pISSN: 1411-8327; eISSN: 2477-5665
Terakreditasi Nasional Peringkat 2, Dirjen Riset dan Pengembangan,
Kemendiktisaintek RI SK No 10/C/C3/DT.05.00/2025, 21 Mar.2025

Maret 2025 Vol. 26 No.1: 73-81
DOI: 10.19087/jveteriner.2025.26.1.073
online pada http://ojs.unud.ac.id/index.php/jvet

Phytochemicals of Peat land *Sauropus androgynus* Leaves and Their Potential Use in Improving Performance of Broiler Chickens

(FITOKIMIA DAUN KATUK (*SAUROPUS ANDROGYNUS*) LAHAN GAMBUT DAN POTENSI PENGGUNAANNYA DALAM PENINGKATAN PERFORMA AYAM PEDAGING)

Ardi Sandriya[*], Nabil Fariz Noorrahman, Maria Haryulin Astuti, Paulini, Ria Anjalani

Animal Science Study Program,
Faculty of Agriculture,
University of Palangka Raya
Jl. Yos Sudarso, Palangka Raya,
Central Kalimantan, Indonesia 74874
[*]Email: ardisandriya@pet.upr.ac.id

ABSTRACT

This study aims to determine the content of secondary metabolites in katuk (*Sauropus androgynus L. Merr.)* leaves growing in peatlands through phytochemical tests. The ethanol extract of katuk (*Sauropus androgynus L. Merr*.) leaves obtained from peatlands was subjected to phytochemical screening, revealing the presence of secondary metabolites such as flavonoids, alkaloids, phenol, saponins, tannins, terpenoids, and steroids. This content has different results from the ethanol extract of katuk leaves from mineral soil. The organoleptic test results demonstrated that the ethanol extract obtained from katuk leaves originating from peatlands had a thick form, the distinctive smell of katuk leaves, a bitter taste, a brown colour, an ash content of 7.56 ± 0.87, and a mass loss of 3.82 ± 1.49. This result is the same as the ethanol extract of katuk leaves from mineral soil. All the ingredients in the ethanol extract of katuk leaves from peatlands can enhance the productivity of broiler chickens. It can be concluded that the type of soil where the plant grows influences the results of its secondary metabolites and the findings from the analysis of the phytochemical content in the extraction of katuk leaves originating from peatlands are different from katuk leaf extract originating from mineral soil.

Keywords: broiler chickens; ethanol extract of katuk leaves; secondary metabolites peatland; performance

ABSTRAK

Penelitian ini bertujuan untuk mengetahui kandungan metabolit sekunder daun katuk (*Sauropus androgynus L. Merr*.) yang tumbuh di lahan gambut melalui uji fitokimia. Ekstrak etanol daun katuk (*Sauropus androgynus L. Merr*.) yang diperoleh dari lahan gambut dilakukan skrining fitokimia dan diketahui adanya metabolit sekunder berupa flavonoid, alkaloid, fenol, saponin, tanin, terpenoid, dan steroid. Hasil skrining fitokimia ekstrak etanol

daun katuk (*Sauropus androgynus L. Merr*.) yang berasal dari lahan gambut mengandung metabolit sekunder berupa flavonoid, alkaloid, tannin, fenol, saponin, steroid, dan terpenoid. Kandungan tersebut berbeda dari ekstrak etanol daun katuk yang diambil dari tanah mineral. Hasil uji organoleptik menunjukan ekstrak etanol daun katuk yang berasal dari lahan gambut memiliki bentuk yang kental, bau khas daun katuk, rasa pahit, warna coklat, kadar abu 7.56±0.87, dan susut massa 3.82±1.49. Hasil ini sama dengan ekstrak etanol daun katuk yang diambil dari tanah mineral. Semua senyawa yang terkandung pada ekstrak etanol daun katuk dari lahan gambut berpotensi meningkatkan produktivitas ayam pedaging. Dapat disimpulkan baahwa jenis tanah tempat tanaman tumbuh mempengaruhi hasil metabolit sekundernya dan hasil skrining fitokimia ekstrak daun katuk yang berasal dari lahan gambut berbeda dengan ekstrak daun katuk yang berasal dari tanah mineral.

