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Lutege, Raymond

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GRADUATE RESEARCH ARTICLE

Comparative Analysis of Phytocompound Variations in Leaves, Bark and Roots of Allspice (*Pimenta Dioica*) Collections in Tanzania

Raymond Malinda Lutege[1*], Pavithravani B. Venkataramana[1], Joseph Ndunguru[2]

[1]Department of Sustainable Agriculture, Biodiversity and Ecosystem, School of Life science and Bio-engineering, The Nelson Mandela African Institution of Science and Technology, (NM-AIST), Arusha
[2]Tanzania Plant Health and Pesticide Authority, (TPHPA), Arusha

* Corresponding Author email:
luteger@nm-aist.ac.tz

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- Raymond Malinda Lutege

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- Dr. Pavithravani B. Venkataramana
- Dr. Joseph Ndunguru

ABSTRACT

Allspice, scientifically known as Pimenta dioica, holds potential as a natural source of beneficial compounds that have been historically used to address various human health concerns. The aim of this research was to explore differences in the compounds found in parts of Allspice (i.e., the leaves, bark, and roots). Petroleum ether, dichloromethane, and methanol were used to extract the substances from each part; the resulting crude extracts were then analyzed using gas chromatography mass spectrometry. To interpret the obtained data, the National Institute of Standards and Technology database was referred to for a spectra analysis. The findings indicated that the leaves contained 81 phytocompounds, bark had 18 types, and roots exhibited 12 varieties. Prominent phytocompounds found in the leaves were eugenol in 72.24% – 73.91% of the total compounds detected. Bark was primarily composed of 1,4-Methanoazulene, decahydro-4,8,8-trimethyl-9-methylene-, [1S-(1. alpha.,3a. beta.,4. alpha.,8a. beta.)] in 74.35% – 84.24%; while roots contained γ-sitosterol at an 86.08% concentration level. In terms of solvent performance, methanol exhibited high efficiency on leaves, while dichloromethane demonstrated optimal results on bark and roots. The findings confirm significant variations in phytocompound composition in different parts of Allspice and underscores the importance of considering specific types of phytocompounds, as well as extraction techniques to achieve valuable outcomes.

Keywords: Phytocompounds; *Pimenta dioica*; Allspice; Tanzania

1 Introduction

Allspice, scientifically known as *Pimenta dioica*, is renowned for its aromatic properties with a combined blended flavour of cinnamon, nutmeg, and cloves [1]. The plant's unique fragrance and flavor have made it a desirable ingredient in culinary endeavors worldwide [2]. Beyond its culinary uses, Allspice has a long history of traditional medicinal applications, ranging from digestive aid to pain relief, as well as antibacterial and antioxidant properties [3]. These attributes are due to the diverse range of phytocompounds present in different parts of the plant, including the leaves, bark, and roots [4].

Variations in the phytocompound composition across the different plant parts have been demonstrated in numerous botanical species [5]. These variations are often associated with the physiological functions of the specific plant part and the interactions thereof with the environment [6]. The leaves, for example, are usually responsible for photosynthesis and transpiration [7]; while the bark provides protection against external stresses [8]; and the roots serve as anchoring structures and are involved in nutrient absorption [9]. Consequently, each plant part might harbor a distinct set of phytocompounds to fulfill these functions. As such, Allspice emerges as a prospective reservoir of diverse phytocompounds, each of which harbors distinct biological functionalities [10].

The extraction process plays a role in obtaining valuable compounds from plant materials. The main goal of this extraction procedure is to optimize the production of compounds and ensure the availability thereof in the resulting extracts [11]. The outcome is not only influenced by the methods used for extraction, but also by the choice of solvent [12]. Various solvents such as methanol, ethanol, acetone, and water have been used to extract compounds from plants [13]. Selecting a suitable solvent depends on the specific types of compounds present in each plant parts and the solubility characteristics thereof in different solvents [14]. Due to the nature and behavior of these compounds, finding the ideal solvent for extraction is a complex task. It is worth noting that the efficiency of the extraction process and the yield of compounds are strongly affected by the manner in which the chosen solvent interacts with the extraction technique [15]. In previous studies on Allspice plants, researchers mostly focused on identifying and characterizing various compounds in the plant's leaves and fruits. There is still a lot we do not know, however, and there is little published data on the natural compounds found in the leaves, bark, and roots of Allspice cultivated in Tanzania; this lack of research was the motivation to conduct this study, and the main goal was to investigate the types of natural compounds present in the leaves, bark, and roots of Allspice by employing various analytical methods.

