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Characterization of the Chemical Components of Various Onion Species in West Sumatra

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Abstract. *Various types of onions have long been utilized as both culinary ingredients and traditional medications, yet comprehensive comparative data on their chemical composition and antioxidant potential in Indonesia are limited. This study provides the first integrated analysis of six onion species cultivated in West Sumatra, namely, shallot (A. cepa* var. *ascalonicum), garlic (A. sativum), common onion (A. cepa* L.*), Dayak onion (Eleutherine palmifolia), chive (A. tuberosum), and leek (A. fistulosum* L.*). Physicochemical properties were determined through proximate analysis, antioxidant activity was assessed using the DPPH assay and expressed as* IC_{50} *values, and lipid-based phytochemical profiles were obtained via Bligh and Dryer extraction, followed by GC–MS. Data were processed and visualized in RStudio. The results indicate that chive exhibited the highest moisture (93.57%) and fat (4.15%) contents, whereas Dayak onion contained the highest amounts of ash (6.29%) and protein (8.74%). Dayak onion exhibited strong antioxidant activity (84.85 ppm), whereas common onion, shallot, and leek demonstrated weak antioxidant activity. Cis-vaccenic acid was the dominant compound in shallot (37.59%) and leek (31.19%), and D-limonene was the dominant compound in Dayak onion (22.39%) and chive (21.16%). The study findings highlight that the Dayak onion is a promising indigenous source of natural antioxidant for functional food and herbal product development, while providing novel baseline phytochemical data for advancing onion bioactivity and biodiversity research.*
Keywords: *antioxidant; chemical composition; extract; onion; West Sumatra.*

Type of the Paper: Regular Article.

1. Introduction

The Indonesian people have long established a body of knowledge of plants with medicinal properties or the ability to cure various diseases. Medicinal plants now serve as an alternative in medical practice, aligned with the increasing preference of the public for natural ingredients that are believed to have lower side effects compared to synthetic drugs. It is their belief that natural medicines are safer, easier to be accepted by the body, and more aligned with health needs holistically, without causing long-term negative impacts as often associated with the use of synthetic drugs [1]. Among the plants that exhibit the potential to be used for medication are onions. Onions have different components depending on the type.

The shallot, for example, has been reported to possess various bioactivities, including antifungal, antiviral, anti-inflammatory, antihypertensive, antidiabetic, antiallergic, and hypolipidemic activities. These activities are attributed to the cinnamic acid, caffeic acid, lauric

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acid, mustard acid, and quercetin contents in shallot [2]. The main aromatic compounds in shallot contain sulfur; when the shallot bulbs are disrupted, the alliinase enzyme catalyzes the hydrolysis of S-alk(en)yl-L-cysteine sulfoxides to produce a variety of sulfur-containing volatile compounds [3]. The sulfur-containing compounds in shallot are not only related to medicinal properties, but also to their pungent aroma. Therefore, the sulfur-containing compound content in shallot serves as an important reference for measuring shallot quality [4].

The garlic contains anthraquinones, saponins, tannins, and alkaloids. These compounds fight oxidants and increase the potential activity of insulin, glucose, and lipid metabolism [5]. Flavonoids are active compounds that function as antibacterial through a mechanism that inhibits the function of the cytoplasmic membrane and the synthesis of nucleic acids. Garlic is also rich in these (quercetin), as well as in other compounds such as glycosides, phenols, petrin, and saponins [6], which act as antioxidants and stimulants of the immune system. In addition, organosulfur compounds also function as antibacterial [7]. The chive contains flavonoid compounds and saponins [8]. Meanwhile, the Dayak onion is known as a powerful antioxidant because it contains secondary metabolite compounds such as flavonoids, ketone aldehydes, carboxylic acids, glycosides, tannins, phenols, carbohydrates, and proteins [9]. In sum, all types of onion contain antioxidants that are beneficial to the body.