Kata-kata kunci: ayam broiler; ekstrak etanol daun katuk; metabolit sekunder; tanah gambut; performa

INTRODUCTION

Peatlands in Southeast Asia account for 56.6%, around 25 Mha of the world's total peatlands of 34-45 Mha in tropical climates. Indonesia has peatlands covering an area of 13.4-14.9 Mha spread across Sumatra, Kali-mantan, Papua and Sulawesi (Yuwati *et al*. 2021). Peatlands have high carbon content. Carbon rich ecosystem can be formed due to complex interactions between several environ-mental elements, including topography, clima-te, hydrology, biogeochemistry and microbial ecology (Miettinen *et al*. 2011). In Indonesia, productive land is often converted into resi-dential, industrial and property areas. So pro-ductive land is increasingly limited and encou-rages farmers and breeders to use marginal land, such as peatlands (Fitri *et al*., 2021). Therefore many peatlands were converted into livestock area. The most popular livestock to develop is poultry.

One of the industries with the quickest growth rate for protein is poultry farming, which also provides the most significant amo-unt of protein from animal sources, which is crucial food availability worldwide (Amer *et al*., 2022). The development of poultry farming is more popular, especially in Indo-nesia, because production results are obtained more quickly compared to other sources of animal protein. In Indonesia, broiler chicken farming continues to experience growth. In 2020, Indonesian broiler chicken farms reached a total production of 3,219,117 tons and will increase in 2022 to 3,765,573 tons (BPS-Statistics Indonesia. 2023). Meeting animal feed adequacy usually uses a commercial feed that is mass-produced. However, there is no evidence that just providing this feed is enough to protect poultry from exposure to disease (Amer *et al*., 2022). The comer-cial chicken business can suffer greatly from the establishment and spread of infec-tious disease, particularly if those diseases are foodborne or zoonotic and potentially to have significant effects on public health (Sandriya *et al*., 2023). So, many farmers use additional feed additives to improve their chickens performance.

Feed additives are widely used in the poultry farming to increase production yields and maintain livestock health. The most widely used feed additives are anti-biotics. The use of antibiotics as feed addi-tives gives rise to several adverse effects such as poultry resistance to treatment and the emergence of resistant bacterial strains which have the potential to become zoonotic (Oleforuh-Okoleh *et al*., 2015). Low antibiotics doses have also been shown to cause DNA damage in mice's digestive systems, which could harm hu-man health and poultry products (Naee-masa *et al*., 2015). Therefore, there is a need for other alternatives to replace the use of antibiotics as feed additives.

Alternative feed ingredients to replace anti-biotics are currently a topic that is being

widely researched. Alternative ingredients that have high potential as additional feed ingre-dients are the use of herbs and medicinal plants (Oleforuh-Okoleh *et al*., 2015). One of the potential medicinal plants is *katuk* (*Sauro-pus androgynus L. Merr*.). Traditionally, the katuk plant (*S. androgynus L. Merr*.) has been used as a herbal medicine for treating bacterial infections, reducing inflammation, diabetes, and cancer (D'Souza *et al*., 2021). These various benefits are obtained from secondary plant metabolites with medicinal functions (Li *et al*., 2020).

Secondary plant metabolism is defined as metabolic products not directly involved in plant growth. This secondary metabolism can be in the form of taxoids, polysaccharides and flavones help protect plants from herbivores, bacteria, fungi and viruses, as well as commu-nication signals between plants (Yang *et al*., 2018). However, the formation of secondary metabolites is very dependent on environ-mental conditions, especially the mineral con-tent in the soil (Li *et al*., 2020). This study was purposed to assess the secondary metabolite composition of katuk (*S. androgynus L. Merr*.) leaves cultivated in peatlands using phyto-chemical analyses, as well as their viability as a potential dietary supplement for broiler chic-kens.

