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Impact of Forest Fires on Wood Anatomy, Soil Composition, and Soil Microorganisms of Acacia origena Asfaw (Leguminosae) in Al Souda Mountain, Southwestern Saudi Arabia

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Acacia origena, a member of the Leguminosae family, thrives in the challenging environmental conditions of southwestern Saudi Arabia and holds significant economic value. However, the recent occurrence of forest fires has posed a considerable threat to this species, prompting a comprehensive exploration of its resilience. This study investigates the impact of forest fires on *Acacia origena*, a resilient species in southwestern Saudi Arabia, with a focus on wood anatomy, soil chemical characteristics, and associated microorganisms in Al Mofareh Mountain, Alsoudah, southwestern Saudi Arabia. Fifteen samples from burned and unburned areas were analyzed. These samples were sectioned in both transverse and tangential planes to facilitate light microscopy and the analysis of wood anatomy, revealing distinctive coloration and structural changes in burned tissues. Larger-diameter specimens demonstrated greater resilience, accumulating tannins and forming tyloses to insulate damaged areas. Soil analysis indicated post-fire alterations in texture, composition, and nutrient levels. Microbial assessments highlighted varying responses in yeast and total germ colonies, it was increased by 75%. These findings provide valuable insights into the ecological responses of *A. origena* and soil ecosystems to fire, emphasizing the importance of comprehensive studies to guide conservation and management efforts in fire-affected regions.

Keywords: *Acacia origena*, Plant physiology, Forest Fires, Soil-Microbes, Al Souda Mountain.

Introduction

One of the standout features of the southwestern region of Saudi Arabia is the high density and diversity of *Acacia* trees, with *Acacia origena* standing out as a prominent species in these landscapes. *A. origena*, a medium-sized tree indigenous to Ethiopia, West Eritrea, Yemen, and the Red Sea region of Saudi Arabia, belongs to the *Leguminosae* family and is well-known for its adaptability to challenging environmental conditions (**Shetta and Shetta, 2015**). Forest fires, beyond altering wood anatomy, have far-reaching consequences on soil composition and microorganisms. The depletion of the nutrient pool and modifications to the physico-chemical and biological quality of soils are well-documented outcomes of these events (**Pellegrini et al., 2018**). Two primary types of impacts on soil emerge: indirect effects arising from changes to ecosystem components, and direct effects from elevated soil temperatures and organic matter combustion (**Cerdà and Doerr, 2008**). The resulting disruptions to the nutrient cycle, through volatilization and substrate transfer, further impact soil properties, creating heterogeneous mosaics that influence fire behavior and ecological processes (**DeBano et al., 1998**). The intensity of the burn, determined by peak temperatures and fire duration, dictates the magnitude of these consequences. While mild to moderate fires generally result in reversible

