The Benefits of Uwi Plant (*Dioscorea alata L.*) for Health: Knowledge, Attitude, and Its Distribution in Daerah Istimewa Yogyakarta

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Abstract. Uwi (*Dioscorea alata L.*) is a plant rich in health benefits, but many people in the Special Region of Yogyakarta (SRY) still do not realize it. This study aims to assess the level of knowledge, attitudes, and level of knowledge about the benefits for health and the distribution of uwi plants in the SRY. This is descriptive-observational research with a cross-sectional design, 578 respondents were taken by accidental sampling and non-random selection. This research used a questionnaire as an instrument. Data were analyzed descriptively. The results showed that 578 respondents had an average score of knowledge level of 86.34 ± 13.96 with a very good category, score of attitudes of 69.76 ± 11.37 and score of knowledge level of health benefits of 66.42 ± 12.57 with a fairly good category. Related to the distribution of uwi plants in the SRY, it was found that 86 respondents (14.88%) had uwi plants in their homes. It can be concluded that people in the Special Region of Yogyakarta have a very good level of knowledge about uwi plants, and have good attitudes and knowledge about the health benefits of uwi plants, but the distribution of uwi plants is still limited in this area.

1 Introduction

Indonesia is the second largest mega biodiversity country after Brazil, but this abundant diversity has not been explored and utilized optimally, and adequate technology has not been applied in utilization, management and conservation efforts [1]. For example, the local uwi (*Dioscorea alata L*) in Indonesia is currently being displaced. The reluctance of farmers to plant *uwi* is related to its low economic value and its benefits that are well explored. Indonesia is the centre of genetic diversity of Dioscorea spp [2].

Based on its morphology, uwi originating from Indonesia has the highest diversity, apart from Papua New Guinea and the Philippines [3], [4]. If this condition is left unchecked, in the long run uwi might become a rare tuber and be eliminated as a cultivated plant. Species extinction has become one of the most significant problems worldwide; such situation is even

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getting worse in a number of developing countries [5], [6]. Over the past decade, the conservation and preservation of endangered species has become an area of interest for biologists and conservationists. Mostly, medicinal plants are over-exploited and become extinct. Since prehistoric times, medicinal plants have been used to cure various diseases and have been so commonly used by local populations in which many people are engaged in the medicinal plant trade worldwide. Today, 25% of prescription medicines contain the ingredients of plant origin [7]. *Dioscorea alata L.* is a plant with various biological activities that are very beneficial for health. It contains some active compounds such as flavonoids, terpenoids, steroids saponins, and others [8]. *D. alata L.* also contains Diosgenin [9], which is a class of aglycone steroidal saponins. Steroidal saponins in *Dioscorea alata* L. tubers have anti-inflammatory, antiallergic, immunomodulatory, and other activities [9], [10], [11]. The results of research by Makiyah et al. proved that ethanol extract of *Dioscorea alata* L. has antiallergic activity and immunomodulatory activity [12], [13], [14], [15], [16], [17].

The local cultural wisdom of the community around the Wonosadi forest in Gunung Kidul Yogyakarta still consumes uwi as a food reserve in the dry season. Uwi tubers are also used for diet for diabetes patients, and in rural areas raw materials for purple uwi tubers are used to treat diarrhea. Therefore, the empowerment of minor tubers such as uwi needs to be done considering the prospect of uwi as a functional food ingredient and food diversification [18]. This study aims to assess the level of knowledge, attitude and level of knowledge about the benefits for health as well as the distribution of uwi (*Dioscorea alata* L.) in Daerah Istimewa Yogyakarta.

2 Research method

This observational research used a cross-sectional design. The research respondents were the residents living in the Special Region of Yogyakarta taken by accidental sampling and non-random selection in the Special Region of Yogyakarta. The inclusion criteria for respondents included male or female, being healthy, teenagers to seniors (12-82 years), residing in the Special Region of Yogyakarta, willing to fill out a questionnaire regarding their level of knowledge, attitudes, level of knowledge about the health benefits and distribution of uwi plant (*Dioscorea alata* L.).