RESEARCH METHODS

Collection of Katuk Leaves

This research obtained fresh katuk (*S. androgynus L. Merr*.) leaves were obtained from the Kalampangan area, Palangka Raya City, Central Kalimantan, Indonesia. The ka-tuk (*S. androgynus*) leaf samples were taken from the same place.

Extraction

Extraction is carried out using the maceration method, namely soaking 250 g of simplicia powder in 70% ethanol filter fluid with a ratio of 1:10. The ethanol solvent (Merck®) used is analytical grade. Soaking is done for 24 hours, filtered and the liquid extract is stored in a closed container. The dregs obtained are soaked again in 70% ethanol filter fluid with a ratio of 1:10 and filtered after 24 hours. All liquid extracts obtained were then concentrated using an evaporator at 40 °C to produce a thick extract.

Phytochemical Screening

Qualitative phytochemical screening was performed using detection reagents by the guidelines outlined in the Indonesian Herb Pharmacopoeia (Ministry of Health Republic of Indonesia, 2017). The tested compounds included flavonoids, alkaloids, tannins, phenols, saponins, steroids and terpenoids.

Extract Characterization

The organoleptic analysis observes characteristics such as colour, shape, taste and aroma. Determining the ash content involved obtaining a 2 g sample of the extract and placing it in a vessel for analysis. After that, the sample is heated using a furnace until the temperature rea-ches 600°C and the carbon bonds are released. Subsequently, the specimen was cooled in a desiccator and weighed to determine the proportion of ash content. Measuring water content involves obtaining a 1-gram sample and depositing it into a container for analysis. The samples were subjected to drying at a temperature of 105°C until they achieved a stable and constant weight. The sample is weighed and the results of the water content calculation are expressed as a percentage.

Data Analysis

The data obtained is presented des-criptively.

RESULTS AND DISCUSSION

Plants are widely used as the main

ingredients for medicine because they contain organic molecules called secondary metabolites. This compound exhibits various pharmacological properties that are efficacious in treatment (Kuttinath *et al*., 2019). The results of the phytochemical screening of ka-tuk leaves originating from peatlands are pre-sented in Table 1. The test results, show katuk leaf extract contains flavonoids, alkaloids, tannins, phenols, saponins, steroids and terpe-noids. Choosing ethanol as an extraction solvent has many advantages, including being relatively safer and having high polarity (Hik-mawanti *et al*., 2021).

Table 1. Phytochemical screening of Katuk leaves originating from peatlands

No	Detected Compound	Katuk Leaf Extract
1	Flavonoid	+
2	Alkaloid	+
3	Tanin	+
4	Fenol	+
5	Saponin	+
6	Steroid	+
7	Terpenoid	+

Note: (+) present; (-) absent

The results of this phytochemical screening are different from those obtained by Fatmawati *et al*. (2022) who carried out extraction using a 70% ethanol solvent and katuk leaves from the Bogor area. In the katuk leaf extract obtained from the Bogor area, secondary metabolite compounds are alkaloids, phenols, flavonoids, saponins, tannins and steroids. There is no terpenoid content in this extract.

Katuk leaves in Indonesia are known as a local medical plant with many benefits (Putranto and Santoso, 2022). One of the ingredients in medicinal plants that provide benefits for broiler chicken farming is alkaloids. In testing the addition of extracts containing alkaloids, alkaloids were proven to have antibacterial and antifungal properties which could increase productivity and feed consumption for broiler chickens (Yusup *et al*., 2021). Alkaloids have a positive effect on digestibility by suppressing intestinal patho-gennic bacteria and modulating intestinal peristalsis (Arain *et al*., 2021).

Phenols derived from plants have antimicrobial and antioxidant activity. The phenols in *Salvia officinalis L.* extract have the most effective antibacterial activity against *Bacillus mycoides, Bacillus subtilis, Enterobacter cloacae* and *Proteus sp.,* (Rasouli *et al*., 2020). The antibacterial mechanism occurs due to the binding of phenol compounds to bacterial cells, possibly disrupting membrane permeability and transport processes. This results in the loss of cations and macromolecules from the cells so that the cells will be disturbed or die (Siregar *et al*., 2019).