2 Materials and Methods

2.1 Plant Material Preparation

A total of 59 Allspice trees were chosen from diverse locations, including Kizimbani in Zanzibar (39°12'90"E, 6°5'34"S); the World Vegetable Center in Arusha (36°41'15"E, 3°23'19"S); and the Kizugu Botanical Garden (38°39'52"E, 5°6'49"S) and Zigi Amani Forest (38°38'59"E, 5°3'49"S) in the Tanga region of Tanzania. The collection process encompassed meticulous selection of leaves, bark, and roots to ensure an adequate amount for extraction. The collected samples were then stored in appropriately labeled bags within a cool, dry environment to preserve their quality. To accurately identify the plant samples, a voucher sample was obtained and stored in the National Herbarium of Tanzania (NHT) at the Tanzania Plant Health and Pesticides Authority (TPHPA) in Arusha, with the voucher's reference number being NHT 12/6/2022.

2.2 Extract Preparation

To increase efficiency and cost-effectiveness, the collected samples of Allspice leaves, bark, and roots from 59 trees were combined into three groups, each of which weighed 1,000 g. These samples underwent a preparation process that included washing with tap water to remove debris, followed by gentle drying to eliminate excess

moisture. The materials were then cut into smaller pieces to enhance the surface area for effective dehydrating. Drying occurred in a well-ventilated room at 32°C for two weeks, with regular checks to ensure complete drying. Once sufficiently dried, the samples were finely crushed using a motor blender and passed through a 1 mm mesh sieve to achieve consistent particle size, resulting in 335 g of leaves, 495 g of bark, and 375 g of roots.

2.3 Chemical and Reagent

The chemicals and reagents such as chlorpyrifos, acetic acid, acetonitrile anhydrous magnesium sulfate, sodium acetate, sodium citrate, florisil, helium, petroleum ether, dichloromethane, and methanol used for crude extraction and a gas chromatography mass spectrometry (GC MS) analysis were purchased from LAB EQUIP LTD in Dar es Salaam, Tanzania. This company is certified under ISO 9001 2008; and deals with quality analytical grade materials that were reliable for this study.

2.4 Crude Extraction

This study employed a sequential extraction method involving solvents of increasing polarity: petroleum ether (PET), dichloromethane (DCM), and methanol (M). A ratio of 1:3 (i.e., 100 g of powder to 300 mL of solvent) was used, with the powder soaked in petroleum ether for 24 hours in a 500 mL flask while being shaken. The extracts were decanted, filtered, and the process was thrice repeated using the above three solvents to ensure comprehensive extraction. This was done separately for the leaves, bark, and roots. After each extraction, the residues were subjected to subsequent extractions. All solvent extracts were dried via a rotary evaporator, and the dried extracts were stored at −80°C for later analysis using GC MS.

2.5 Gas Chromatography – Mass Spectrometry Analysis

The extraction method was used to obtain extractants, which were then analyzed using GC MS to identify their chemical components. In this process, 2 g of each extract (i.e., from the leaves, bark, and roots) were placed in separate 50 mL centrifuge tubes. A chlorpyrifos standard was also included for individual analysis, with 5 µL added to a separate tube. 2 mL of a solution containing 1% acetic acid in acetonitrile were added to the extract solutions; and the resulting mixture was shaken for one minute before simultaneously adding 0.6 g of anhydrous magnesium sulfate, 0.3 g of sodium acetate, and 0.2 g of sodium citrate to each centrifuge tube. Centrifugation was then carried out for a duration of 30 minutes to allow the layers to separate. The upper layer was collected in 15 mL centrifuge tubes and treated with an additional amount of 0.2 g anhydrous magnesium sulfate and 0.1 g florisil. After one minute of agitation and subsequent centrifugation lasting for 10 minutes, a volume of 1 mL from the solvent layer was transferred to vials for a GC MS analysis.