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ecosystem changes, increased hydrophobicity can render the soil less water-absorbent, heightening vulnerability to erosion (**Certini, 2005**). Fires also release nutrients, altering water relations and microbial activities, thereby shaping the post-fire ecological landscape (**Chen, 2006**). Hardwoods like *A. origena* are particularly valued in the region for their multiple uses, including as a source of wood for fuel and lumber, as a producer of valuable gum, tannins, and fodder, and for their significance in creating habitats for honeybees. Additionally, *A. origena* plays a vital role in preserving soil fertility through nitrogen fixation and has medicinal applications in local communities (**El-Juhany et al., 2003**). The intricate biological structure of wood, composed of diverse cell types and chemistries, plays a crucial role in supporting plant life (**Barnett and Jeronimidi, 2003**). A comprehensive analysis of wood anatomy facilitates the identification of climatic, ecological, or geomorphic influences on the tree growth (**Gärtner, 2007**). Wood, as a resilient repository of information about past environmental events, holds the key to understanding the enduring impacts of forest fires. Surviving air pollution, multiple fires, and ecological shifts leave discernible imprints on the wood, forming a tangible record. Despite its potential, wood anatomical techniques remain underutilized in studying the impact of fire on tree growth (**Budi et al., 2001**).The occurrence of wildfires is a global phenomenon with well-established implications for shaping vegetation patterns and community dynamics across ecosystems (**Pausas and Keeley, 2009**). Saudi Arabia, covering a vast portion of the Arabian Peninsula, is primarily characterized by arid desert landscapes, with the exception of the southwestern highlands, which receive significant rainfall and support diverse plant communities (**Masrahi, 2012**). The unique geological history of this region suggests a floristic affinity with West Africa, making it a hotspot for biodiversity (**Vincent, 2008**). Research indicates that forest fires modify both the physical and biological characteristics of the soil, with living organisms more sensitive to environmental changes and soil heating than chemical and physical soil properties (**Darwesh et al., 2018&2019**). Microbial cells' lysing and altered reproductive capacity under the influence of soil heating are direct consequences of fire on soil microflora (**Guénon et al., 2013**). Moreover, the relative abundance of bacteria over fungi tends to increase after moderate-intensity fires due to their greater resilience to heat (**Ntoko et al., 2018**). So, the aim of this study was to investigate the impact of forest fires on *Acacia origena* Asfaw in Al Souda Mountain, Southwestern Saudi Arabia, with a focus on understanding changes in wood anatomy,soil composition, and soil microorganisms.

Materials and Methods

Study Area and Sampling Design

The distribution of *Acacia origena* in Al Mofareh Mountain, Alsoudah, southwestern Saudi Arabia, was categorized into unburned and burned areas. Each category comprised 15 specimens, with precise geographic coordinates as follows:

Unburned Area: Fifteen specimens at 18°12'01.0"N 42°25'08.6"E.

Burned Area: Fifteen specimens at 18°12'10.5"N 42°25'14.0"E.

The sampling design was structured based on the degree of exposure to fire, encompassing two cases: burned and unburned. The selected sites (**Fig. 1**) shared similarities in aspect, slope, soil, and plant species composition but differed in terms of fire exposure.

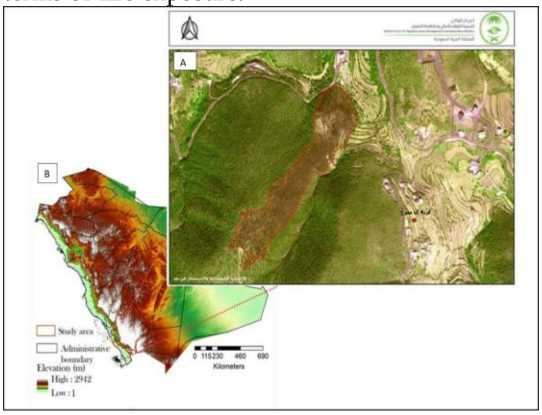

Fig. 1. (A) The study area in Saudi Arabia, (B) The location of the burning forest) National Center for Vegetation Cover development &combating desertification)

Climate of the Study Area

The climate in Alsoudah, outlined in **Table 1**, exhibits annual temperature variations. December marks the coldest conditions with a minimum temperature of 7.7 °C, while June records the warmest temperatures, reaching a maximum of 31.1°C. Notably, June and July are the warmest months, with mean temperatures of 24.3°C and 24.4°C, respectively. Relative humidity (RH) varies from 27% in November to 68% in December. Wind speed (WS) remains moderate, ranging from 4 to 10 (1.853 km h^{-1}), and rainfall (RF) exhibits diverse patterns, with peaks in March (34.9 mm).