Flavonoids have biological activity as antibiotics. Flavonoids are antibacterial through three mechanisms, namely inhibiting nucleic acid synthesis, inhibiting cell membrane function and inhibiting energy metabolism (Pangestika *et al*., 2020). Flavonoids have a hepatoprotective effect by acting as free radical scavengers that bind directly to Reactive Oxygen Species (ROS) or Reactive Nitrogen Species (RNS) and increase the activity of endogenous antioxidants (glutathione) in suppressing the production of free radicals in liver cells (Mistiani *et al*., 2020). Free radicals cause meat damage by producing unpleasant odours, loss of taste, texture, consistency and nutritional value (Kishawy *et al*., 2019). Flavonoids can increase the height of chicken duodenal villi (Fard *et al*., 2014).

Saponins are found in many secondary plant metabolites. Saponins are glycosides with high molecular weight. Giving saponin to broiler chickens can support growth rate, feed conversion efficiency and reduce harmful ammonia emissions from manure (Chaudhary *et al*., 2018). Zhang *et al*. (2017) added saponin from mangoes to broiler chicken feed. This addition showed that saponin could improve growth performance, meat quality, and plasma lipid metabolism in broiler chickens. The addition of saponin to broiler chicken feed was also useful for optimizing the immune system without disrupting growth rates (Bera *et al*., 2019). Apart from that, saponin in

broiler chickens is also useful in anti-coccidiosis and controlling the development of bacteria in the intestine (Bafundo *et al*., 2021).

Tannin is one of the secondary phenolic metabolites most commonly found in plant extracts. Adding low doses of tannin is very beneficial for the growth of broiler chickens. Giving low doses of tannin to broiler chickens can stimulate antioxidant status, improve the appearance of intestinal morphology and increase immunity (Hidayat *et al*., 2021). In research conducted by Perić *et al*. (2022) administering tannin to broiler chickens increased villi height, ratio, and villi area. Tannin exhibits the capacity to combat coc-cidiosis (Tosi *et al*., 2013).

Steroids are complex, fat-soluble orga-nic molecules not ester derivatives (Wutsqa *et al*., 2021). Plant steroids contribute to fat emulsification, improve digestion, and absorb vitamins and minerals to support poultry growth (Alghirani *et al*., 2021). Addition of the extract ccan make steroids increase avera-ge body weight and produce better Feed Conversion Ratio (Sahoo *et al*., 2015). Terpenoids are also called isoprenoids because their carbon structure is the same as that of isoprene compounds. This compound has anti-inflammatory properties in the respiratory tract, skin, joints and nerves (Wutsqa *et al*., 2021). Terpenoids can preserve the oxidative stability of lipids in broiler chicken meat (Alghirani *et al*., 2021).

This difference in results is thought to be due to the growing conditions of plants in different environments. The soil type in the Bogor area, West Java, Indonesia is a mineral soil type. All soil on the island of Java is classified as mineral soil because of its small variations (Miettinen *et al*., 2011). Meanwhile, the samples for this research were taken in the peat lands of Palangka Raya, Central Kali-mantan. Central Kalimantan is one of the regions with the most extensive peatlands in the world, and the third largest in terms of total land area in Indonesia (Puspitaloka *et al*., 2020). Peatland soil is very different from mineral soil (Schaafsma *et al*., 2017).

Plants need nutrients that are divided into two, namely macro and micronutrients. Peat land is land that has low nutrient elements. So it can be classified as having low fertility (Dhandapani *et al*., 2021). This is further exacerbated by the very low pH which causes several important nutrients are not available to plants (Puspitaloka *et al*., 2020). Low pH levels make peatlands classified as acidic. Very acidic conditions in peat lands results of low level of Kalium, Calcium and Maganesium (Adrial *et al*., 2020).

Mineral soils consist mainly (usu-ally > 95%) of mineral particles and control many soil properties (Wilson, 2019). In the Bogor area, West Java, Indonesia, the soil pH level is in the range of 4.69, so even though it is classified as mineral soil, this acidic condition causes phosphorus (P) deficiency (Martinsen *et al*., 2015).

