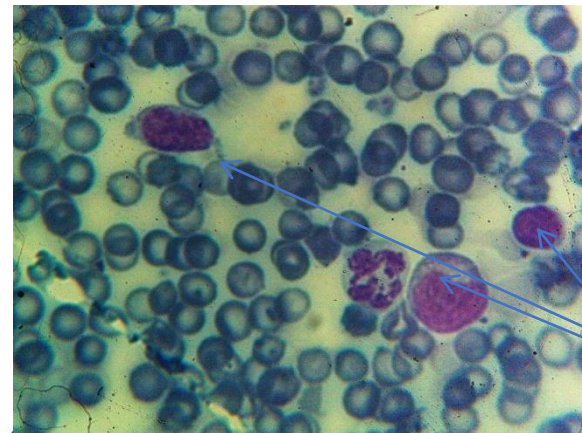
Prophylactic potentials of Fabaceae plant and *Euphorbia hirta*



Monoblast



Monocytes

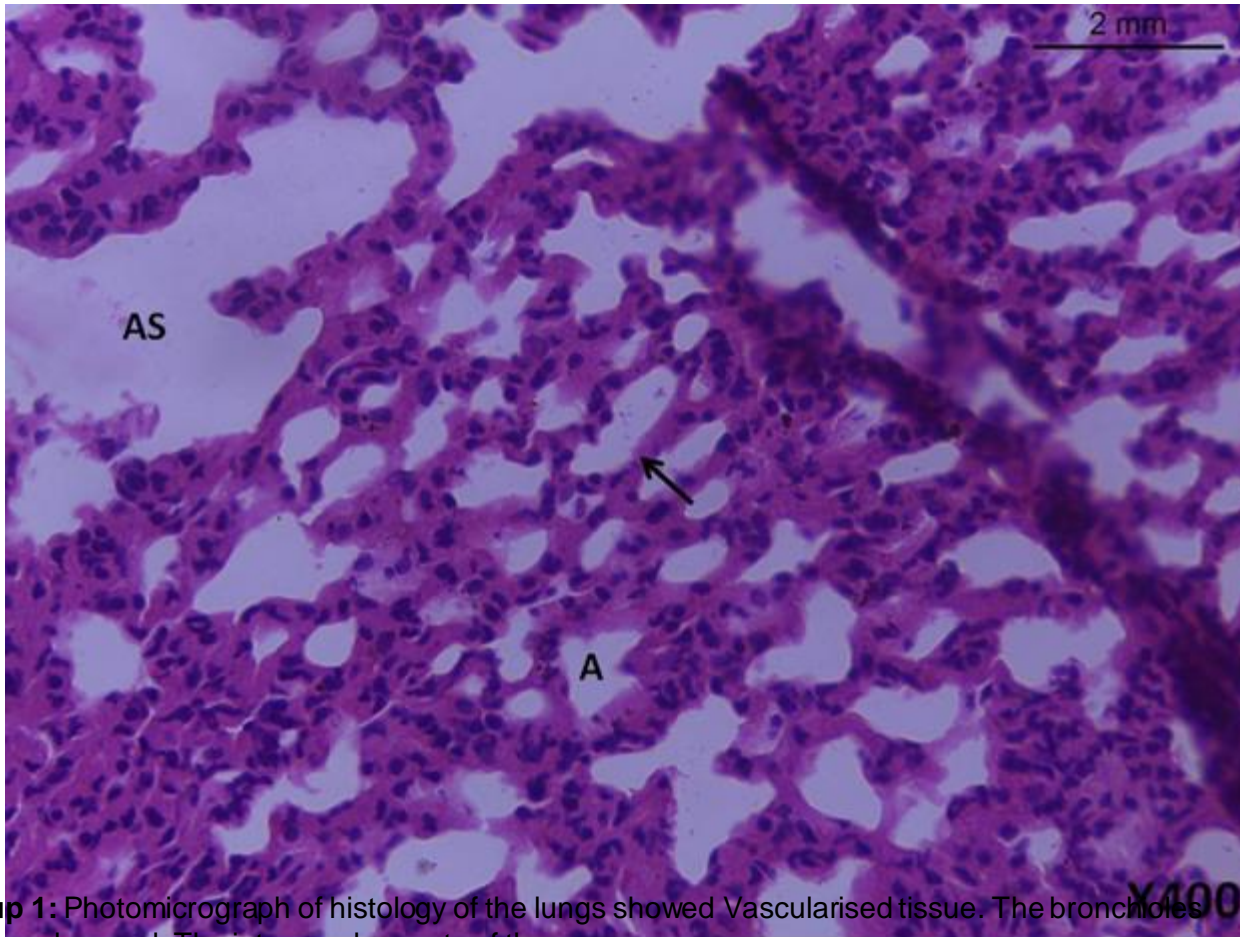