Antioxidants reduce damage caused by ROS (reactive oxygen species) and RNS (reactive nitrogen species), hence their ability to limit the negative effects of free radicals by preventing the formation of reactive radicals or by interfering with free radical reactions. In other words, antioxidants work by delaying or preventing the oxidation of free radical compounds. Antioxidants are essential to prevent oxidative stress, which currently is believed to have a significant negative impact on various diseases [10]. In addition to being antioxidant, onions also have the potential as antihypertensive, antineoplasm, and antimicrobial, as well as the potential in cholesterol lowering, platelet aggregation reduction, and atherosclerosis plaque reduction [11].

The compounds contained in onions can be obtained through lipid extraction using the Bligh and Dryer method, which involves the use of a combination of chloroform, methanol, and water solvents to efficiently extract lipids. This extraction method is a cold extraction method that does not involve heat, thus preventing the damage of components that are vulnerable to heat. This study aimed to identify the chemical components of several types of onion found in West Sumatra and conduct *in vivo* tests on the identified chemical components to assess their potential effectiveness in overcoming diseases.

2. Materials and Methods

2.1. Materials

The raw materials used in this study were shallots (*Allium cepa*) and garlic (*Allium sativum*) from Nagari Alahan Panjang, Solok Regency, West Sumatera, Indonesia, a region lying at about 1,300–1,500 meters above sea level with a temperature of 18–26°C; common onions (*Allium cepa* L.) from a the Traditional Market of Padang City; Dayak onions (*Eleutherine bulbosa*) from Nagari Lubuk Alung, Padang Pariaman Regency, West Sumatera, Indonesia, a region lying at 100–200 meters above sea level with a temperature of 24–32°C (used in the bulb part); leeks (*Allium fistulosum* L.) from Nagari Suliki, Lima Puluh Kota Regency, West Sumatera, Indonesia, a region lying at 1,000 meters above sea level with a temperature of 18–26°C (used in the leaf and bulb parts); and chives (*Allium tuberosum*) from Padang City, West Sumatera, Indonesia, a region lying at 0–50 meters above sea level with a temperature of 24–32°C (used in the leaf part). The chemicals used for analysis were PA methanol, technical methanol, chloroform (merck), 30% NaOH, H_2SO_4, selenium catalyst, 0.02 N HCl, distilled water, boric acid, N-hexane, and DPPH solution. The tools used for analysis were a gas chromatograph mass spectrometer (Shimadzu GCMS-QP2010 Ultra), spektrofotometritipeuv-vis tipe 1800 shimadzu double beam, a rotary vacuum evaporator, an oven, an hot plate, a picnometer, water baths, a desiccator, an analytical balance, and glassware.

2.2. Methods

2.2.1. Research Design

This research was conducted using a descriptive method. The data obtained are presented in both qualitative and quantitative forms, elaborated based on numerical values and averages. The samples consisted of six types of onion, purposively collected from several regions in West Sumatra to compare the dominant compounds found in each type due to differences in geographical growing conditions. This research did not use a control group but compared each type of onion as an independent variable based on the analyzed chemical parameters as dependent variables. The analyses involved the determination of moisture content, ash content, protein content, fat content, and antioxidant activity (IC_{50}). In addition, chemical compound profiling using Gas Chromatography–Mass Spectrometry (GC–MS) was performed to identify potential bioactive compounds in each extract.

2.2.2. Bligh and Dryer Exctraction

Fresh onions were prepared by removing the skin first, followed by crushing the onions using a mortar until smooth. Each crushed onion (2.5 grams) was mixed with 2.5 mL of chloroform and 5 mL of methanol and vortexed for 10 minutes. Another 1.25 mL of chloroform was then added, and the mixture was vortexed for two minutes. After a series of vortexing, the mixture was filtered. The filtrate obtained was centrifuged for 10 minutes at a speed of 3000 rpm before being added with 1.25 mL of distilled water. The organic phase at the bottom was collected, while the phase at the top was discarded. The extracts obtained were analyzed using GC–MS [12].