The GC MS device (Agilent Technologies, 7890A GC System) was set up using a GC column with a length of 25 m, a diameter of 320 µm, and an injection volume of 1 µL. With a heating rate of 5°C per second, the temperature increased from a temperature of 50°C to 150°C and then to 180°C. Helium was utilized as the carrier gas at a flow rate of 1.2 mL per minute to maintain a linear velocity of 47.661 cm per second. The detection system employed was the Agilent Technologies 5975C inert XL EI/CI MSD with Triple Axis Detector, the primary function of which was to detect and analyze metabolites found in the extracted samples. Throughout the experiment the detector was maintained at a temperature of 250°C.

To identify constituents in plant extracts indices related to substance retention and the patterns of mass fragmentation were compared to those available in the National Institute of Standards Technology library. Retention indices played a role, in confirming compound identification. Furthermore, concentrations of identified compounds were determined by measuring peak areas and expressing them as percentages to the total sample.

3 Results

3.1 Phytocompound yield in Allspice leaves extracts using methanol, petroleum ether, and dichloromethane solvents

Table 1 below presents the phytocompound content of Allspice leaves which was obtained through crude extraction, followed by Gas Chromatography Mass Spectrometry analysis for quantification and identification. A total of 81 compounds were identified (31 in methanol, 24 in petroleum ether, and 26 in dichloromethane). The peak area percentages in the table represent the concentration of each identified compound. The most prominent compounds, including eugenol (72.24% - 73.91%), naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-, (1S-cis)- (2% - 4.6%), copeane (1.69% - 2.19%), 3-carene (0.75% - 1.56%), caryophyllene (0.59% - 1.33%), and γ-sitosterol (0.99% - 4.975%) in both dichloromethane and methanol extracts. The remaining compounds had abundances below 1%.

Table 1: *Phytocompound composition from Allspice leaves extracts using methanol, petroleum ether, and dichloromethane solvents.*

Peak No.	Retention Time	Library ID	Area %		
			M	PET	DCM
1	3.14	D-Limonene	0.56	—	—
2	3.59	3-Carene	1.44	1.56	0.75
3	4.25	1,4-Cyclohexadiene, 1-methyl-4-(1-methylethyl)-	0.62	0.58	0.86
4	4.67	Eugenol	72.88	73.91	72.24
5	5.59	Copeane	1.69	1.79	2.19
6	5.72	cis-11-Tetradecen-1-ol	0.38	—	—
7	5.94	Caryophyllene	1.33	1.33	0.59
8	6.01	1H-Cyclopenta [1,3] cyclopropa [1,2] benzene, octahydro-7-methyl-3-methylene-4-(1-methylethyl)-, [3aS-(3a. alpha.,3b. beta.,4. beta.,7. alpha.,7aS*)]-	0.22	0.22	—
9	6.10	10s,11s-Himachala-3(12),4-diene	0.17	—	—
10	6.24	α-Caryophyllene	0.72	0.80	0.31
11	6.34	Naphthalene, 1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl)-, (1. alpha.,4a. alpha.,8a. alpha.)-	1.27	1.50	0.60
12	6.44	Isoledene	0.75	0.89	—
13	6.52	Phenol,2,4-bis (1,1-dimethylethyl	—	—	2.55
14	6.74	Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-, (1S-cis)-	3.70	4.60	2.00
15	6.90	1H-3a,7-Methanoazulene, 2,3,4,7,8,8a-hexahydro-3,6,8,8-tetramethyl-, [3R-(3. alpha.,3a. beta.,7. beta.,8a. alpha.)]-	0.35	0.37	—
16	7.42	E-14-Hexadecenal			1.54
17	8.07	Naphthalene, 1,2,3,4,4a,7-hexahydro-1,6-dimethyl-4-(1-methylethyl)-	0.20	0.23	—
18	8.18	Naphthalene, 1,2,4a,5,8,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-, [1S-(1. alpha.,4a. beta.,8a. alpha.)]-	0.10	—	—
19	8.29	Tricyclo[5.4.0.0(2,8)]undec-9-ene,2,6,6,9-tetramethyl-	0.65	0.71	0.36
20	11.06	Cyclohexadecane	—	—	1.36
21	12.24	1-Methoxy-3-(2-hydroxyethyl) nonane	0.87	—	—
22	13.67	1,4-Eicosadiene	0.17	—	—

