

An ethnobotanical study of Indonesian medicinal plants to treat obesity

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ABSTRACT

An unhealthy diet and lack of exercise have contributed to overweight and public health problems in the last 30 years. Indonesia utilizes medicinal plants combating the growing issue of obesity. The quantitative data analysis was conducted by utilizing the quantitative indexes as follows: relative frequency of citation (RFC), use value (UV), and family use value (FUV). Bray–Curtis similarity, which was analyzed by provinces, ethnic, family, medicinal plants, potion numbers, and traditional healers' codes data. This study conducted 73 species of medicinal plants from 32 plant families used by 30 ethnic groups in Indonesia. Three species were reported to have at least 0.068 RFC and UV with three citations, namely *Gymnanthemum amygdalinum* (Delile) Sch.Bip, *Euphorbia heterophylla* L., and *Zingiber zerumbet* (L.). Roscoe ex Sm. Zingiberaceae had the highest number of species (10 species), and the highest FUV was found for Fagaceae (0.068). The Ratahan and Wandamen clusters, as well as the Dayak Tabuyan and Kanayan Mempawah clusters, had similar knowledge of the use of medicinal plants to control obesity. Traditional healers from 30 ethnicities across eight provinces in Indonesia have been known to use these plants to control obesity. Extensive research can be conducted on widely utilized medicinal plants as anti-obesity plant resources.

1. INTRODUCTION

The World Health Organization (WHO) affirms that overweight and obesity are complex disorders characterized by an excessive buildup of body fat that can harm human health [1]. Body mass index (BMI), waist circumference, and body fat percentage are typical metrics for assessing and monitoring obesity levels [2,3]. Adults worldwide are considered obese if their BMI is higher than 30 kg/m²; however, people of Asian descent are considered overweight if it is less than 23 kg/m² and obese if it is greater than 27 kg/m² [4,5]. The WHO classified obesity as a disease in 1998 [1]. It estimated globally that 40%

of women and 39% of males over 18 years were overweight in 2016 since the prevalence of obesity in the United States increased from 30.5% to 41.9% between 1999 and March 2020, while the proportion of severely obese people rose from 4.7% to 9.2% [1,6]. Obesity among adults in middle-rural areas tends to be higher than in urban and rural areas. Obesity tends to be higher in middle-class areas with low incomes [2,7,8].

The Indonesian Basic Health Research called Riset Kesehatan Dasar (RISKESDAS) is a comprehensive survey that covers various aspects of health, including health status, causes of death, morbidity, disability, nutritional status, environmental health, household consumption, knowledge and attitudes, and health behaviors [9]. According to the RISKESDAS data, obese cases in Indonesia continues to rise, with the BMI category for adults above 18 years in Indonesia having an obesity percentage value of 21.8% compared to 14.8% in 2013 and 10.5% in 2007 [10–12].

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Increased body fat in obesity leads to dysfunctional of adipose tissue and aberrant fat, which improves physical performance but has detrimental implications for one's metabolism, biomechanics, and mental health [13–15]. Additionally, obesity enables to generate several chronic diseases, such as diabetes, cancer, heart disease, liver disease, renal issues, and nerve degeneration [16–18].

Several countries have been practicing on using medicinal plants for treating obesity, including China, Japan, Thailand, and the Himalayan countries [19,20]. Widely, the indigenous and local knowledge of medicinal plants has long been a source of research to examine plant potential effects and develop therapeutic resources [21]. Research on Medicinal Plants and Traditional Medicine or Riset Tumbuhan Obat dan Jamu (RISTOJA) was an explorative research that documented the traditional use of medicinal plants and traditional medicine based on ethnics in Indonesia. Numerous plants have been explored for their potential utilization to support weight management and improve overall health status [22,23]. Although individuals have used medicinal plants to maintain weight for generations, their safety and medicinal effectiveness are still becoming a concern [24]. Indonesia's archipelago geography can help the vast diversity of local knowledge and wisdom in conquering obesity [25]. This study will inventory and evaluate herbal remedies derived from Indonesian medicinal plants, which are extensively acknowledged and employed by various ethnic groups for obesity treatment, thereby highlighting a substantial traditional knowledge base to assist individuals in weight loss. This information would be advantageous to society in exploring more utilization of Indonesian plants that have been used to maintain an ideal body weight.