2.2.3. Moisture Content Analysis

The drying method can determine moisture content in a food sample. In this study, the initial mass of each sample was weighed using an analytical balance. Next, the sample was placed in a preheated oven to a specific temperature (105°C) and left for a set duration (24 hours) to ensure that all moisture evaporated. After drying, the sample was removed from the oven and allowed to cool in a desiccator to prevent moisture absorption from the air. Once the sample had cooled, the final mass was determined. The analysis of moisture content provided essential information about the onions' quality and shelf life [13].

2.2.4. Ash Content Analysis

The procedure for ash content analysis began by weighing approximately 2 grams of a dried sample and placing it in a ceramic crucible. The crucible was heated in a furnace at 550°C for 4–six hours until all organic matter was burned off, leaving only inorganic residue. After incineration, the crucible was removed and cooled in a desiccator to prevent moisture absorption. Once cooled, the weight of the crucible containing the ash was measured. This procedure provided information about the mineral content and purity of the onions [13].

2.2.5. Protein Content Analysis

The procedure for protein content analysis began by weighing 1 gram of a sample into a Kjeldahl flask, followed by adding a catalyst mixture and 25 mL of concentrated sulfuric acid. The mixture was then heated until the solution became clear. Once cooled, the solution was diluted with distilled water, and 75 mL of 30% NaOH was added to make it alkaline. The solution was then filtered, and the released nitrogen was captured in a boric acid solution. Afterward, the solution was titrated with 0.1 N HCl to determine the nitrogen content. The protein content was calculated by multiplying the nitrogen content obtained by the appropriate conversion factor, providing information about the protein content in the sample [13].

2.2.6. Fat Content Analysis

The procedure for fat content analysis began by weighing approximately 1 gram of a dried sample and placing it into an extraction flask. Next, a solvent (ether or petroleum ether) was added to the flask, and extraction was performed using a Soxhlet apparatus for several hours. During the extraction process, the solvent evaporated, leaving dissolved fat behind. The remaining fat was then weighed to determine its mass. This procedure provided information about the fat content in the analyzed sample [13].

2.2.7. Antioxidant Analysis

A sample of 1 gram was placed into a 100 mL volumetric flask, and methanol was added to the calibration mark to obtain a concentration of 10,000 mg/L. Then, serial dilutions were performed by adding methanol to obtain samples with concentrations of 200, 400, 600, 800, and 1,000 mg/L. To determine antioxidant activity, 2 mL of each concentration was taken and mixed with 1 mL of DPPH solution at a concentration of 100,000 mg/L. The mixture was homogenized for 15 minutes in a dark place. A blank was prepared by pipetting 2 mL of methanol and adding 0.5 mL of methanol and 0.5 mL of DPPH solution. The absorbance was measured using a UV-Vis spectrophotometer at a wavelength of 517 nm [14].

2.2.8. Gas Chromatography–Mass Spectrometry (GC–MS) Analysis

Onion characterization used a Shimidzu GCMS–QP2010 Ultra spectrometer (Shimadzu Scientific Instruments, Columbia, MD, USA). The instrument operated in an electron ionization (EI) mode set at 70eV electron energy with a scan range of 40–400 amu and a scan speed of 3 scans per second, coupled with GC–MS solution software. A DB-5ms capillary column (Agilent Technologies, Santa Clara, CA, USA) 30 m in length and 0.25 mm in inner diameter, with a stationary phase of phenyl arylene polymer virtually equivalent to (5%-Phenyl)-methylpolysiloxane and a column stationary phase layer thickness of 0.25 µm, was used. Helium was utilized as a phase of motion with a pressure regulation at 200 kPa and a flow rate of 1.37 mL/min in the column. The injector temperature was set at 250°C, and the ion source temperature was set at 200°C. The GC oven temperature was initially programmed to 50°C in 2°C/min increments until the final pad temperature reached 260°C [15].