Table 1: (*Contd.*)

Peak No.	Retention Time	Library ID	Area %		
			M	**PET**	**DCM**
23	16.30	(E, E)-7, 11, 15-Trimethyl-3-methylene-hexadeca-1,6,10,14-tetraene			
24	17.12	m-Mentha-4,8-diene, (1S,3S)- (+)-	0.53	0.53	—
25	18.07	9-Eicosene, (E)-	0.94	—	1.26
26	19.54	Furan, 2,5-dihydro-2,5-dimethoxy-	—	0.9	—
27	21.06	1,3-Cyclohexadiene, 1-methyl-4-(1-methylethyl)-	0.18	0.19	—
28	23.64	2-Chloropropionic acid, hexadecyl ester	—	—	0.58
29	23.78	Tritretracontane	—	—	0.35
30	24.41	1,1'-Biphenyl, 4,2',3',4'-tetramethoxy-6-methyl-	0.15	—	—
31	26.08	Heptacosane, 1-chloro-	—	—	0.45
32	28.52	1-Heneicosyl formate	—	—	0.32
33	28.63	Eicosane	—	—	0.81
34	29.19	1,2,4-Metheno-1H-indene, octahydro-1,7a-dimethyl-5-(1-methylethyl)-, [1S-(1. alpha.,2. alpha.,3a. beta.,4. alpha.,5. alpha.,7a. beta.,8S*)] -	—	0.15	—
35	29.44	Naphthalene, decahydro-4a-methyl-1-methylene-7-(1-methylethenyl)-, [4aR-(4a. alpha.,7. alpha.,8a, beta]	—	0.11	—
36	29.95	Octadecane, 1-chloro-	—	—	1.21
37	30.59	Cyclotetracosane	0.65	0.52	0.39
38	31.04	Bicyclo [4.4.0] dec-1-ene, 2-isopropyl-5-methyl-9-methylene-	0.58	—	1.72
39	33.39	Hexadecane	—	0.12	1.36
40	34.48	1-Octadecene	—	—	0.53
41	35.73	Heneicosane, 11-decyl-	0.33	1.32	1.00
42	36.10	Vitamin E	0.17	—	—
43	39.34	γ-Sitosterol	4.97	—	0.99
44	39.54	Pregn-5-en-3-ol,21-bromo-20-methyl-, (3. beta.)-	—	2.98	—
45	40.14	1,4-Methanoazulene, 7-bromodecahydro-4, 8, 8-trimethyl-9-methylene-	0.90	0.46	—
Total % identified phytocompounds			**97.68**	**95.99**	**98.16**
Total number of identified phytocompounds			**31**	**24**	**26**

Key: M: Methanol extract; PET: Petroleum Ether extract; DCM: Dichloromethane extract.

3.2 Phytocompound yield in Allspice bark extracts using methanol, petroleum ether, and dichloromethane solvents

Table 2 presents 18 phytocompounds identified in Allspice bark with a total composition number of 3, 3 and 12 compounds in methanol, petroleum ether and dichloromethane extract respectively. The most predominant compound was 1,4-Methanoazulene, decahydro-4,8,8-trimethyl-9-methylene-, [1S-(1. alpha.,3a. beta.,4. alpha.,8a. beta.)] (74.35% – 84.24%) across all solvent's extracts. However, other compounds with significant amounts were pregn-5-en-3-ol,21-bromo-20-methyl-, (3. beta.)- (8.72% - 7.055%) in petroleum ether and dichloromethane extracts, stigmasta-5,22-dien-3-ol, acetate, (3. beta.)- (9.83%), and 1,4-methanoazulene, 7-bromodecahydro-4, 8, 8-trimethyl-9-methylene- (8.58%) in methanol extracts, and 2,2,7,7-tetramethyltricyclo

[6.2.1.0(1,6) undec-4-en-3-one (7.03%) in petroleum ether, and 9,19-cyclolanost-24-en-3-ol, acetate, (3. beta)- (6.89%) in dichloromethane.