Macrophages

Results and Discussion

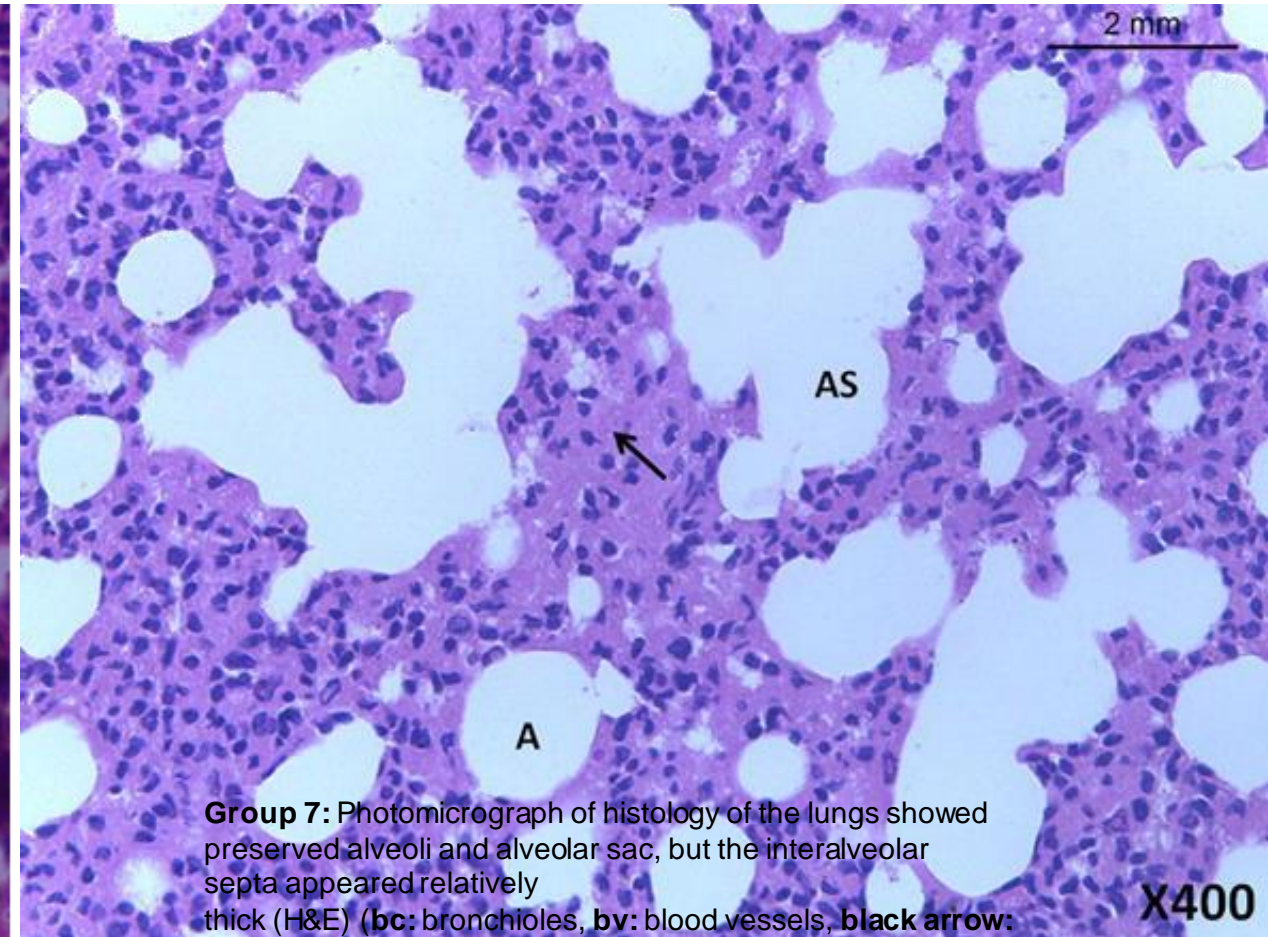
Comparison of the lung histopathology of unprotected and protected mice