2.2.9. Data Analysis

All experiments were conducted in triplicate for each onion type. The results are expressed as means ± standard deviations (SDs). Data analysis and visualization were carried out using RStudio software. Principal Component Analysis (PCA) was used to visualize the distribution of metabolite compounds among the onion types based on GC–MS data.

3. Results and Discussion

An analysis of moisture content, ash content, protein content, fat content, and antioxidant activity (IC_{50}) was carried out on several types of onions, namely, shallot, garlic, common onion, leek, Dayak onion, and chive. The analysis results can be seen in Table 1.

3.1. Moisture content

As high moisture content increases onions' vulnerability to damage during storage, it is deemed necessary to determine the optimal moisture content of onions to maintain the onion quality during storage. Too high a water content of onions can cause rot and damage, such as the appearance of roots, while too low a water content of onions can result in high weight loss, thereby decreasing the quality of the bulbs. Moisture content is one of the factors that affect the durability of food [16].

Table 1. Results of analysis of the chemical characteristics of several types of onions

Types of Onion	Chemical characteristics				
	Water Content (%) Mean ± SD	Ash Content (%) Mean ± SD	Protein Content (%) Mean ± SD	Fat Content (%) Mean ± SD	IC_{50} (ppm) Mean ± SD
Shallot	84.32 ± 0.73	5.52 ± 0.003	2.52 ± 0.003	1.12 ± 0.02	166.87 ± 104
Garlic	72.65 ± 0.47	4.55 ± 0.04	6.55 ± 1.82	1.05 ± 0.01	567.57 ± 354.2
Common onion	93.14 ± 0.95	5.82 ± 0.05	6.14 ± 0.002	0.84 ± 0.02	162.29 ± 0.90
Leek	91.67 ± 0.69	1.62 ± 0.01	1.81 ± 0.001	1.57 ± 0.02	169.47 ± 1.51
Dayak onion	79.21 ± 2.19	6.29 ± 0.06	8.74 ± 0.03	2.11 ± 0.02	84.85 ± 120
Chive	93.57 ± 0.04	3.26 ± 0.03	3.13 ± 0.02	4.15 ± 0.02	665.40 ± 354.2

Note: SD = standard deviation

Based on the data in Table 1, moisture content varied for each type of onion. The highest moisture content was found in chive, which was 93.57%. Garlic had been previously found to have a moisture content ranging from 13.68% to 56.72%, significantly lower than the 83.3 grams of moisture per 100 grams found in chive, confirming the lower moisture content of garlic [17]. This research is in line with the research conducted by Sitinjak and Sinaga [18], which found garlic's moisture content at 72.65%. The results of this study are also consistent with the research of Hidayat et al. [19], which recorded a garlic moisture content of 60–63%. The moisture content of shallot reached 84.32%. Mutia [16] also reported a moisture content of 85.25%. Leek had a moisture content of 91.67%. Meanwhile, Dayak onion had a moisture content of 79.21%, which is classified as fairly high. The high moisture content increases Dayak onion's susceptibility to fungal growth, especially that of *Aspergillus niger*, which are a major cause of agricultural loss [20].

3.2. Ash content

Ash is an inorganic residue from the combustion or oxidation of organic components of food [21]. Ash content is a mixture of organic matter and minerals found in food. The initial principle of ash content measurement is to determine the amount of ash in a material, which corresponds with the amount of minerals in the material [22]. Determining ash content will help control the amount of inorganic contaminants that are often carried on plant preparations, such as soil [23]. Based on the study results shown in Table 1, ash content differed for each type of onion. The highest ash content was found in Dayak onion at 6.29%, followed by common onion at 5.82%, shallot at 5.52%, garlic at 4.55%, chive at 3.26%, and leek at 1.62%. The variety in ash content is in line with the findings of Manfaati et al. [21], who reported that nutrient content differs based on onion variety.