TABLE 1. The mean values of metrology data of the Abha (Al Souda) region, during the study period (2023)

Months	Temperature (°C)			RF (mm)	WS (km h^{-1})	RH (%)
	Min.	Max.	Mean			
January	20.0±1.2	7.9±0.95	14±1.53	65±2	8±2	13.9±1.23
February	21.5±2.2	9.7±0.78	15.6±1.32	60±1	8±1	15.95±1.72
March	23.5±1.1	11.7±1.21	17.5±2.01	62±2	8±2	34.9±2.9
April	25.9±2.02	13.4±1.34	19.5±2.11	61±2	10±1	39±3.1
May	29±1.5	15.4±0.97	22.2±1.25	49±3	5±1	26.2±1.94
June	31.1±1.3	16.9±1.12	24.3±2.11	32±3	6±1	7.3±1.2
July	30.9±2.5	17.5±1.31	24.4±1.22	50±1	6±1	18.5±1.1
August	30.7±2.1	17.0±1.05	23.9±2.45	58±2	5±1	24.2±2.23
September	29.8±2.5	15.4±1.2	22.8±1.76	33±3	5±1	5.5±0.78
October	26.2±1.6	12.1±0.93	19.3±1.9	27±1	6±1	3.7±0.32
November	23.0±1.07	9.4±0.89	16.4±1.11	40±3	4±1	5.9±0.22
December	21.0±1.2	7.7	14.5±1.32	68±3	4±1	3.59±0.13

Slide Preparation:

The collection process involved gathering branches, removing leaves, and washing branches to eliminate dirt. Discs for sampling were collected near the ground from three mature individuals. Samples were soaked in water for five days to prevent cell structure damage during cutting. After soaking, samples underwent dehydration in an increasing alcohol sequence for 55 minutes per step. Subsequently, samples passed through paraffin wax in four stages at 60°C for an hour, were embedded in custom molds, and left to solidify. Microtomes were employed to cut thin sections (10-20 µm) in both longitudinal and tangential directions. Wood anatomical properties were captured using a digital camera mounted on a light microscope, following the IAWA terminology (**Wheeler et al., 1989**).

Micro-section Image Analysis:

Micro-section images captured with a microscope at 40× magnification was used to calculate average vessel diameter (VD) and vessel area (VA) (**Table 3**). Effects of fire on rays (R), vessels, pith area (PA), and Tyloses (T) were investigated using Motic Image Plus 3.0 software (**Wondifraw and Abara Mangasha, 2019**).

Soil Samples Analysis and Microorganisms Enumeration:

The study covered burnt and non-burnt areas of Al Mufarah Mountain, each with comparable plant species. Twelve soil samples were randomly collected for physicochemical analysis, and additional samples were obtained from the soil beneath *Acacia origena* for bacteriological analysis. Soil collection involved sampling from the upper soil surface (0–30 cm) after removing litter and debris, utilizing a Dutch auger. The samples were air-dried, stored in plastic bags. Soil samples were sent to the soil analysis laboratory at King Saud University, and the analysis included soil texture, electrical conductivity, pH, organic matter, and micronutrients (N, P, K, Mo, Co, Ni, Pb), following the methodology outlined (**Aref et al., 2011**). Antimicrobial counting was conducted using the ISO 4833 method. International Organization for Standardization (ISO), 2013 for general microbial enumeration, ISO 15213:2003 method (**ISO, 2013**). International Organization for Standardization (ISO), 2003 for sulfite-reducing bacteria, and ISO 4832:2006 (**ISO, 2003**). International Organization for Standardization (ISO), 2006 for the enumeration of coliforms (**ISO, 2006**). These methods are designed for analyzing environmental samples in food production and handling, animal feeding, and human consumption.

Data analysis:

The data were subjected to one-way ANOVA according to **Snedecor and Cochran (1982)**. using SPSS ver. 26.0, and considering $p<0.05$ as a significant level. Duncan 's HSD is used to test differences among sample means for significance.

Results

Impact of fire on wood anatomy characteristics of A. origena in an unburned and burned samples

When identifying the characteristics of A. origena in unburned samples (**Table 2,3&Fig. 2**), the results revealed distinct coloration features: the pith displayed a violet hue, while the primary and secondary xylem exhibited a pale red tint. Moreover, the pith cells were densely filled with tyloses. The rays, characterized by their diffuse and dense nature, showed growth rings with indistinct boundaries. The calculated pith area was 40630.5 μm^2 and solitary vessels or radial groups of interconnected vessels exhibited a diffuse pattern, with an average area of 12222.56 μm^2 and an average diameter of 90.79 µm. Additionally, homogeneous uniseriate rays were evenly distributed throughout the tracheid cells. on the other hand, the burned tissues of A. origena exhibited a noticeable reduction in internal longitudinal structures. The pith appeared black and narrow, with an estimated area of 12572.0 μm^2, and the cells were devoid of tyloses. Vessels appeared narrow and scattered, featuring an average area of 2323.135 μm^2. In contrast, the average vessel diameter increased to 101.225 µm. Additionally, a significant change was observed in both the number and intensity of rays (**Fig. 3&Table 2,3**).