A



Group 1: Photomicrograph of histology of the lungs showed Vascularised tissue. The bronchioles appeared normal. The interalveolar septa of the alveoli appeared thick. (H&E) (**bc:** bronchioles, **bv:** blood vessels, **black arrow:** interalveolar septa, **AS:** alveolar sac, **A:** alveoli)

B

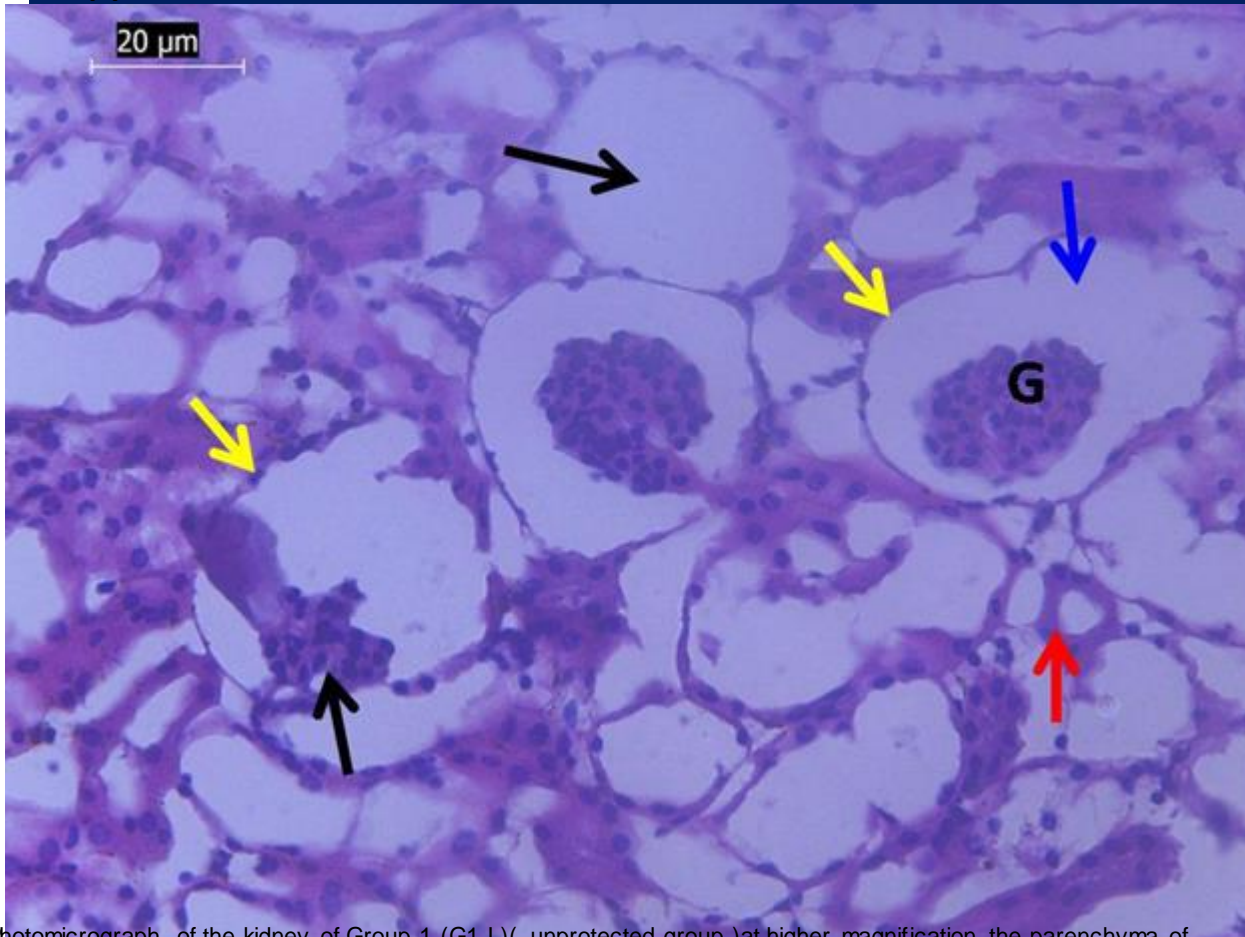


Group 7: Photomicrograph of histology of the lungs showed preserved alveoli and alveolar sac, but the interalveolar septa appeared relatively thick (H&E) (**bc:** bronchioles, **bv:** blood vessels, **black arrow:** interalveolar septa, **AS:** alveolar sac, **A:** alveoli, **Yellow arrow:** smooth muscle, **blue arrow:** columnar shaped cells, **asterisk:** inflammatory cells, **edema**)