In this study, shallot was found to contain ash at 5.52%, which is lower than the values for shallots from Palu Valley, Sigi Regency, (6.20%) but higher than the 2.67% content reported by Manfaati et al. [21]. Daniela et al. [24] found that every 100 g of onion tubers contained minerals that included 36 mg of calcium, 40 mg of phosphorus, and 0.8 mg of iron.

Meanwhile, the ash content in garlic in this study was 4.55%, close to the 3.697% level reported by Zulfanita et al. [25]. According to Ladeska et al. [6], garlic contains minerals, including sulfur in the form of diallyl thiosulfinate (allicin) and diallyl disulfide (ajoene). In common onion, this study found an ash content of 5.82%, similar to the 5.16% level reported by Murnah [26]. According Wang et al. [27], common onions contain active components, especially minerals, such as potassium, phosphorus, calcium, manganese, sodium, and sulfur, as well as iron, zinc, copper, and selenium. Furthermore, this study found an ash content of 1.62% in leek, similar to the 0.82% level reported by Puspadewi et al. [28]. The ash content of Dayak onion in this study was 6.29%, similar to the ash content reported by Nurasiyah [29], namely, 6.39%. However, another study by Saragih [30] showed a value three times as high as that reported in this study, namely, 19.20%. Finally, the ash content of chive in this study was 3.26%, below the 7% standard for ash content set by SNI 01-3709-1995 [31].

3.3. Protein content

Protein is a macronutrient that plays a vital role in the body as a regulatory and building agent. It is a compound consisting of amino acids linked by peptide bonds. It is involved in metabolic processes, cell defense mechanisms, as well as enzyme and hormone functions [32]. This study found protein contents of 2.52% in shallot and 6.55% in garlic. Kiura et al. [33] reported that 100 grams of garlic contained 5.3 grams of protein. The protein content in common onion was 6.14%. In leek, it was 1.81%, quite similar to the 1.83% level found by Dewi et al. [34]. Meanwhile, the protein contents in Dayak onion and chive were 8.61% and 3.13%, respectively. Vidiantika et al. [32] has previously found that every 100 grams of chive contained 2.2 grams of protein. From these results, it can be concluded that Dayak onion contained the highest level of protein among the onions. Dayak onion contains the amino acid phenylalanine, which plays a role in the formation of anthocyanins through enzymatic reactions; the anthocyanins that are formed in turn produces the red pigment in Dayak onion [9].

3.4. Fat content

Fats and oils are classified as lipids, a group of organic compounds characterized by its insolubility in water and solubility in organic solvents such as ether, benzene, and chloroform [35]. In this study, fat content significantly varied from one type of onion to another, reflecting the influence of factors such as planting media, fertilizer use, plant age, plant variety and genetics, testing techniques, and environmental conditions. The results obtained for different kinds of onion from this study as well as from those preceding it provide valuable insights into the nutrient composition of onion plants.

The fat content of shallot in this study was 1.12%. Using various treatments of planting media, Valdes et al. [36] found similar values of fat content in shallot within the range of 1.33–1.75 grams. Meanwhile, common onion and leek were found to contain fat at 0.84% and 1.57%, respectively. Hidayat et al. [37] reported a fat content of 0.40 grams in every 100 grams of leek. In this study, Dayak onion was found to contain fat at 2.11%, higher than the 0.96% level reported by Mokoginta et al. [9]. Finally, this study found a fat content of 4.15% in chive, which is significantly higher than reported by Fadlilah and Lestari [38] (0.39%).