Phosphorus (P) deficiency occurs due to the strong uptake of phosphate to surface oxides in the soil and the formation of insoluble iron (Fe) and aluminium (Al) phosphate (Cross and Schlesinger, 1995). However, the condition of mineral soil like this is still considered suitable for use as agricultural land.

Characteristics of a Katuk Leaf Extract from Peatlands

The results of organoleptic tests to see the characteristics of the extract are presented in Table. 2. The extract has a typical thick extract form, with a distinctive odour, bitter taste and a brown colour. These results are in line with the research conducted by Fatmawati *et al.* (2022), who obtained samples of katuk leaves from the Bogor area, West Java, Indonesia. The ash content of katuk leaf extract taken from peatlands is below 10%, namely 7.59%. Extracts have an ash content below 10% are classified as good (Hikmawanti *et al*., 2021). Ash content measurements are carried out to determine the content of organic and inorganic compounds and pro-vide an

overview of the mineral content. The drying mass loss of peat land katuk leaf extract was 3.82%. A mass loss range of less than 5% includes good quality (Hik-mawanti *et al*., 2021). The shrinkage rate is used to determine the maximum amount of compounds lost during the drying process.

Table 2. Characteristics of katuk leafextract originating from peatlands

No	Detected Compound	Katuk Leaf Extract
1	Form	Thick extract
2	Smell	Typical
3	Flavor	Bitter
4	Color	Brown
5	Ash Content	7.56±0.87
6	Lose mass	3.82±1.49

Note: Data presented are mean (n=3)

Potential of Peatland Katuk Leaves as Feed Additive

The use of katuk leaves has various contents according to phytochemical results (Table 1) and has benefits for the development of broiler chickens. Several studies have been conducted to test the effect of adding katuk leaves to feed. Katuk leaf extract with a 4.5 g/kg concentration can reduce haemorrhages in thigh meat and decrease fishy odour. Katuk leaf extract is rich in flavonoids, antioxidants and anti-inflammatory. These factors were predicted to play a role in reducing of haemorrhages in thigh meat. *Sauropus andro-gynus* leaves were rich in methylpyro-glutamate. Methylpyroglumate might convert to glutamic acid in the chicken gastrointestinal tract, increasing the glutamic acid levels in meat. These compounds may play an important role in decreasing of broiler meat odour (Santoso *et al*., 2013). The use of katuk leaf flour with a concentration of 9 g/kg produces a yellower carcass colour (Qotimah *et al*., 2014). This is because katuk leaf extract is rich in β-carotene, the katuk carotene content per 100 g is 10,020 μg. This substance is a colouring agent for the carcass.

Research conducted by Letis *et al*. (2017) used dry katuk leaf extract with a concentration of 17.07 g/kg, wet katuk leaf extract with a concentration of 0.96 g/kg, and katuk leaf juice with a concentration of 34.68 g/kg, which showed that it could reduce abdominal fat (inhibition of lipogenesis), increasing body weight growth and redu-cing cholesterol levels. The increase in body weight is thought to be due to the role of active compounds in eicosanoids and steroids, namely Androstan-17-one,3-ethyl-3-hydroxy-5alpha which can increase metabolism. The non-polar compounds in katuk leaves are more anabolic steroids. The presence of this compound is thought to be able to stimulate cell growth and increase body weight. The reduction in cholesterol occurs due to the ability of phytosterols to reduce cholesterol absorption and partially desuppress cholesterol biosynthesis. These results also align with research of Ismail *et al*. (2021) where giving 5% dense katuk leaf flour affected fat and carcass weight.

CONCLUSIONS

The ethanol extract of katuk (*S. androgynus*) leaves from peatlands is rich in secondary metabolites, including flavornoids, alkaloids, tannins, phenol, saponins, steroids and terpenoids. This content differs from the ethanol extract of katuk leaves obtained from regions characterized by mineral soil types. The organoleptic test results, the ash content and water content of the ethanol extract of katuk leaves from peat land were comparable to those of the ethanol extract of katuk leaves collected from mineral soil. Ethanol extract from katuk leaves can be used to improve the performance of broiler chickens.