This research was conducted from August 2020 to July 2021 and the approval was obtained from the Health Research Ethics Committee, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta. Meanwhile, the research instrument was a questionnaire on the level of knowledge, attitudes, level of knowledge about the health benefits and distribution of uwi plants using the Guttman scale. Respondents have previously been informed about the objectives of this research and expressed their willingness to be the respondents. The questionnaire was given in Google forms and could be accessed by respondents. This questionnaire has also been tested for validity and reliability by researchers. The validity test of the questionnaire on the level of knowledge and attitudes about uwi plants was carried out using the Pearson Product Moment correlation test with a significance value (r) of less than 0.05. The questionnaire was declared valid if the calculated r was less than 0.444. The results of the validity test on the 22 question items in the questionnaire showed that 21 question items were valid. Thus, 21 question items were used in this research.

The map of the distribution of uwi plants was obtained from survey results showing that *Dioscorea alata* L. was found, and its position was plotted on the map according to the location of the sub-district. The map layer used as a basis for location plotting was the Special Region of Yogyakarta Province administration layer whose level of detail reaches sub-district level, so that these locations can be explicitly seen on the map. Data in the form of knowledge levels, attitudes and levels of knowledge about the health benefits and distribution of uwi plants in the Special Region of Yogyakarta were analyzed descriptively.

3 Results and Discussion

This research aims to measure the level of knowledge and attitudes of community members about the uwi plant, as well as the level of knowledge about the health benefits of the uwi plant. 578 people participated as the respondents. As shown in Table 1, the characteristics of gender showed 27% male respondents, i.e.156 people, fewer than female respondents at 73% (422 people). This proved that there were more female respondents than male respondents.

Table 1. Respondents' characteristic

Characteristic	**N**	**Percentage (%)**
Gender:		
Male	156	27
Female	422	73
Age:		
Teenager (12-25 years)	91	15.7
Adults (26-45 years)	195	33.7
Elderly (46-65 years)	283	49
Seniors (> 65 year)	9	1.6
Occupation:		
None	114	19.7
Teacher/lecturer	173	29.9
Employee	105	18.2
Self-employed	72	12.5
Civil servants	86	14.9
Trader	17	2.9
Farmer	7	1.2
Income (Minimum wage of the Special		
Region of Yogyakarta):	207	35.8
<IDR 2,004,000 -	147	25.4
IDR 2,004,000- IDR 4,004,000-	117	20.2
IDR 4.004.000,- IDR 6,004,000-	107	18.5
> IDR 6,004,000-		
Education:		
Middle/High School	124	21.6
College	453	78.4
Origin of the respondents:		
Yogyakarta	113	19.6
Bantul	119	20.6
Sleman	252	43.6
Kulon Progo	55	9.5
Gunung Kidul	39	6.7

The characteristics of respondents based on age showed that the respondents were dominated by the elderly between 46 years and 65 years, 49% or 283 people. This showed that the respondents in this study were dominated by elderly people. The majority of respondents' occupations were teachers or lecturers with a percentage of 29.9%, which indicated that the majority of respondents worked as academics, followed by respondents as the unemployed ones with the percentage of 19.7%, followed by respondents working as the employees with a percentage of 18.2% and those working as farmers at the lowest percentage (1.2%).

For income characteristics according to the regional minimum wage in the Special Region of Yogyakarta, the dominant income below IDR 2,004,000, was at the percentage of 35.8%, followed by income of IDR 2,004,000 to IDR 4,004,000, with a percentage of 25.4%, income of IDR 4,004,000 to IDR 6,004,000 with a percentage of 20.2% and the income above IDR 6,004,000 at the lowest percentage (18.5%). In terms of educational level, 78.4% were at the undergraduate or tertiary education level (453 people), while at the secondary education level (middle/high school), there were 124 people or 21.6%. This showed that the majority of respondents in this study have a high level of education, namely undergraduate level.

For the distribution of regencies/municipalities in the Special Region of Yogyakarta, the majority of respondents came from Sleman district at 43.6%, followed by respondents from Bantul district at 20.6%, those living in Yogyakarta district at 19.6%, those from Kulon Progo district at 9.5%, and those from Gunung Kidul district at the lowest percentage at 6.7%.

Table 2. Level of Knowledge, Attitudes and Level of Knowledge about the Health Benefits of *Uwi* Plants (*Dioscorea alata* L.)