TABLE 2. Average vessel's diameter in micrometers, and the average vessel and pith area in square micrometers of different samples of *A. origena*

Species	No. of samples	Vessel area (µm)	Vessel diameter (µm)	Pith area (μm^2)
Acacia unburned	15	12222.56± 12.28	90.79± 5.19	40630.5±80.9
Acacia burned	15	2323.135± 23.02	100.225± 7.11	12572.0± 88.05

TABLE 3. General appearance of the rays, vessels, tyloses, and area of the pith of different samples of *A. origena*

Species types	No. of samples	Rays	Vessels	Tyloses
Acacia. unburned	15	Normal	Arranged and sequential	Present
Acacia burned	15	larger and more numerous	Narrow, inconsecutive	Absent

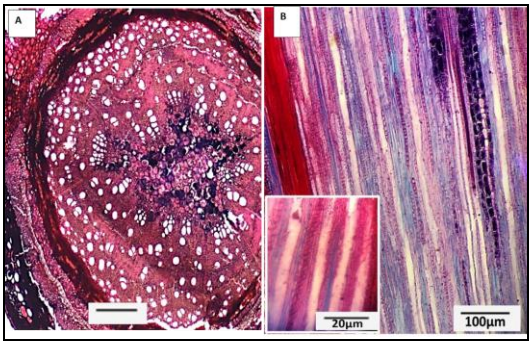

Fig. 2. Cross-section of unburned *A. origena*; (A) transverse section shows the vessels and pith., (B) The longitudinal section shows the vessels and rays

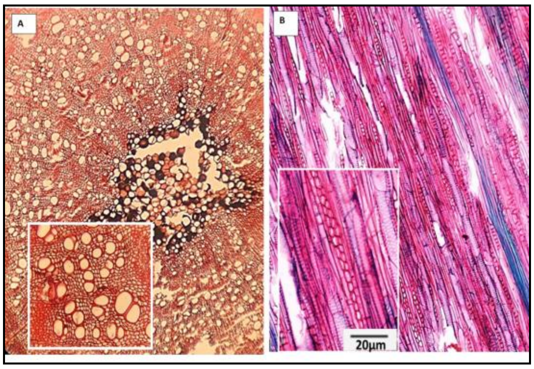

Fig. 3. Cross-section of burned *A. origena*; (A) transverse section shows the vessels and pith, (B) The longitudinal section shows the vessels and rays

Impact of Fire on Characteristics of Soil Associated with *Acacia origena:*

The fire significantly influenced the soil's texture, with marked differences in sand, silt, and clay content between the burned and unburned sites in the Al Mufareh Mountain Forest (**Table 4**). Following the fire, there was a notable increase in silt, with the average percentage rising from 55 to 75 %. Conversely, clay content decreased by approximately 2%. Results also indicated that sand in unburned areas constituted 34.27%, while post-fire, it was 24.72 %. However, there were no discernible differences in the percentages of total limestone (CT %) and active limestone (CA %), which remained at 4.00% for CT and 3.00% for CA in both burned and unburned areas. The soil exhibited a slightly alkaline nature, with pH ranging from 7.61 in unburned sites to 7.66 in burned sites. Notably, the average electrical conductivity (EC 1:5) remained consistent at 0.60 mS/cm before and after the fire. After the wildfires that impacted the forest, our results revealed a reduction in the nitrogen percentage in following the fire (2022). Specifically, nitrogen decreased from 8.61% in unburned soil to approximately 6.91% after the fire. Regarding K_2O, the pre-fire level was higher at 657.93 mg/kg, and its availability decreased to 568.76 mg/kg after the fire. Notably, soil organic matter (OM) percentage increased from 6.42 to 11.96%. The initial Phosphorus pentoxide (P_2O_5) level in the soil was decreased from 657.93 to 568.76 mg/kg. Fluctuations were observed in other primary nutrients, with calcium (Ca) increasing from 11509.40 to 12921.40 mg/kg, magnesium (Mg) decreasing from 756.16 to 649.76 mg/kg, and sodium (Na) experiencing a marked decrease from 90.98 to 77.12 mg/kg after the fire acceding. The nitrogen-to-carbon ratio (C/N) serves as an indicator of mineralization rate, correlating with biological activity in the soil. When comparing unburned sites with burnt sites, this ratio increased from 4.33 to 9.84.