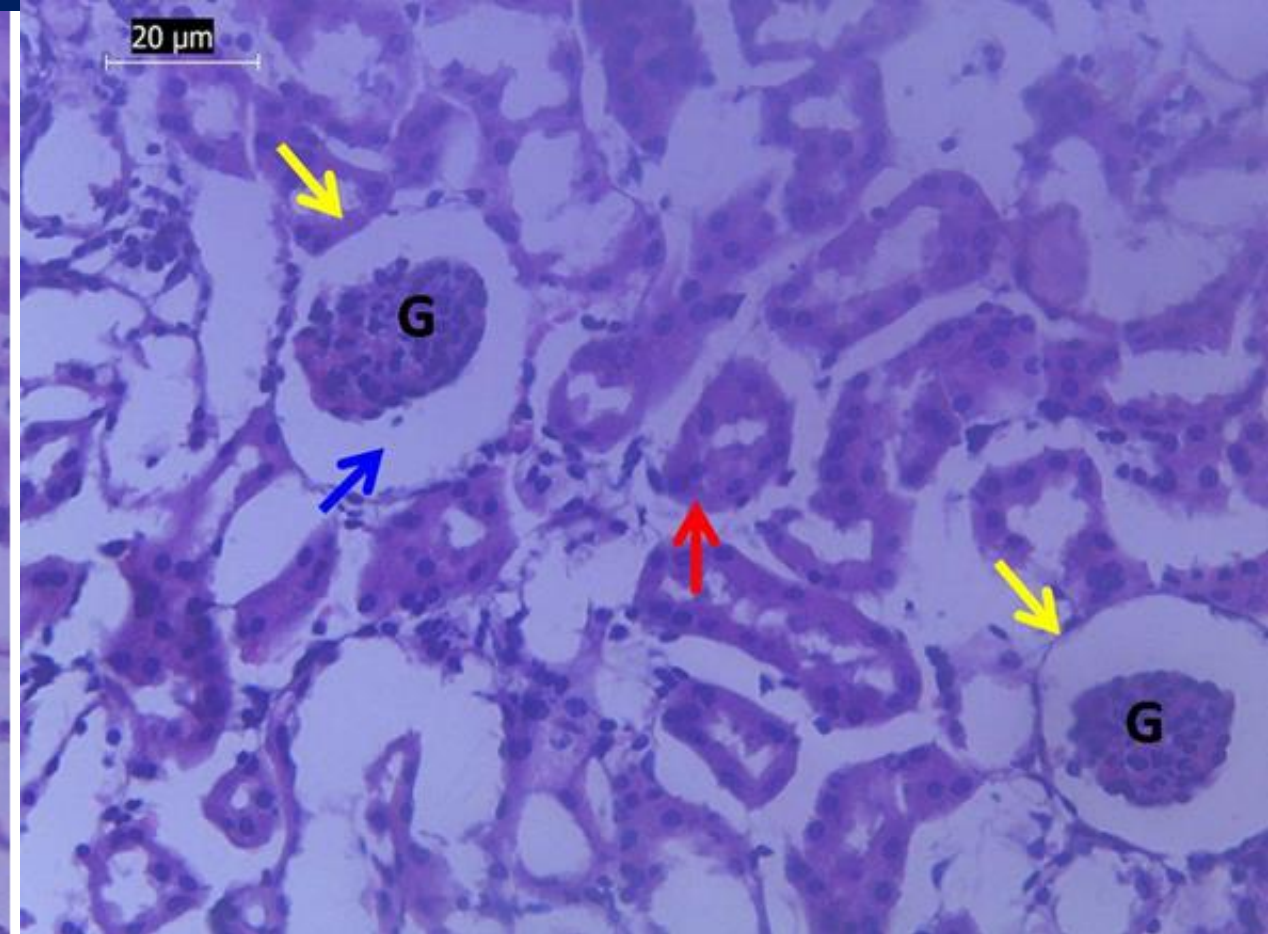
Results and Discussion

Comparison of the kidney histopathology of unprotected and protected mice

A



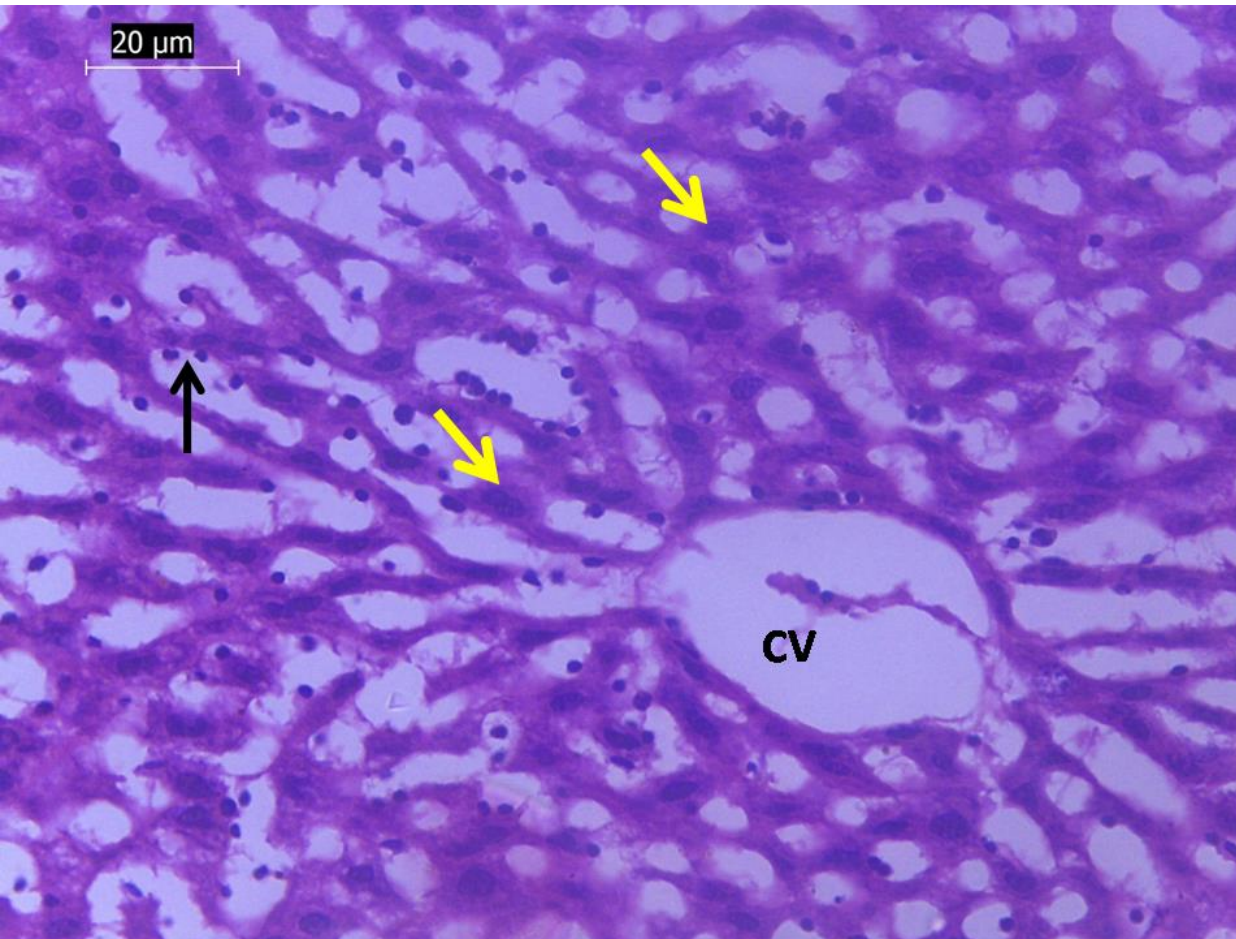
Photomicrograph of the kidney of Group 1 (G1 L), (unprotected group) at higher magnification the parenchyma of the cortex appeared damaged with series of glomerular degeneration and atrophy leading to the enlargement of the urinary space. The depletion of the brush border (formed by clusters of cilia at the apical surface of the epithelia lining) of the proximal convoluted tubules (PCT) and enlargement of the collecting tubules were observed (**Yellow arrow**: Bow man's capsule, **blue arrow**: urinary space, **G**: glomeruli, **black arrow**: atrophied glomeruli, **red arrow**: PCT).