SUGGESTION

Additional *in vivo* studies are required to ascertain the variations in effi-cacy when are utilized katuk leaves culti-vated in diverse soil compositions to enhan-ce the productivity of broiler chickens.

REFERENCES

Adrial A, Priyanto R, Salundik S, Prihantoro

I. 2020. Nutrient Adequacy and - of Parasitic Worm in Bali Cattle at Peatlands. *Indonesian Journal of Agricultral Science* 25: 269-276.

Alghirani MM, Chung ELT, Sabri DSM, Tahir MNJM, Kassim NA, Kamalludin MH, Nayan N, Jesse FFA, Sazili AQ, Loh TC. 2021. Can Yucca schidigera be used to enhance the growth performance, nutrient digestibility, gut histomorphology, cecal microflora, carcass characteristic, and meat quality of commercial broilers raised under tropical conditions. *Animals* 11: 1-14.

Amer SA, Al-Khalaifah HS, Gouda A, Osman A, Goda NIA, Mohammed HA, Darwish MIM, Hassan AM, Mohamed SKA. 2022. Potential effects of anthocyanin-rich roselle (*Hibiscus sabdariffa L*.) extract on the growth, intestinal histomorphology, blood biochemical parameters, and the immune status of broiler chickens. *Antioxidants* 11: 1-20.

Arain MU, Mughal GA, Bughio S, Arain MB, Siyal F, Arain AM. 2021. In vivo activity of different feeding levels of Greater Celandine (*Chelidonium majus*) extract on the growth performance and digestibility in broilers. *Int J Vet Sci Res* 7: 88–94.

Bafundo KW, Männer K, Duerr I. 2021. The combination of quillaja and yucca saponins in broilers: effects on performance, nutrient digestibility and ileal morphometrics. *British Poultry Science* 62: 589–595.

Bera I, Tyagi PK, Mir NA, Begum J, Dev K, Tyagi PK, Biswas A, Sharma D, Mandal AB. 2019. Effect of dietary saponin rich soapnut (*Sapindus mukorossi*) shell powder on growth performance, immunity, serum biochemistry and gut health of broiler chickens. *Journal of Animal Physiology and Animal Nutrition* 103: 1800–1809.

BPS-Statistics Indonesia. 2023. Statistik Indonesia 2023. Badan Pusat Statistik. 1–816.

Chaudhary SK, Rokade JJ, Aderao GN, Singh A, Gopi M, Mishra A, Raje K. 2018. Saponin in poultry and monogastric animals: A review. *Int J Curr Microbiol Appl Sci* 7: 3218–3225.

D'Souza JN, Nagaraja GK, Prabhu A, Navada KM, Kouser S, Manasa DJ. 2021. *Sauropus androgynus* (L.) leaf phytochemical activated biocompatible zinc oxide nanoparticles: an antineoplastic agent against human triple negative breast cancer and a potent nanocatalyst for dye degradation. *Applied Surface Science* 552: 1-21.

Dhandapani S, Evers S, Ritz K, Sjögersten, S. 2021. Nutrient and trace element concentrations influence greenhouse gas emissions from Malaysian tropical peatlands. *Soil Use and Management* 37: 138–150.

Fard SH, Toghyani M, Tabeidian SA. 2014. Effect of oyster mushroom wastes on performance, immune responses and intestinal morphology of broiler chickens. *International Journal of Recycling of Organic Waste in Agriculture* 3: 141–146.

Fatmawati S, Hikmawanti NPE, Fadillah A, Putri AM. 2022. Antioxidant Activity and Sun Protection Factor (SPF) Graded Extract of Katuk Leaves (*Sauropus androgynus (L.) Merr*.). *IOP Conference Series: Earth and Environmental Science* 1041: 1-9.