No	Parameter	Score	Note
1	Level of knowledge	86.34 ±13.96	Very good
2	Attitude	69.76 ±11.37	Pretty good
3	Level of Knowledge about Health Benefits	66.42 ±12.57	Pretty good

In this study, data were collected regarding the level of knowledge, attitudes and level of knowledge about the health benefits of uwi plants using a questionnaire with the results in the form of scores in tense as shown in Table 3. Table 2 showed that the level of knowledge about uwi plants had an average score of 86.34 ± 13.96 in the very good category, an attitude score towards the uwi plant with an average score of 69.76 ± 11.37 in the quite good category, and the level of knowledge about the health benefits of the uwi plant with an average score of 66 .42 ±12.57 in the quite good category.

Wild Yam (Dioscorea spp.), known in Indonesia as Uwi (uwi-uwian type), is a type of tuber that grows widely in Indonesia, although it is now difficult to be found in market. Planting of yam tubers is still quite widespread in rural areas [19]. Dioscorea is a genus of tuber plants that has the potential to be developed as a food source because the nutritional content in its tubers is quite high. Dioscorea tubers contain 15–25% carbohydrates, 1–2.5% protein and 0.05–0.25% fat [20]. Apart from macro elements, the tubers also contain 10–62 mg calcium, 35–53 mg phosphorus, 0.3–1.0 mg iron, 0.10 mg thiamin, 0.01 mg riboflavin, 0.8 mg niacin and 10 mg ascorbic acid. –15 mg [21]. The results of several research showed that, in general, Dioscorea has a higher protein content of around 1.2–1.8% compared to the protein content in cassava [22]. The starch content of various types of Dioscorea ranges from 14.0–62.3% [23].

The chemical content of 6 types of *D. alata* tubers showed varying values, including carbohydrates 20.87–31.64%, glucose 0.006–0.458%, protein 1.44–2.36%, fat 0.43–1.27%, water content 64.96–75.82%, ash content 0.53–1.53% and crude fiber 1.47–5.43% [24]. The results of the analysis of *D. alata* flour included carbohydrates 77.95–82.88%, water 7.77–10.66%, ash 2.1–3.7%, fat 0.12–0.52% and protein 2.59– 10.49% [25]. The starch in *D. alata* tubers has a low glycemic index, so it has the potential as an alternative food ingredient to accompany wheat flour that is safe for diabetes sufferers. Also it has the potential to be a substitute food ingredient for gluten-free wheat flour that is safe to be consumed by those suffering from autistic [26]. Uwi and health benefits in 2020, it is estimated that 3.8 million Indonesians will suffer from diabetes; this is due to people's diet which is very fond of consuming sugar (especially Javanese). One food ingredient that can be used as an alternative source of healthy food is uwi (*D. alata*) because this tuber has low sugar content but high carbohydrate content so it is suitable for diabetes sufferers [27].

Ihediohanma et al. [28] reported that the glycemic index (IG) value of *Dioscorea alata* was lower than other Dioscorea species. *D. alata* has an IG value of 22.4 [29]. Uwi consumption can significantly reduce blood sugar levels and body weight compared to controls [30]. The total dietary fiber content and mineral content of uwi is high so it is very good for diet formulation [31]. Uwi has low dry matter content but has a high amylose content. It has higher total dietary fiber than brown rice and the two varieties have total dietary fiber comparable to wheat flour. The high amylose and total dietary fiber content in uwi is highly useful for consumption by diabetes patients and the wider community [32]. Uwi flour also has low gluten levels, so it can be consumed by children with special needs (autism). This shows the potential for using *uwi* as a functional food to supplement fiber and minerals in the body [33].

Uwi tubers can be extracted with Diosgenin - a compound similar to saponin which is a precursor for the synthesis of steroid hormones as a raw material for contraceptives [34]. Diosgenin is a group of natural saponins that can be found in many nuts and tubers of the *Dioscorea sp* type [35]. Dioscoreaceae (genus Dioscorea) has the potential to synthesize steroid sapogenins [36]. Steroid sapogenin is a secondary metabolite which is a precursor to sterol (cholesterol) biosynthesis. Diosgenin is absorbed through the intestines and plays an important role in regulating cholesterol metabolism, reducing the risk of heart disease, lung cancer and blood cancer and has esterogenic effects [37], [38]. One of the local raw materials that contains inulin is the tubers of *Dioscorea spp*. with insulin levels between 2.88–14.77% [39]. Dioscorin inhibits angiotensin-converting enzyme which increases renal blood flow and reduces blood pressure in vivo and in vitro [40], [41]. Dioscorin also shows carbonic anhydrase, trypsin inhibitor, dehydroascorbate reductase, and monodehydroascorbate reductase activities [35].