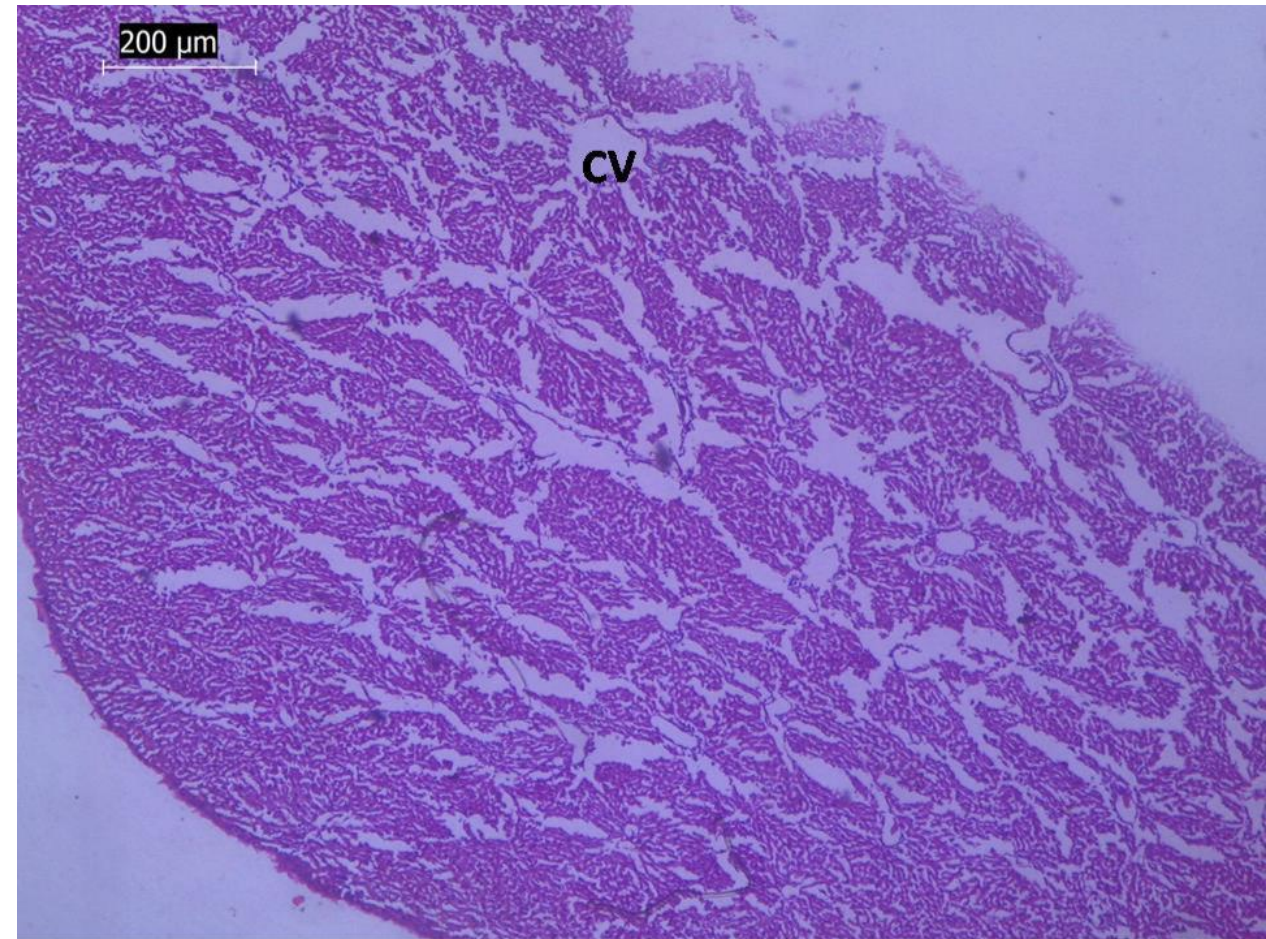
Photomicrograph of the kidney of Group 6 (G6 HL), protected with high dose 500 mg/kg of *Mucuna pruriens* at higher magnification showed signs of cellular recovery. Traces of cellular alterations including mild glomerular degeneration were observed. The epithelia cells of the PCT and collecting tubules appeared restored (**Yellow arrow**: Bow man's capsule, **blue arrow**: urinary space, **G**: glomeruli, **black arrow**: atrophied glomeruli, **red arrow**: PCT)

Results and Discussion

Comparison of the liver histopathology of unprotected and protected mice



Photomicrograph of the hepatic tissue of C1 LS at higher magnification showed mild infiltration of inflammatory cells within the parenchyma particularly in the sinusoid of the hepatic tissue. The vascular vessels appeared uncongested (CV: central vein, **yellow arrow**: hepatocytes, inflammatory cell)



Photomicrograph of the hepatic tissue of Group 6 (C6+FL) protected with **MUSEP** 500 mg/kg of *Mucuna pruriens*, showed restoration of the cyto-morphology of the hepatic tissue. Mild dilation of the sinusoid was observed (CV: central vein).