TABLE 4. Chemical and physical soil properties in burnt and unburned soils associated with *A. origena*

parameter	Burnt	Non-Burnt
Clay	18.51	19.32
silt	56.78	46.41
Sand	24.72	34.27
CT (%)	4.0	4.00
CA (%)	3.0	3.00
PH	7.66	7.61
OM %	11.69	6.42
EC (mS/cm)	0.60	0.60
N (%)	6.91	8.61
P_2O_5 (mg kg^{-1})	124.35	128.63
K_2O (mg kg^{-1})	568. 76	657.93
Ca (mg kg^{-1})	12921.40	11509.40
Mg (mg kg^{-1})	649.76	756.16
Na (mg kg^{-1})	77.1	90.98
C/N ratio	9.84	4.33

Impact of Fire on Soil Microorganisms associated with Acacia origena

The comparative analysis between soil samples from burnt *A. Oregina* and non-burnt (**Table 5**) samples underscores distinct microbial responses to the burn condition. The soil under burnt *Acacia* exhibits a higher total germ count, indicating a potential impact of *Acacia* burning on overall microbial populations. Notably, yeast counts are significantly elevated in the burnt soil, suggesting a specific response to the burn condition. In contrast, molds, total coliforms, and sulfite-reducing bacteria remain consistently low in both samples, with no significant difference observed between the burnt and unburnt conditions. This comparative insight highlights the nuanced microbial dynamics influenced by burned *A. origena.*

TABLE 5. The counting of microorganisms in the soil associated with *A. origena*

Species	Sampling type	Setting	Method	Result UFC/g
A. oregina	**Soil sample under a burnt Acacia**	**Total germs at a 30°C**	ISO 4833	7.3×10^4
		Yeasts	ISO 4832	8.0×10^2
		Molds	ISO 4832	<1
		Total coliforms	ISO 4832	<1
		Sulfite-reducing bacteria (Sporulated bacteria)	ISO 15213	<1
	Soil sample under non burnt Acacia	**Total germs at a 30°C**	ISO 4833	5.6×10^4
		Yeasts	ISO 4832	2.2×10^2
		Molds	ISO 4832	<1
		Total coliforms	ISO 4832	<1
		Sulfite-reducing bacteria (Sporulated bacteria)	ISO 15213	<1