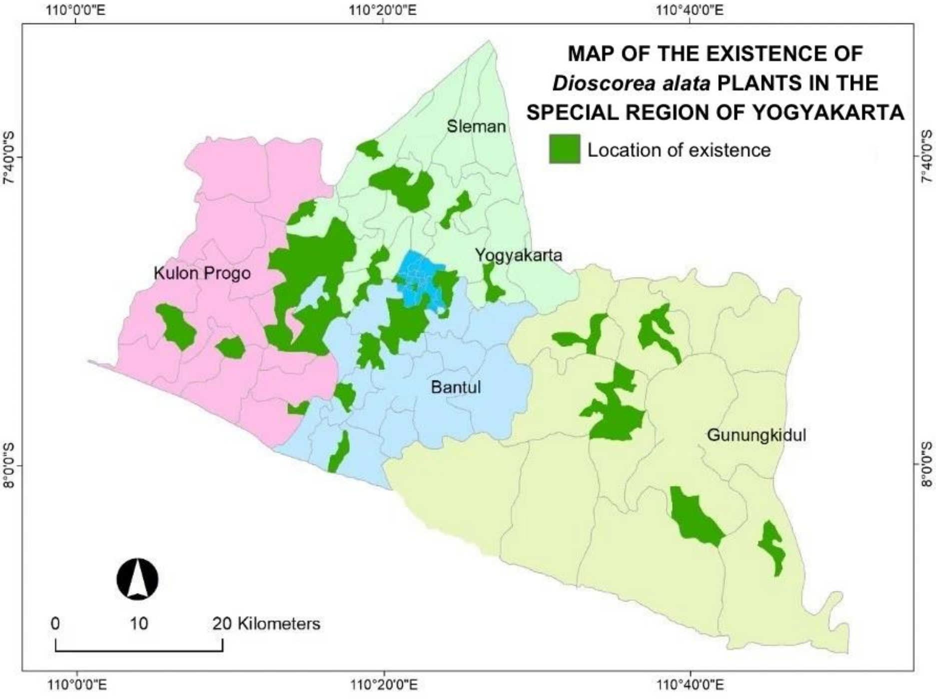

Fig 1. The actual distribution of *Dioscorea alata* L. in the Special Region of Yogyakarta based on survey results.

Figure 1 shows the actual distribution of *Dioscorea alata* L. in the Special Region of Yogyakarta based on the results of a survey of 86 respondents (14.88%) who stated that there were uwi plants in their yard out of a total of 578 respondents who provided feedback on the questionnaire. The results of observations in Figure 1 showed that the distribution of uwi plants is still limited to several locations in the Special Region of Yogyakarta as shown in green on the Special Region of Yogyakarta map. This is possibly due to the limited number of respondents who have uwi plants in their homes and the uneven distribution of respondents throughout all sub-districts in the Special Region of Yogyakarta because at the time this research was conducted in the atmosphere of the COVID-19 pandemic.

Table 3 shows the distribution of locations at sub-district and subdistrict levels in 5 districts/municipalities in the Special Region of Yogyakarta. The list of Subdistrict names and the list of sub-district names in the Special Region of Yogyakarta region are based on Minister of Home Affairs Regulation number 137 of 2017 and number 72 of 2019 concerning Codes and Government Administration Area Data.

Table 3. Actual distribution of *Dioscorea alata* L. in the Special Region of Yogyakarta based on survey results at sub-district level