Table 2: *Phytocompound composition from Allspice bark extracts using methanol, petroleum ether, and dichloromethane solvents.*

Peak No	Retention Time	Library ID	Area %		
			M	PET	DCM
1	4.24	1-Dodecene	—	—	0.92
2	5.57	Cyclododecane	—	—	1.79
3	6.50	Phenol,2,4-bis(1,1-dimethylethyl)	—	—	1.71
4	7.40	5-Octadecene, (E) -	—	—	2.26
5	11.02	1-Nonadecene	—	—	1.88
6	18.04	2-Chloropropionic acid, hexadecyl ester	—	—	1.41
7	23.61	5-Eicosene, (E)-	—	—	0.97
8	28.50	Heptafluorobutanoic acid, heptadecyl ester	—	—	0.46
9	30.77	Trichloroacetic acid, hexadecyl ester	—	—	0.30
10	39.35	Stigmasta-5,22-dien-3-ol, acetate, (3. beta.)-	9.83	—	—
		Pregn-5-en-3-ol,21-bromo-20-methyl-, (3. beta.)-	—	8.72	7.05
11	39.92	1,4-Methanoazulene, decahydro-4,8,8-trimethyl-9-methylene-, [1S-(1. alpha.,3a. beta.,4. alpha.,8a. beta.)]	81.59	84.24	74.35
12	40.11	1,4-Methanoazulene, 7-bromodecahydro-4, 8, 8-trimethyl-9-methylene-	8.58	—	—
		2,2,7,7-Tetramethyltricyclo [6.2.1.0(1,6) undec-4-en-3-one	—	7.03	—
13	40.20	9,19-Cyclolanost-24-en-3-ol, acetate, (3. beta)-	—	—	6.89
Total % identified phytocompounds			**100**	**99.99**	**99.99**
Total number of identified phytocompounds			**3**	**3**	**12**

Key: M: Methanol extract; PET: Petroleum Ether extract; DCM: Dichloromethane extract.

3.3 Phytocompound yield in Allspice roots extracts using methanol, petroleum ether, and dichloromethane solvents

In the roots of Allspice extracts, a total of 12 compounds were successfully identified. Among these, 2 compounds were detected in the methanol extracts, while the dichloromethane extracts revealed a more diverse composition, comprising 10 distinct compounds, no compounds were identified in the petroleum ether extracts. In the methanol extracts, γ-Sitosterol dominates with an impressive 86.08% abundance (Table 3). Also, dichloromethane extracts exhibit a more intricate composition, with significant peaks attributed to various compounds, including 2-tetradecene, (E)- (18.55%), 1-Nonadecene (15.65%), 7-hexadecene, (Z)- (15.49%), and phenol,2,4-bis(1,1-dimethylethyl) (15.57%). Furthermore, 2-Chloropropionic acid, hexadecyl ester (11.21%) were notable in the dichloromethane extracts.

Table 3: *Phytocompound composition from Allspice roots extracts using methanol, petroleum ether, and dichloromethane solvents.*

Peak No.	Retention Time	Library ID	Area %		
			M	PET	DCM
1	4.25	E-11,13-Tetradecadien-1-ol	—	—	8.23
2	5.35	Eugenol	13.92	—	—
3	5.57	7-Hexadecene, (z)-	—	—	15.49
4	6.50	Phenol,2,4-bis(1,1-dimethylethyl)	—	—	15.57
5	7.40	2-Tetradecene, (E)-	—	—	18.55
6	11.02	1-Nonadecene	—	—	15.65
7	18.04	2-Chloropropionic acid, hexadecyl ester	—	—	11.21
8	23.62	1-Heneicosyl formate	—	—	7.78
9	28.50	1-Heptacosanol	—	—	4.30
10	30.77	Carbonic acid, octadecyl 2, 2,2-trichloroethyl ester	—	—	3.22
11	39.28	γ-Sitosterol	86.08	—	—
Total % identified phytocompounds			**100**	—	**100**
Total number of identified phytocompounds			**2**	—	**10**

Key: M: Methanol extract; PET: Petroleum Ether extract; DCM: Dichloromethane extract.