Results and Discussions

Kidney Function Test

Table 6: Kidney function test

Grps	CRT	PROTEIN	UREA
C1	10.68±5.38 ^a	32.57±4.56 ^d	2.71±0.09 ^f
C2	13.03±0.71 ^a	33.71±6.00 ^d	3.43±1.28 ^f
C3	9.09±0.02 ^a	38.59±19.6 ^b	3.55±0.45 ^f
C4	13.83±5.12 ^a	31.88±8.55 ^d	3.34±0.33 ^f
C5	11.38±4.85 ^a	49.53±14.11 ^b	2.86±0.099 ^f
C6	14.12±3.89 ^a	62.78±20.01 ^b	3.16±2.47 ^f
C7	5.82±4.29 ^a	27.26±11.15 ^d	4.13±0.06 ^e
C8	17.69±4.48 ^a	61.37±10.04 ^b	2.20±1.20 ^f
C9	10.86±3.01 ^a	49.93±24.31 ^b	4.23±0.08 ^e
C10	18.74±16.72 ^a	55.77±5.29 ^b	3.03±0.92 ^f
C11	17.41±3.33 ^a	51.49±6.78 ^b	2.64±0.55 ^f
C12	11.21±1.59 ^a	75.37±5.74 ^c	4.27±0.078 ^e
C13	4.85±3.71 ^a	32.43±2.49 ^d	2.60±1.20 ^f
C14	6.63±2.26 ^a	46.55±15.75 ^b	1.66±0.66 ^f

Values are expressed as mean±SE. Values with the same alphabet in a column are not significantly different whereas values with different alphabet are significantly different.
CRT- creatinine

Results and Discussions

Liver Function Test

Table 7: Liver function test

Grps	PRO	AST	ALT	ALP	ALB	TBIL	CBIL	UCBIL	URIC
C1	12.02±4.05 ^a	29.20±0.17 ^b	11.84±1.76 ^a	86.94±20.70 ^a	4.62±0.11 ^c	13.50±0.52 ^a	11.07±1.23 ^f	2.44±1.60 ^a	266.09±64.98 ^b
C2	7.81±0.30 ^a	25.45±3.92 ^b	17.94±3.22 ^b	89.70±15.1 ^a	3.74±1.64 ^b	8.97±4.34 ^a	6.05±2.80 ^d	2.92±1.54 ^a	357±47.43 ^d
C3	11.31±0.74 ^a	23.84±4.51 ^b	28.22±12.88 ^b	78.66±12.42 ^a	4.50±0.32 ^c	8.33±3.88 ^a	4.41±2.10 ^b	3.91±1.78 ^a	275.21±33.66 ^c
C4	16.81±7.56 ^a	51.48±25.85 ^c	19.38±5.95 ^b	86.94±26.22 ^a	3.57±0.27 ^b	10.26±3.79 ^a	4.99±0.87 ^c	5.27±4.6 ^a	243.93±35.40 ^a
C5	19.84±9.72 ^a	27.00±4.00 ^b	28.68±18.28 ^b	80.04±13.80 ^a	3.13±1.04 ^b	6.19±1.94 ^a	4.35±0.47 ^b	1.84±1.46 ^a	276.67±18.67 ^c
C6	10.51±0.74 ^a	41.50±10.50 ^c	16.04±1.48 ^a	81.42±1.38 ^a	3.90±0.27 ^c	11.56±2.86 ^a	9.84±1.47 ^e	1.72±1.39 ^a	237.53±3.02 ^a
C7	13.75±1.88 ^a	27.17±0.17 ^b	28.00±6.33 ^b	114.54±1.38 ^a	4.99±0.27 ^d	6.29±1.66 ^a	4.09±1.56 ^b	2.20±0.09 ^a	270.86±32.54 ^c
C8	12.70±1.83 ^a	30.81±1.17 ^b	12.40±0.72 ^a	78.42±7.14 ^a	4.72±0.33 ^d	10.26±6.01 ^a	5.75±3.17 ^c	4.52±2.84 ^a	256.44±43.96 ^b
C9	10.40±4.20 ^a	28.35±0.34 ^b	13.04±0.5 ^a	74.52±16.56 ^a	4.94±0.00 ^d	5.83±1.01 ^a	3.51±0.55 ^a	2.32±1.57 ^a	286.52±10.20 ^c
C10	10.45±3.13 ^a	26.99±1.02 ^b	22.38±1.64 ^b	85.56±0.00 ^a	3.51±0.99 ^b	7.03±2.41 ^a	6.27±2.71 ^d	0.75±0.30 ^a	269.6±34.28 ^b
C11	7.72±0.00 ^a	24.31±0.00 ^b	39.17±0.00 ^c	71.76±0.00 ^a	1.76±0.00 ^a	14.06±0.00 ^a	12.30±0.00 ^g	1.46±0.00 ^a	278.30±0.00 ^c
C12	8.55±0.00 ^a	32.38±0.00 ^b	14.08±0.00 ^a	74.52±0.00 ^a	4.94±0.00 ^d	7.03±0.00 ^a	3.96±0.00 ^b	3.07±0.00 ^a	289.50±0.00 ^c
C13	19.74±5.97 ^a	49.90±18.90 ^c	20.03±4.83 ^b	74.52±2.76 ^a	3.90±0.60 ^c	8.51±4.07 ^a	5.81±2.12 ^c	2.69±1.94 ^a	256.36±45.35 ^b
C14	14.46±2.02 ^a	72.71±3.29 ^a	29.99±1.83 ^b	73.14±6.9 ^a	2.58±0.27 ^b	11.84±3.15 ^a	7.25±1.11 ^d	4.59±2.04 ^a	380.05±2.67 ^e