City/Regency	Subdistrict	Ward
Yogyakarta	Kraton	Panembahan
	Gondokusuman	Demangan
	Umbulharjo	Tahunan
	Wirobrajan	Wirobrajan
	Umbulharjo	Warungboto
	Panembahan	Kraton
Kulon Progo	Wates	Giripeni
	Kokap	Hargorejo
	Nanggulan	Wijimulyo
	Sentolo	Sentolo
	Sentolo	Tuksono
	Sentolo	Sukoreno
	Sentolo	Banguncipto
	Sentolo	Pongganggan
	Galur	Banaran
Gunungkidul	Rongkop	Semugih
	Patuk	Putat
	Patuk	Nglegi
	Semanu	Candirejo
	Nglipar	Kedungpoh
	Nglipar	Nglipar
	Playen	Logandeng
	Playen	Playen
	Wonosari	Siraman
	Wonosari	Pulutan
	Wonosari	Wonosari
	Wonosari	Gari
	Wonosari	Kepek
Bantul	Sanden	Srigading
	Sedayu	Argomulyo
	Sedayu	Argorejo
	Sedayu	Argodadi
	Sewon	Pendowoharjo
	Sewon	Panggungharjo
	Pandak	Triharjo
	Banguntapan	Banguntapan
	Bantul	Ringinharjo
	Kasihan	Tirtonirmolo
	Pajangan	Guwosari
Sleman	Sleman	Caturharjo
	Berbah	Tegaltirto
	Gamping	Ambarketawang
	Tempel	Pondokrejo
	Minggir	Sendangagung
	Moyudan	Sumberagung
	Moyudan	Sumbersari
	Moyudan	Sumberarum
	Moyudan	Sumberagung
	Moyudan	Sumberrahayu
	Ngaglik	Sinduharjo
	Tempel	Pondokrejo
	Godean	Sidoarum
	Godean	Sidoluhur
	Godean	Sidorejo

However, from the results of this research, the distribution of uwi plants in several areas with the same sub-districts has matched the real data, so the data is written in more detail in Table 4 by displaying a comparison of the results of the real distribution and a more summarized data distribution with the location of Subdistrict or the same sub-district written just once.

As shown in Table 4, the most dominant distribution of uwi plants in Sleman Regency is spread across 9 Subdistrict and 29 sub-districts, in addition to the fact that the number of respondents from the Sleman Regency area was the largest in this study. Meanwhile, Gunung Kidul Regency is spread across 6 Subdistricts and 19 sub-districts. In this case, Gunung Kidul district had the smallest number of respondents in this study. The third order for the distribution of uwi plants is Kulon Progo district with 5 Subdistricts and 15 sub-districts, and Bantul district with 7 Subdistricts and 14 sub-districts and the last sequence is Yogyakarta municipality with 5 Subdistricts and 9 sub-districts.

Data on the area of planting and production of uwi in Indonesia is currently unavailable. In Indonesia, the centers for planting uwi can be found in Central Java, East Java, South Kalimantan, Southeast Sulawesi and Maluku [42]. Uwi is a cultivated plant, but it is still rarely planted on a large scale. Commonly, people only do a limited amount of work as part-time work [43]. In Nigeria, uwi has been cultivated seriously and en masse. Nigeria, which has a dry climate, can become the leading producer of uwi in the world [44].

Table 4. Data on the number of Subdistricts and sub-districts in the Special Region of Yogyakarta and the real number of sub-districts where *Dioscorea alata* L. plants were found, as well as the number of sub-districts after subtracting due to similarity in location.

No	Regency	Number of sub-districts		Number of wards		
		Appropriate to population data	Reduced the location found the same *Dioscorea alata*	Appropriate to population data	Found the *Dioscorea alata*	Reduced to the same location
1	Bantul	17	7 (41.17%)	75	14 (18.67%)	11
2	Gunungkidul	18	6 (33.33%)	144	19 (13.19%)	13
3	Kulon Progo	13	5 (38.46%)	87	15 (17.24%)	9
4	Sleman	17	9 (52.94%)	86	29 (33.72%)	15
5	Yogyakarta	14	5 (35.71%)	45	9 (20%)	6
Total		79	32 (40.51%)	437	86 (19.68%)	54
Mean (%)			40.32%		20.56%	

Note: The percentage written in brackets refers to the division of the number of locations where uwi plants are distributed divided by the number of Subdistricts/districts multiplied by 100%.

4 Conclusion and recommendation

The residents of the Special Region of Yogyakarta have a very good level of knowledge about uwi plants. Their attitudes and knowledge about the health benefits of uwi plants are also quite good. The study revealed that the residents had excellent knowledge (86.34 ± 13.96), fairly good attitudes (69.76 ± 11.37), and health benefit awareness (66.42 ± 12.57). Moreover, the actual cultivation remains very low, with only 14.88% of respondents growing uwi plants. This condition indicates that the distribution of uwi plants in the Special Region of Yogyakarta was still limited. Future research could investigate the correlation between *uwi* consumption and specific health outcomes and study its potential role in therapeutic diets. Community health programs could also integrate cultivation and consumption into their health promotion strategies, potentially improving dietary diversity and nutritional security in the region. These approaches could help translate the knowledge about *uwi*'s health benefits into actual consumption practices, contributing to better public health outcomes.