3.5. Antioxidant Activity

Antioxidants are substances that protect cells from damage caused by unstable molecules known as free radicals. Given their vital role in life, it is essential that antioxidants be included in diets to improve health. Antioxidants can reduce the risk of developing degenerative diseases such as cardiovascular disease, cancer, hypertension, atherosclerosis, and osteoporosis, among others. Consumption of food rich in antioxidants can improve immunological status and inhibit the onset of degenerative diseases due to aging. Therefore, adequate amounts of antioxidants are required for good health for individuals of all age groups. Antioxidants can either be produced endogenously or be obtained from exogenous sources, such as natural ingredients with pigments or secondary metabolite compounds [39]. Antioxidant activity results from hydroxy group bonds on aromatic rings that are easily oxidized by donating H atoms to free radicals. If the level of enzymatic antioxidants as part of the body's defense system is no longer adequate in warding off free radicals, oxidative stress may occur. It refers to a state of imbalance between oxidants and antioxidants [40].

Antioxidant activity in this study was measured using the DPPH method and expressed as IC_{50} values. IC_{50} is a widely accepted parameter to express antioxidant capacity as it quantitatively represents the concentration of an extract required to inhibit 50% of DPPH radicals [10] in units (µg/mL or mg/L), allowing for a standardized comparison of antioxidant potency among different samples. The lower the IC_{50} value, the stronger the antioxidant activity of the sample [41]. Antioxidant activity is classified based on IC_{50} values as very strong (< 50 ppm), strong (50–100 ppm), moderate (100–150 ppm), weak (150–200 ppm), or very weak (> 200 ppm) [42]. In this study, IC_{50} antioxidant analysis was carried out at sample concentrations of 200 ppm, 400 ppm, 600 ppm, 800 ppm, and 1000 ppm. Absorbance was calculated to obtain the percentage of inhibition using the regression equation. Extraction used the Bligh and Dryer method with the like-dissolved-like principle, which is based on the similarity of polarity between the solute and the solvent so that the polar substance will be soluble in the polar solvent and the non-polar substance will be soluble in the non-polar solvent [43].

With regard to antioxidant activity, this study found differing results, as shown in Table 1, than those reported in existing literature on various types of onions. In this study, Dayak onion was found to have an IC_{50} value of 84.85 mg/L, which is classified as strong. Mokoginta et al. [9] and Putri and Marsiati [44] both found antioxidant activity within the same category, with IC_{50} values of 41.46 mg/L and 46.14 mg/L, respectively. On the other hand, chive was found to have an IC_{50} value of 665.40 mg/L, which is classified as very weak. Another study [source] also found a weak antioxidant activity in chive, with an IC_{50} value of 284.56 mg/L. Although these categories are similar, variations in the composition of chives and antioxidant test techniques could cause differences in the IC_{50} values obtained. As for garlic, the IC_{50} value obtained in this study was 567.5 mg/L, which is categorized as very weak. Hikmah and Anggarani [45] have previously found that garlic had an IC_{50} value of 299.54 mg/L. The consistency of these results shows that the categorization of garlic as a very weak antioxidant is not significantly affected by the test method or extraction conditions. In this study, shallot had an IC_{50} value of 166.87 mg/L, placing it within the weak antioxidant category. In comparison, Mladenović et al. [46] obtained an IC_{50} value of 384.03 mg/L in shallot. Despite variation in the IC_{50} values, which could be attributed to the different methods and test materials used, antioxidants within this category could still overcome free radicals. Furthermore, in this study, leek had an IC_{50} value of 169.47 mg/L, classifying it as a weak antioxidant. However, Ladeska et al. [7] found a significantly lower IC_{50} value in leek, namely, 61.05 mg/L. The extraction method used and the quality of sample could significantly affect the antioxidant effectiveness, and thus variations in these aspect could lead to variations in IC_{50} value. Finally, this study found an IC_{50} value of 162.29 mg/L in common onion, which is classified as weak. This is in contrast to the IC_{50} value of 65.31 mg/L reported by Kuntorini and Astuti [47]. This discrepancy may be caused by differences in the extraction method and onion composition, which could vary according to the region of origin of the sample used. The difference in the resulting values could be caused by multiple environmental factors, such as the plant seeds from which the plants grew, weather or climate, the environment where the plants grew, and the planting method used [48].