4 Discussion

4.1 Phytocompound composition across leaves, bark and roots of Allspice

It was discovered that there is a significant variance in the availability of phytocompounds among the leaves, bark, and roots of the Allspice plant. The leaves demonstrated a higher presence of diverse phytocompounds that are distributed across various chemical profile, followed by bark and roots. The heightened variations of numerous phytocompounds in the leaves, bark and roots can be attributed to manifold physiological activities within the plant's foliage, genetic variations, variations in season and organ, the age of the plants, and specific cultivation practices employed [16], [17]. Additionally, it indicates the plant's adaptive responses to its environment and the specific ecological roles played by each plant part [18]. This intricate network of processes leads to the formation and accumulation of a diverse array of secondary metabolites [19].

In Table 1, Eugenol was observed as the most predominant constituent in Allspice leaves, constituting 72.24% to 73.91%. In contrast, smaller amounts of eugenol were observed in the roots, comprising 13.92% of the total composition. The findings align with previous research that reported eugenol variation in different parts of Pimenta plants. The highest level of eugenol has been reported in leaves, with reports indicating more than 90% of eugenol compared to berries, which have shown levels ranging between 60% and 90% [20]. Variations in oil composition were noted based on origin; essential oils harvested from Sri Lanka exhibited a high content of eugenol, reaching 85.3%, in USA leaves revealed a lower amount at 62.1%, while Cuban leaves contain 54% eugenol and in Mexico, leaves exhibit the highest eugenol concentrations, reaching 94.8% [21]. Additionally, no eugenol was identified in bark however, previous studies found a high concentration of eugenol in Allspice bark ranging from 87.55% to 87.88% [22]. It is important to note that even though the presence of eugenol in Allspice roots has not been previously reported, the study found a small amount of eugenol present in the roots; although in smaller quantities compared to the leaves, this suggests that the distribution of this compound extends throughout various parts of the plant.

The bark exhibited a significantly higher proportion of 1,4-Methanoazulene, decahydro-4,8,8-trimethyl-9-methylene-, [1S-(1. alpha.,3a. beta.,4. alpha.,8a. beta.)] or longifolene (74.35% – 84.24%) as presented in Table 2. This compound falls under the category of sesquiterpene compounds. In contrast, a previous study reported

low amounts of sesquiterpenes in *Pimenta dioica* bark, averaging concentrations of 0.34% –3.47% [23]. Additionally, the *Pimenta racemosa* stem was reported to contain 0.01% of longifolene [22]. Contrary to the findings, previous research on *Psidium guajava*, a member of the Myrtaceae family, reported a high concentration of 23.3% for the sesquiterpene compound (naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-, (1S-cis)-) in its leaves [24]. This study recorded the concentration of sesquiterpene compound in Allspice leaves at 1.79%. Additionally, leaves of *Pimenta dioica* from Jamaica exhibited a slightly higher concentration of 4.85% in comparison to the recorded results.

Table 3, identified γ-Sitosterol as significant constituents in the roots with lesser amount in bark and leaves. The overall presence of γ-Sitosterol in the plant parts is noteworthy, with roots exhibiting the highest concentration at 86.08%, followed by the bark at 9.83%, and the leaves at 0.99% – 4.97%. The presence and composition of γ-Sitosterol in the roots of Allspice have not been previously reported in the existing literature. However, a study indicated that members of the Myrtaceae family were found to contain γ-Sitosterol [25]. In a prior investigation, the presence of phytosterol compounds in the roots, bark, seeds, and leaves of *Moringa oleifera* Lam from Nepal was observed. These compounds exhibited varying concentration ranges, consistently higher in all examined plant parts [26].