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References

1. Sutarno and Sugiyarto, "Keanekaragaman hayati Indonesia dan pemanfaatannya untuksumber energi," in *Prosiding Seminar Nasional Energi Hayati Sebagai Solusi Krisis, Energi: Peluang dan Tantangannya di Indonesia*, Surakarta, 2006.
2. I. Khairullah, M. Mawardi, and Sarwani, "Sumberdaya hayati pertanian lahan rawa dalam Karakteristik dan Pengelolaan Lahan Rawa," 2006.
3. M. Flach and Rumawas, *Plant resources of South-East Asia 9 : Plants yielding non-seed carbohydrates*. Bogor: Prosea Foundation, 1996.
4. Purnomo, B. S. Daryono, Rugayah, and I. Sumardi, "Studi Etnobotani *Dioscorea spp*. (Dioscoreaceae) dan Kearifan Budaya Lokal Masyarakat di Sekitar Hutan Wonosadi Gunung Kidul Yogyakarta," *J. Natur Indones.*, vol. 14, no. 3, 2012, doi: http://dx.doi.org/10.31258/jnat.14.3.191-198.
5. C. Rahbek and R. K. Colwell, "Species loss revisited," *Nat. 2011 4737347*, vol. 473, no. 7347, pp. 288–289, May 2011, doi: 10.1038/473288a.
6. P. A. Tedesco, R. Bigorne, A. E. Bogan, X. Giam, C. Jézéquel, and B. Hugueny, "Estimating how many undescribed species have gone extinct," *Conserv. Biol.*, vol. 28, no. 5, pp. 1360–1370, Oct. 2014, doi: 10.1111/COBI.12285.
7. R. Qureshi, A. Waheed, M. G. Alshad, and T. Umbreen, "Medico-ethnobotanical inventory of tehsil Chakwal, Pakistan," *Pakistan J. Bot.*, vol. 41, no. 2, pp. 529–538, 2009.
8. A. Chandrasekara and T. Josheph Kumar, "Roots and Tuber Crops as Functional Foods: A Review on Phytochemical Constituents and Their Potential Health Benefits," *Int. J. food Sci.*, vol. 2016, 2016, doi: 10.1155/2016/3631647.
9. W. Y. Cheng, Y. H. Kuo, and C. J. Huang, "Isolation and identification of novel estrogenic compounds in yam tuber (Dioscorea alata Cv. Tainung No. 2)," *J. Agric. Food Chem.*, vol. 55, no. 18, pp. 7350–7358, Sep. 2007, doi: 10.1021/JF0711690.
10. M. Jesus, A. P. J. Martins, E. Gallardo, and S. Silvestre, "Diosgenin: Recent Highlights on Pharmacology and Analytical Methodology," *J. Anal. Methods Chem.*, vol. 2016, 2016, doi: 10.1155/2016/4156293.
11. K. S. Jayachandran, A. H. Rachel Vasanthi, and N. Gurusamy, "Steroidal Saponin Diosgenin from Dioscorea bulbifera Protects Cardiac Cells from Hypoxia-reoxygenation Injury Through Modulation of Pro-survival and Pro-death Molecules," *Pharmacogn. Mag.*, vol. 12, no. Suppl 1, pp. S14–S20, 2016, doi: 10.4103/0973-1296.176114.
12. [12] S. N. N. Makiyah, Z. Noor, Widodo, M. Rifa'i, and M. S. Djati, "Ethanol Extracts of Tubers *Dioscorea alata* L. As Antiallergic Agent on Mice Balb/C Induced with Ovalbumin," *Int. J. Pharma Bio Sci.*, vol. 5, no. 3, pp. 214–220, 2014.
13. S. N. N. Makiyah, M. S. Djati, R. Muhaimin, and Widodo, "Lymphocyte Proliferation on Hypersensitivity of Balb/C Mice After Given Ethanol Extract Tuber of *Dioscorea alata* L.," in *The 3rd International Conference on Biological Science 2013 (The 3rd ICBS-2013)*, Knowledge E, Sep. 2015, p. 107. doi: 10.18502/KLS.V2I1.125.