Various environmental factors such as air, water, soil, temperature, precipitation, and elevation, as well as genetic variation among the plant species or within the individuals of same species, have an extensive influence on the synthesis and concentration of phytochemicals and their bioactive potential [49]. For example, the synthesis of secondary metabolites, specifically phenolics and flavonoids, is mainly affected by environmental factors such as day length, intensity of light, temperature, concentration of nutrients, and water in the soil [50].

3.6. GC–MS Analysis

GC–MS analysis was employed to identify the volatile compounds present in the onion extracts obtained in this study, which may include a subset of secondary metabolites. The results of the GC–MS analysis are expressed as peaks representing different compounds (Fig. 1). Each peak was analyzed using a mass spectrometer and compared to an internal Willey library integral the GC–MS system. Despite its benefits, GC–MS has disadvantages in slow analysis time, the need for chemical modification, and the limited number of molecules analyzed [51].

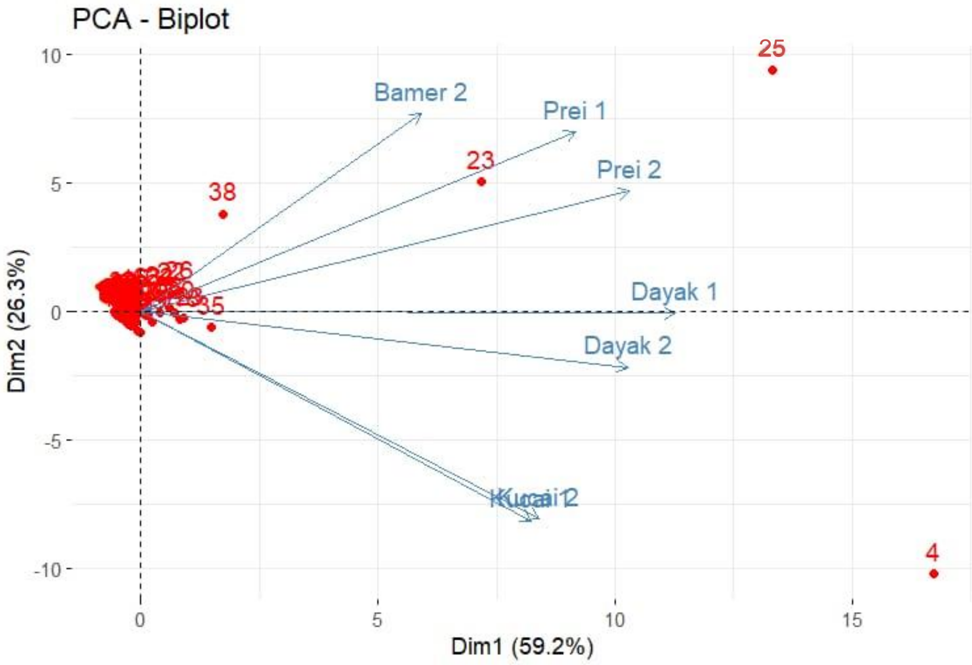

Fig. 1. PCA biplot illustrating metabolite compunds across several types of onions

The biplot above illustrates the distribution of metabolite compounds across several types of onion, represented by two main dimensions: Dim 1 and Dim 2. Dim 1 explains 59.2% of the variation in the samples, while Dim 2 explains 26.3% of the variation, resulting in a combined 85.5% variation in the data. This provides a fairly comprehensive representation of the metabolite differences between different types of onion. This analysis began with the extraction of lipids from onions using the Bligh and Dryer method. This method involved using a mixture of chloroform , methanol, and water solvents to separate lipids from other components in the samples. This mixture rendered phase separation, with lipids dissolved in the chloroform layer and the rest dissolved in the methanol–water layer [52].