Discussion

Soil characteristics and their associated microorganisms of *A. origena* Asfaw in the unique ecological setting of Al Souda Mountain, situated in the southwestern region of Saudi Arabia. The data indicated adverse effects of fire on the anatomical features of *A. origena* wood. Anatomical characteristics of *A. origena* wood exposed to wholly burnt exhibited an apparent reduction in pith area and the complete disappearance of tyloses, accompanied by an increase in the number and intensity of rays. Furthermore, there was an increase in the average diameter and area of the vessels. The climate significantly influences the development of water transport pathways in wood, as well as the formation of fibers in *Acacia sensu stricto* (**Warwick et al., 2017**). *Pseudotsuga menziesii, L. occidentalis, and P. ponderosa a*ll exhibited the production of narrower and more numerous tracheids in response to fire injury. Additionally, narrower and more numerous vessels were identified within the fire ring in *Castanea sativa* (**Arbellay et al., 2014**). Conversely, sustained viability may be attributed to various factors. According to **Cochrane & Schulze (1999)**. Individuals with a greater vessel diameter may be more adept at withstanding fire than their smaller counterparts. This phenomenon has also been documented in other tropical forests that have experienced a single fire (**Darwesh et al., 2020**). Angiosperms respond to fire by accumulating tannins, producing tyloses, and altering their morphological and chemical structures to isolate the affected area (**Sallé et al., 2014; Darwesh et al., 2023**). Additionally, compared to trees with fewer ducts, those with more resin ducts can respond to attacks with more resin due to an extensive reservoir and greater biosynthetic capacity. Numerous studies have found a positive correlation between resin ducts and tree growth (**Ferrenberg et al., 2014; Hood et al., 2015**).

As a result of forest fire, chemical, physical and microbial properties of soil associated with *A. origena* were affected post-fire., it was observed that the characteristics of the soil displayed noticeable changes following a fire outbreak. The comparison between burnt and non-burnt areas reveals significant differences in soil properties. The burnt area exhibits lower clay and sand content but higher silt content, indicating alterations in textural composition. The changes in soil texture in a burnt area, characterized by lower clay and sand content but higher silt content, are a result of the impact of forest fires on soil properties. Forest fires can lead to alterations in the distribution of sand, silt, and clay particles due to the differential effects of fire temperatures on these soil components. Clay particles are more susceptible to high temperatures, leading to their reduction after a fire, while silt particles may increase. This shift in textural composition is influenced by factors such as the combustion of organic matter, incomplete burning of biomass, and the addition of ash, which can contribute to changes in soil texture post-fire (**Agbeshie et al., 2022**). While total limestone (CT %) and active limestone (CA %) remain consistent, pH is slightly higher in the burnt area. Organic matter content is significantly elevated in the burnt area, suggesting an impact of fire on soil organic content. Nitrogen levels are slightly lower in the burnt area, and phosphorus and potassium levels show a modest decrease. Calcium, magnesium, and sodium levels vary, indicating potential shifts in nutrient dynamics. The C/N ratio is higher in the burnt area, reflecting changes in carbon-to-nitrogen ratios. These findings underscore the influence of fire on diverse soil parameters, emphasizing the need for further investigation into the ecological implications and long-term effects on soil health. These outcomes accommodate with the findings of various researchers, reinforcing the validity and consistency of the observed trends in the field. **Rodríguez-García et al. (2014)** noted that where fires destroy vegetation, litter layers, and heating mineral soils. Fire changes soil bulk density, texture, porosity, moisture content, color, and permeability. **Barbhuiya with some coauthors (2012)** reported changes in soil texture in burned sites. One possible explanation is that fires destroy vegetation, litter layers, and heating mineral soils so changed soil bulk density, texture, porosity, moisture content, color, and permeability. The temperature or duration to which the soil was exposed during the fire, in which clay, sand, and silt comprise the soil texture, has high-temperature thresholds. Typically, these components are not impacted by fire unless heated to a high level at the mineral soil surface.

Nardoto& Bustamante (2003) mentioned that clay is one of the most easily altered by high temperatures due to the irreversible deletion of hydroxyl ions (OH) and disintegration of crystalline structure. The results of **Cheng et al., (2023)** showed an increase in silt after the fire, in Cerrado Stricto sensu sites, the percentage of sand, silt, and clay changed between burned and unburned sites at 0–5 cm depth. Physical weathering of the sand-sized particles into the silt and clay-sized particles may explain the observed shift in particle size distribution after heating and burning. This observation lends support to the hypothesis that disturbances, including fire, can influence crucial processes such as litter formation and decomposition. These alterations, in turn, modify the rate of organic matter accumulation and, consequently, the pattern of nutrient cycling. The observed variations in results could be attributed to factors such as vegetation cover. where the type of vegetation plays a role in determining the quantity and quality of ash produced (**Pellegrini et al., 2023**).