14. S. N. N. Makiyah, Widodo, M. Rifa'i, and M. S. Djati, "The influence of ethanol extract *Dioscorea alata* L. on CD4+CD62L+ and CD8+CD62L+ profile of BALB/c mice model digestive tract allergy," *AIP Conf. Proc.*, vol. 1744, no. 1, p. 020054, Jun. 2016, doi: 10.1063/1.4953528.
15. S. N. N. Makiyah and B. Hapsari, . "Proliferasi Limfosit Setelah Pemberian Saponin Steroid Dalam Umbi Uwi Ungu (*Dioscorea alata* L.) Secara In Vitro Melalui Pengamatan Profil Sitokin CD4, CD8, CD62L," Bantul, 2017.
16. S. N. N. Makiyah, "Steroidal Saponin Isolates of *Dioscorea alata* L. Induced B220IgE and B220IgG1 In Vitro," in *8th Annual Basic Science International Conference Convergence of Basic Sciences, Toward the World's Sustainability Challenges*, Malang, 2018.
17. S. N. N. Makiyah and S. Harimurti, "Fraksi Metanol Umbi *Dioscorea alata* L. Sebagai Agen Imunomodulatori secara In Vitro dan In Silico," Bantul, 2019.
18. Purnomo, B. . Daryono, Rugayah, I. Sumardi, and H. Shiwachi, "Phenetic analysis and intra-spesific classification of Indonesian water yam germplasm (*Dioscorea alata* L.) based on morphological characters. Sabrao J of Breeding and Genetics," *SABRAO J. Breed. Genet.*, vol. 44, no. 2, pp. 277–291, 2012.
19. Plantamor, "*Dioscorea alata*." [Online]. Available: https://plantamor.com/species/info/dioscorea/alata#gsc.tab=0
20. J. Purseglove, *Monocotyledons. Tropical Crops*. New York: John Wiley and Sons, 1972.
21. D. Coursey, *Dioscorea spp. (Dioscoreaceae): In: Evolution of Crop Plants*. London: Simons (ed.)., 1976.
22. A. L. Charles, K. Sriroth, and T. T. chi Huang, "Proximate Composition, Mineral Contents, Hydrogen Cyanide and Phytic Acid of 5 Cassava Genotypes," *Food Chem.*, vol. 92, no. 4, pp. 615–620, 2005, doi: 10.1016/j.foodchem.2004.08.024.
23. D. R. Wulandari, "Pengembangan *Dioscorea spp*. sebagai Bahan Pangan Fungsional Bebas Gluten dan Konservasinya Secara In Vitro."
24. L.M. Yusuf, "Karakter Morfologi dan Kandungan Kimia Beragam Umbi *Dioscorea alata* L. di Pulau Wangi-Wangi Kabupaten Wakatobi Sulawesi Tenggara," Universitas Haluoleo, 2016.
25. M. N. Afiidin, Y. Hendrawan, and R. Yulianingsih, "Analisis Sifat Fisik dan Kimia pada Pembuatan Uwi Kuning (*Dioscorea alata*), dan Uwi Putih (Dioscorea alata)," *J. Keteknikan Pertan. Trop. dan Biosist.*, vol. 2, no. 3, pp. 297–303, 2014.
26. V. Maithili, S. P. Dhanabal, S. Mahendran, and R. Vadivelan, "Antidiabetic activity of ethanolic extract of tubers of *Dioscorea alata* in alloxan induced diabetic rats," *Indian J. Pharmacol.*, vol. 43, no. 4, pp. 455–459, May 2011, doi: 10.4103/0253-7613.83121.
27. Swa, "Diabetes research focuses on local foods," *The Jakarta Post*, 1999.
28. I. N.C, N. C. Onuegbu, A. Peter-Ikechukwu, and C. N. Ojimba, "A Comparative Study and Determination of Glycemic Indices of Three Yam Cultivars (*Dioscorea rotundata, Dioscorea alata* and *Dioscorea domentorum*)," *Pakistan J. Nutr.*, vol. 11, no. 6, 2012, doi: 10.3923/pjn.2012.547.552.
29. I. P. Sari, E. Lukitaningsih, Rumiyati, and I. M. Setiawan, "Glycaemic Index Of Uwi, Gadung, and Talas which Were Given on Rat," *Tradit. Med. J.*, vol. 18, no. 3, pp. 127–131, 2013.
30. B. Anyaehie and E. Iyare, "*Dioscorea alata* L. reduces body weight by reducing food intake and fasting blood glucose level," *Br. J. Med. Med. Res.*, vol. 3, no. 4, 2013.
31. F. D. Wireko-Manu, B. Maziya-Dixon, A. Robert, and I. N. Oduro, "Nutritional and

biochemical composition of *D. alata* (Dioscorea spp.) tubers," *J. Food Agric. Environ.*, vol. 7, no. 2, pp. 373–378, 2009.