PRO-protein, AST-aspartate, ALT- alanine aminotransferase, ALP-alkaline phosphate, ALB- albumin, TBIL- total bilirubin, CBIL- conjugated bilirubin, UNBIL- unconjugated bilirubin

Results and Discussions

Formulation of 500 mg/kg of Fabaceae plant



In collaboration with Pharmacy Department,
University of Nigeria Nsukka
Nigerian Institute of Medical Research
Lagos University Teaching Hospital

Further clinical study on ;

- Disintegration time test
- Friability test
- content uniformity test
- Absolute drug content
- Dissolution test
- NAFDAC

Research Evidence for policy

RESEARCH EVIDENCE TO INFLUENCE POLICY

Evidence obtained from this research should influence environment and climate policies , which include;

1. Discontinuous use of *Alchornea cordifolia* and *Pentaclethra macrophylla* for tree planting mitigation approach and landscaping as these plants disperse abundant pollen in the atmosphere which are highly allergenic and cause asthma –like symptoms in the lungs.
2. Refuse dumps should be sited at least one kilometre away from peoples inhabitations and should be frequently removed on an interval of one or two days. Refuse dumps are major sources of airborne fungal spores.
3. Increase awareness on aeroallergens spatial distribution to asthmatic patients and other relevant stakeholders by continous sensitization programs , as this will enhance prophylactic adaptive strategies.
4. Environmental policy should legalised the use of entomphilous plants (plants with brightly coloured flowers) than the anemophilous plants (plants with dull flowers) for aesthetic purpose and landscaping as they produce less quantity of pollen, the anemophilous plants discharge abundant pollen into the atmosphere.
5. Advocacy on the use of the discovered bioproduct of plant than the use of synthetic drugs for prophylaxis against allergic diseases.

Conclusion

- Aeroallergens are always present in the atmosphere, though their abundance and spatial distribution are modulated by weather variability and change. As climate continues to change, it unleashes profound effects on aeroallergens and influences on public health negatively. There is a hope of suppressing allergies using the novel bioproduct of a plant discovered from this research.

Publications;

1. **Dimphna N. Ezikanyi and Happiness Oselebe (2020). Effect of Oreodoxa oleraceae Jacq. Pollen protein allergens in albino mice. Postepy Dermatologii Alergologii 37 (4): 559-564.**
2. **Dimphna N. Ezikanyi (2021). Aeroallergen spatial distribution in Northern Nigeria. Aerobiologia (In press).**

Acknowledgements

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