Fitri D, Ulupi N, Arief II, Mutia R, Abdullah L. 2021. Physiological conditions, performance and meat quality of kampung chicken on free range system in peatland. *Livestock Research for Rural Development* 33: 1–6.

Hidayat C, Irawan A, Jayanegara A, Sholikin MM, Prihambodo TR, Yanza YR, Wina E, Sadarman S, Krisnan R, Isbandi I. 2021. Effect of dietary tannins on the performance, lymphoid organ weight, and amino acid ileal digestibility of broiler chickens: A meta-analysis. *Veterinary World* 14:

1405-1411.

Hikmawanti NPE, Fatmawati S, Asri AW. 2021. The effect of ethanol concentrations as the extraction solvent on antioxidant activity of Katuk (*Sauropus androgynus (L.) Merr*.) leaves extracts. *IOP Conference Series: Earth and Environmental Science* 755: 1-7.

Ismail I, Nohong B, Semaun R. 2021. Broiler carcass weight and percentage with the addition of katuk leaf flour (Sauropus Androgynus) in herbal concoction. *Agromedia* 39(1): 24–32.

Kishawy ATY, Amer SA, El-Hack ME, Saadeldin IM, Swelum AA. 2019. The impact of dietary linseed oil and pomegranate peel extract on broiler growth, carcass traits, serum lipid profile, and meat fatty acid, phenol, and flavonoid contents. *Asian-Australasian Journal of Animal Sciences* 32: 1161-1171.

Kuttinath SKH, Rammohan R. 2019. Phytochemical screening, antioxidant, antimicrobial, and antibiofilm activity of Sauropus androgynus leaf extracts. *Asian J Pharm Clin Res* 12: 244–250.

Letis ZM, Suprayogi A, Ekastuti DR. 2017. Supplementation of various preparations katuk leaves in feed causing a decrease of abdominal fat, fat and cholesterol levels to carcass of broiler chickens. *Jurnal Veteriner* 18(3): 461-468.

Li Y, Kong D, Fu Y, Sussman MR, Wu H. 2020. The effect of developmental and environmental factors on seconddary metabolites in medicinal plants. *Plant Physiology and Biochemistry*. 148: 80–89.

Martinsen V, Alling V, Nurida NL, Mulder J, Hale SE, Ritz C, Rutherford DW, Heikens A, Breedveld GD, Cornelissen G. 2015. pH effects of the addition of three biochars to acidic Indonesian mineral soils. *Soil Science and Plant Nutrition* 61: 821–834.

Miettinen J, Shi C, Liew SC. 2011. Influence of peatland and land cover distribution on fire regimes in insular Southeast Asia. *Regional Environmental Change* 11: 191–201.

Mistiani S, Kamil KA, Rusmana D. 2020. The Effect a Levels of Burahol (Stelechocarpus Burahol) Leaves Extract in The Diet on Internal Organs Weigh of Broiler Chickens*Journal of Tropical Animal Nutrition and Feed Science* 2: 42-50.

Naeemasa M, Qotbi AAA, Seidavi A, Norris D, Brown D, Ginindza M. 2015. Effects of coriander (*Coriandrum sativum L*.) seed powder and extract on performance of broiler chickens. *South African Journal of Animal Science* 45: 371–378.

Oleforuh-Okoleh VU, Ndofor-Foleng HM, Olorunleke SO, Uguru JO. 2015. Evaluation of growth performance, haematological and serum biochemical response of broiler chickens to aqueous extract of ginger and garlic. *Journal of Agricultural Science* 7: 167-173.

Pangestika AR, Widodo E, Sudjarwo E. 2020. Total flavonoid, and antibacterial activity as potential feed additive in broiler. *International Research Journal of Advanced Engineering and Science Phytochemical* 5: 305–307.

Perić L, Žikić D, Stojčić MĐ, Tomović V, Leskovec J, Levart A, Salobir J, Kanački Z, Rezar V. 2022. Effect of chestnut tannins and vitamin e supplementation to linseed oil-enriched diets on growth performance, meat quality, and intestinal morphology of broiler chickens. *Agriculture* 12: 1-12.