4.2 Influence of solvents extraction on phytocompound diversity

The comparative crude extraction based on polarities among methanol, dichloromethane, and petroleum ether revealed distinct performance trends across different plant parts; the results indicated that distinct solvents led to diverse extraction efficiencies. The difference can be clarified by the differing polarization of the extraction solvents used, which in turn contribute to a significant fluctuation in the concentration of bioactive compounds within the extract [27]. Methanolic solvent exhibited greater extraction yields in leaves (Table 1), compared to dichloromethane and petroleum ether extracts; this suggests that the extraction process is more effective when using solvents with higher polarity [28]. This pattern shifted in the case of bark and roots (Table 2 & 3), where dichloromethane demonstrated superior extraction capabilities; this confirms that the composition and distribution of the targeted compounds within the plant parts play a role in determining the most suitable solvent for extraction [29].

The observed variations in the number and concentration of phytocompounds among the different extracts may be attributed to the solvent-specific extraction efficiency and selectivity [30]. Methanol, being a polar solvent, likely extracted a broader spectrum of polar compounds in leaves, while petroleum ether and dichloromethane, being less polar, targeted a different set of compounds. Also, the following factors could contribute to the high yield; strong interaction between solvents and phytocompounds, high affinity of solvent and the ability of solvents to breakdown cell wall in extracting compound in a specific plant part [31]

4.3 Biological potentials of phytocompounds

The reported phytocompounds exhibited an extensive array of biological effects that encompass anticancer, antifungal, antimicrobial, nematocidal, and anti-oxidative properties and anti-diabetic effects [15]. Among the phenylpropanoids, eugenol has been described as having antibacterial properties, which were tested against both gram-negative and gram-positive bacteria [32]. Another research study investigated the potential of eugenol compound as an antimicrobial agent against different types of bacteria that are commonly found in food; specifically, this study examined the effectiveness of eugenol against three types of foodborne pathogens, including *Escherichia coli*, *Salmonella enterica serovar typhimurium*, and *Staphylococcus aureus* [33]. These results indicate that eugenol has promising antimicrobial properties that could potentially be used to prevent the growth of these harmful bacteria in food products.

Sesquiterpenes(longifolene) have gained attention for their potential to combat fungal infections. Previous research has explored the effectiveness thereof against types of fungi, including *Penicillium chrysogenum* and *Leotiomycetes* [34]. However, preceding study indicate that longifolene has minimal-to-no-activity when tested against these fungal groups. Despite being present in significant amounts in Allspice, these sesquiterpenes may not be sufficient as standalone antifungal agents against the tested fungal strains; this suggests that additional factors or compounds may be necessary to enhance their properties, or that their effectiveness might be specific to certain fungal species or strains not included in the tests [35].

Phytosterols has ability to interfere with the transporters to absorb cholesterol and promote its elimination from the body through fecal excretion; this mechanism contributes to a reduction in bloodstream cholesterol levels [36]. In addition to their ability to reduce cholesterol, phytosterols also demonstrate inflammatory properties. Chronic inflammation is closely linked to cardiovascular diseases such as atherosclerosis, where there is an accumulation of cholesterol in arteries [37]. Furthermore, studies have shown that phytosterols can regulate the response of phagocytosis and inhibit inflammatory by suppressing the production of pro-inflammatory cytokines and reducing the activation of inflammatory pathways [38].

5 Conclusion

The study compared the variation of compounds in Allspice grown in Tanzania, specifically focusing on the plant's leaves, bark, and roots. The results indicated differences in the presence of various beneficial compounds, with the highest concentration found in the leaves, followed by the bark, and then the roots. However, each part of the plant demonstrated a unique compound compared to the others. In extraction, methanol proved to be the most efficient solvent for leaves, while dichloromethane was found to be the most effective for extracting compounds from the bark and roots. These findings contribute to a better understanding of the distribution of beneficial compounds in different parts of the Allspice plant and inform optimal extraction methods for specific plant components.

6 Declarations

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6.2 Competing Interests

There is no conflict of interest regarding this research. There are no financial or personal relationships with other individuals or organizations have inappropriately influenced, or could be perceived to influence, the work presented in this manuscript.

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