The extracted metabolite compounds were analyzed using Gas Chromatography–Mass Spectrometry (GC–MS). The principle of separation in this method is by partitioning the components of a compound based on the boiling point and polarity of the components of the compound using the gas phase as the phase of motion [53]. The two treatments for leek (Prei 1 and Prei 2) are shown with arrows close to each other on the biplot, suggesting similar metabolite profiles. Compound 23 and Compound 38 (octadecanoic acids) appear as markers for leek, as indicated by the proximity of the biplot line leading from each of these compounds to where leek is on the diagram; this indicates that leek had a significant octadecanoic acid content.

The treatments for Dayak onion (Dayak 1 and Dayak 2) are also located close to each other on the biplot, indicating similar metabolite profiles between the two. The biplot lines indicate that Dayak onion had metabolic components similar to chive and shallot, although no specific compounds appear as prominent markers as with leek. The treatments for chive (Chive 1 and Chive 2) are similarly distributed as Dayak onion, as indicated by adjacent biplot lines, suggesting that chive had a similar metabolite profile to Dayak onion. The metabolite compounds in chive tended to be more evenly distributed, without any prominent markers. On the other hand, shallot (Bamer 2) had a similar distribution to leek and chive, suggesting similarities in some metabolite components.

Analysis showed that both octadecanoic acids (Compound 23 and Compound 38) appear significant in leek, with a biplot line pointing directly to leek's position. This shows that octadecanoic acids were the main components of leek. Compound 4, which is D-limonene, appears to be dispersed in all types of onion, which means that D-limonene was a common component found in the different kinds of onion tested. Compound 25, cis-vaccenic acid, appears to be distributed far from the center, suggesting that cis-vaccenic acid was a specific marker for a particular treatment or type of onion with an uneven distribution among different types of onion. The biplot above provides a clear visual representation of how various metabolite compounds were distributed among different types of onion. Leek appears to have specific markers in the form of octadecanoic acids, while D-limonene was a common compound found in all types of onion. The similarity of metabolite profiles in leek, Dayak onion, and chive is indicated by the proximity of their biplot lines, while the distribution of compounds such as cis-vaccenic acid characterizes specific differences.

4. Conclusions

This study concludes that various types of onion in West Sumatra have diverse chemical characteristics. The highest moisture content, 93.57%, was found in chive. Dayak onion showed the highest ash and protein contents, at 6.29% and 8.74%, respectively, with a potent antioxidant activity as indicated by an IC_{50} value of 84.85. The highest fat content was found in chive at 4.15%, while the lowest was found in common onion. GC-MS analysis showed that cis-vaccenic acid was the dominant chemical component in shallot and leek. Meanwhile, the dominant element for Dayak onion and chive was D-limonene. These findings suggest that the Dayak onion may serve as a promising candidate for the development of natural antioxidant sources in functional food or herbal formulations. Additionally, this study provides a comparative chemical profile of six onion species grown in West Sumatra using a GC–MS-based lipid extraction approach, offering valuable baseline data for future studies on bioactivity and phytochemical diversity among different onion species. This study confirms that onions have a variety of beneficial chemical components, which support their use as natural ingredients in Indonesia.

Abbreviations

GC–MS	Gas Chromatography-Mass Spectrometry
ROS	Reactive oxygen species
PA	Pro Analysis
DPPH	(1,1-diphenyl-2-picrylhydrazyl)

Data avaibility statement

Data will be shared upon request by the readers.

CRediT authorship contribution statement

Fauzan Azima: contributed to the writing of the original draft, conceptualization, methodology, resources, formal analysis, investigation, and data curation. **Daimon Syukri**: was involved in writing the review and editing, validation, data curation, formal analysis, conceptualization, supervision, and funding acquisition. **Fenita Miati**: focused on conceptualization, supervision, data curation, and writing the review and editing.

Declaration of competing interest

The authors of this manuscript declare no conflict of interest or competing interest.

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