According to **Kotroczó et al., (2023)**, there is documented evidence of an increase in soil organic matter resulting from the burning of live ground cover and litter, leading to a significant amount of root material dying back. During combustion, the nutrients from small twigs are volatilized and released into the atmosphere, eventually settling in the soil in a highly soluble state. Also, electrical conductivity (EC) did not change after the fire it could be attributed to the timing of sample collection. Soil temperature is known to influence electrical conductivity, with higher temperatures leading to increased conductivity (**Hasan and Hossam, 2023**). Our sampling was conducted after extinguishing the fire, allowing sufficient time for soil temperatures to decrease in nitrogen (N) content was observed, a macronutrient highly affected by forest fires. For instance, nitrogen depletion occurs due to volatilization during forest fires when soil temperatures reach 200 °C. Furthermore, N loss after a fire may be attributed to leaching and erosion. A decrease in nutrient availability one year after a severe fire was observed. Exchangeable cation losses may result from ash erosion, cation leaching, and plant absorption during post-fire succession, with high vaporization thresholds (**Xiong et al., 2020**).

During combustion, nutrients are evaporated, and the amount lost to the atmosphere depends on temperature. Ca volatilizes over 1962°C, Mg above 1107°C, K above 774°C, and Na above 880°C. Increased burning of organic matter is associated with elevated Ca^{2+} in shrubland and heathland ecosystems. Ca and Mg losses during a fire are often restricted to particle forms in smoke and fine ash. Moreover, the high ion potentials of calcium and magnesium reduce the probability of after-fire leaching as releasing cationic substances from organic materials and accumulating ash in the burned area increase pH. The results of the microbial analysis present intriguing insights into the influence of fire on the soil microbial communities. The higher total germ counts in the soil under burnt *Acacia* suggests a potential stimulation or alteration of microbial populations in response to the burn condition. The substantial elevation in yeast counts in the burnt soil further emphasizes the specificity of microbial responses to Acacia burning. Yeasts play crucial roles in nutrient cycling and organic matter decomposition, and their increased presence may indicate an adaptive response to the altered soil conditions post-burning. This observation aligns with existing research indicating that fire can be a significant driver of microbial community dynamics in soil (**Ali et al., 2021**).

Conclusion

The investigation into the wood anatomy of *A. origena* yielded distinct responses to fire exposure. Unburned samples displayed unique coloration features, including a violet pith and pale red xylem, whereas burned tissues exhibited a significant reduction in internal structures. These findings highlight *A. origena's* adaptability to fire-induced stress. Notably, the study revealed that increased organic matter is a prominent outcome, while the impact of fire varies depending on soil temperature and depth. Furthermore, the chemical and physical characteristics of ash are influenced by the intensity and duration of the fire. Concerning soil microbial communities, bacteria generally exhibit lower sensitivity to fire compared to fungi. Importantly, the study emphasized that fire did not have a detrimental effect; instead, it led to an enhancement in essential nutrients, which is reflected in the vegetation cover.

Declarations:

Ethical Approval:

The collection of plant material, are in compliance with relevant Institutional, National, and international guidelines.

Author Contributions:

Conceptualization, R.N.A,W.M.A and A.M.R.; methodology, R.N.A,W.M.A and A.M.R.; software, R.N.A,W.M.A and A.M.R.; validation, R.N.A,W.M.A and A.M.R.; formal analysis, R.N.A, W.M.A and A.M.R.; investigation, R.N.A, W.M.A and A.M.R.; writing—original draft preparation, R.N.A, W.M.A and A.M.R.; writing—review and editing, R.N.A, W.M.A and A.M.R.; visualization, R.N.A, W.M.A and A.M.R.; supervision, R.N.A, W.M.A and A.M.R.; project administration, R.N.A, W.M.A and A.M.R.; funding acquisition, R.N.A, W.M.A and A.M.R All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest:

The authors declare no conflict of interest.

Data Availability Statement:

The data in this study are available upon request from the corresponding author.

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