Puspitaloka D, Kim Y, Purnomo H, Fulé PZ. 2020. Defining ecological restoration of peatlands in Central Kalimantan, Indonesia. *Restoration Ecology* 28: 435–446.

Putranto HD, Santoso U. 2022. Effects of supplemented *Sauropus androgynous* leaves powder on reproductive traits of Indonesian indigenous hens. *J. Indonesian Trop Anim Agric* 47: 44–

54.

Qotimah S, Santoso U, Soetrisno E. 2014. Effects of Protein and Katuk (*Sauropus androgynus*) Leaves Extract Supplementation Levels on Carcass Qualities of Broilers. *Indonesian livestock science journal* 9(2): 130–136.

Rasouli B, Movahhedkhah S, Seidavi A, Haq QMI, Kadim I, Laudadio V, Mazzei D, Tufarelli V. 2020. Effect of sage (*Salvia officinalis L*.) aqueous leaf extract on performance, blood constituents, immunity response and ileal microflora of broiler chickens. *Agroforestry Systems* 94: 1179–1187.

Sahoo SP, Kaur D, Sethi APS, Sharma A, Chandra M. 2015. Evaluation of *Yucca schidigera* extract as feed additive on performance of broiler chicks in winter season. *Veterinary World* 8: 556-560.

Sandriya A, Sujoko H, Wibowo S, Silitonga L, Yuanita I, Aritonang N. 2023. The Level of Application of Biosecurity in Broiler Farms in The City of Palangka Raya). *Buletin Veteriner Udayana*. 15: 905-914.

Santoso U, Kususiyah K, Fenita, Y. 2013. Effect of *Sauropus androgynus* extract (sale) on fat deposition in broiler fed low protein diets. *Journal of the Indonesian Tropical Animal Agriculture* 38(3): 176–184.

Schaafsma M, Van Beukering PJH, Oskolokaite I. 2017. Combining focus group discussions and choice experiments for economic valuation of peatland restoration: A case study in Central Kalimantan, Indonesia. *Ecosystem Services* 27: 150–160.

Siregar DI, Budiman H, Aliza D, Balqis U, Asmilia N, Ismail I. 2019. Histopathology view of thymus in broiler chickhen infected by escherichia coli and given kemangi leaves (*Ocimum basilicum*) extract. *Jurnal Medika Veterinaria* 13: 185-191.

Tosi G, Massi P, Antongiovanni M, Buccioni A, Minieri S, Marenchino L, Mele M. 2013. Efficacy test of a hydrolysable tannin extract against necrotic enteritis in challenged broiler chickens. *Italian Journal of Animal Science*. 12: 392-395.

Wilson MJ. 2019. The importance of parent material in soil classification: A review in a historical context. *Catena* 182: 1-7.

Wutsqa YU, Suratman S, Sari SLA. 2021. Detection of terpenoids and steroids in Lindsaea obtusa with thin layer chromatography. *Asian Journal of Natural Product Biochemistry* 19: 66-69.

Yang L, Wen KS, Ruan X, Zhao YX, Wei F, Wang Q. 2018. Response of plant secondary metabolites to environmental factors. *Molecules* 23: 1-26.

Yusup FH, Frasiska N, Rahayu N. 2021. Addition of bidara leaves (*Ziziphus spina–christi L*.) in drinking water on production and mortality of broiler chickens. IOP Conference Series. *Earth and Environmental Science* 902: 1-4.

Yuwati TW, Rachmanadi D, Pratiwi Turjaman M, Indrajaya Y, Nugroho HYSH, Qirom MA, Narendra BH, Winarno B, Lestari S. 2021. Restoration of degraded tropical peatland in Indonesia: A review. *Land* 10: 1-31.

Zhang YN, Wang J, Qi B, Wu SG, Chen HR, Luo HY, Yin DJ, Lü FJ, Zhang HJ, Qi GH. 2017. Evaluation of mango saponin in broilers: effects on growth performance, carcass characteristics, meat quality and plasma biochemical indices. *Asian-Australasian Journal of Animal Sciences* 30: 1143-1148.