32. W. M. Faustina Dufie, I. Oduro, W. O. Ellis, R. Asiedu, and B. Maziya-Dixon, "Potential health benefits of water yam (*Dioscorea alata*)," *Food Funct.*, vol. 4, no. 10, pp. 1496–1501, Oct. 2013, doi: 10.1039/C3FO60064E.
33. G. Lionora, D. R. S. Dewi, and D. E. S. Rahaju, "Analisis Kelayakan Bisnis Kue Muffin dari Tepung Uwi," *J. Ilm. Widya Tek.*, vol. 12, no. 1, 2013, doi: https://doi.org/10.33508/wt.v12i1.1446.
34. Suismono, "Teknologi Pengolahan dan Pemanfaatan Pangan Lokal Berbasis Umbi-Umbian," *J. Pangan*, vol. 17, no. 3, 2008, doi: https://doi.org/10.33964/jp.v17i3.266.
35. A. Y. Prabowo, T. Estiasih, and I. Purwantiningrum, "Umbi Gembili (*Dioscorea esculenta* L.) Sebagai Bahan Pangan Mengandung Senyawa Bioaktif: Kajian Pustaka," *J. Pangan dan Agroindustri*, vol. 2, no. 3, 2014.
36. L. Dinan, J. Harmatha, and R. Lafont, "Chromatographic procedures for the isolation of plant steroids," *J. Chromatogr. A*, vol. 935, no. 1–2, pp. 105–123, Nov. 2001, doi: 10.1016/S0021-9673(01)00992-X.
37. D. E. Okwu and C. U. Ndu, "Evaluation of the Phytonutrients, Mineral and Vitamin Contents of Some Varieties of Yam (*Dioscorea sp*.)," *Int. J. Mol. Med. Adv. Sci.*, vol. 2, no. 2, pp. 199–203, 2006.
38. S. Moalic *et al.*, "A plant steroid, diosgenin, induces apoptosis, cell cycle arrest and COX activity in osteosarcoma cells," *FEBS Lett.*, vol. 506, no. 3, pp. 225–230, Oct. 2001, doi: 10.1016/S0014-5793(01)02924-6.
39. S. Winarti, E. Harmayani, and R. Nurismanto, "Karakteristik dan profil inulin beberapa jenis uwi (*Dioscorea spp*.)," *Agritech*, vol. 31, no. 4, 2011, doi: https://doi.org/10.22146/agritech.9647.
40. Y. H. Liao, C. Y. Tseng, and W. Chen, "Structural characterization of dioscorin, the major tuber protein of yams, by near infrared Raman spectroscopy," *J. Phys. Conf. Ser.*, vol. 28, no. 1, p. 119, Jan. 2006, doi: 10.1088/1742-6596/28/1/025.
41. M. Te Chuang, Y. S. Lin, and W. C. Hou, "Ancordin, the major rhizome protein of madeira-vine, with trypsin inhibitory and stimulatory activities in nitric oxide productions," *Peptides*, vol. 28, no. 6, pp. 1311–1316, Jun. 2007, doi: 10.1016/J.PEPTIDES.2007.04.011.
42. Direktorat Kacang-kacangan dan Umbi-umbian, *Sekilas pengenalan & budidaya : talas, garut, ganyong, gembili, ubi kelapa, gadung, iles-iles, suweg/acun*. Jakarta: Direktorat Kacang-kacangan dan Umbi-umbian, 2022.
43. R. Bimantoro, "Uwi (Dioscorea spp.) bahan pangan non-beras yang belum diolah," *Bul. Kebun Raya*, vol. 5, no. 1, pp. 7–18, 1981.
44. J. E. Obidiegwu and E. M. Akpabio (2017). The geography of yam cultivation in southern Nigeria: Exploring its social meanings and cultural functions, Journal of Ethnic Foods, 4, (1), 28-35, https://doi.org/10.1016/j.jef.2017.02.004.