2. MATERIALS AND METHODS

RISTOJA was held by the National Institute of Health Research and Development (NIHRD), which performed in ethnic groups throughout Indonesia, with a total of 405 ethnicities. The ethnic groups involved in the study were determined using some criteria. The ethnic group should have at least 1000 native members and reside in a definite area for generations, among them at least five practitioners as traditional healers using plants for treating their communal diseases. The data on plant ingredients for reducing excess body weight resulted from RISTOJA results in 2012, 2015, and 2017 and was authenticated until 2019 officially obtained from the Data Management Laboratory. The plant data used were plants that have been identified to the species level. The data analysis step includes data analysis in the form of the number of ingredients, the number of plant species, and the plant parts used. A total of 405 ethnicities were interviewed about herbs to treat several diseases, including obesity. However, after further screening, only 30 ethnicities had anti-obesity herbs. All these ethnicities are spread across different regions so they are only found in certain areas.

2.1. Data collection

The informants were interviewed using a semi-structured questionnaire. Using purposive sampling, traditional healers were determined to be resource persons. Before the

informant is interviewed, the data collector must read the "Explanatory Script," which explains what data will be asked, as well as the benefits that can be obtained by the informant. If the informant is willing, the traditional healer will give consent by signing the "Consent After Explanation (PSP)." Data collection is carried out in accordance with the confessions and memories of informants without coercion, steering, or direction on a particular topic to avoid bias. The data collected were the demographics of traditional healers, symptoms and types of disease, types of plants, uses of plants in medicine, parts of plants used, ingredients, preparation methods and methods of preparation, how to use the treatment, local wisdom in managing and using medicinal plants, and environmental data. Demographic data on traditional healers included the informant's name, gender, age, education, and length of time practicing traditional medicine [26]. Medicinal plants were collected as herbarium specimens to support taxonomic identification at the research site by team members with a background in biology (botanists) and further morphological authentication by plant taxonomy experts from various universities (UGM, UNS, UNHAS, UNAND, UHO, UNSOED) and Lembaga Ilmu Pengetahuan Indonesia, (the Indonesian Institute of Sciences), after the herbarium specimens were sent to NIHRD. Medicinal plants identified by taxonomists using photos and herbariums confirmed through the Flora of Java book and online databases. DNA barcodes and voucher specimens were not used in species identification. The habitat survey method was conducted in the open-air environment. Understanding traditional applications of medicinal plants was the goal of the interview questions, which also covered the local plant's name, the sections of the plant that were utilized, and the preparation and administration techniques.

Data in the form of information obtained from informants. Data collection was carried out by determining informants based on data from the Health Service, and informants were selected based on target locations and then selected based on ethnicity. In-depth interviews were conducted with these informants. Qualitative data validation was carried out using the triangulation method. Triangulation was carried out to reduce bias and functioned in controlling the quality of interview data (qualitative). Triangulation is conducted among informants, informant notes, and ambient circumstances. Data quality verification was carried out by field researchers, before being submitted to the data management team.

2.2. Data analysis

Relative frequency of citation (RFC) of species N: Number of informants mentioning the use of species X divided by total number of informants [27].

$$RFC = FC/N$$

FC states the absolute number of informants interviewed who use certain types of plants to treat overweight. N is the number of informants who have concoctions of medical plants to treat overweight.

Use value (UV) of species N = total number of use-reports across all use-categories for species X divided by total number of informants [27].

$$FUV = (\sum UVs) / N_s$$

Family use value (FUV) signifying the use value of a given plant family that was used as medicine informants. $\sum UVs$ represents the sum of the use values for all species belonging to a particular family divided by the total number of species in the same family, and N_s describes the number of species in a particular family [28–30].

The RFC and UV data obtained were then analyzed with Pearson correlation coefficient using EXCEL to determine the relationship between RFC and UV and the strength of the relationship between the two with a correlation level of significance of 0.05. Standard deviation was calculated to measure the data distribution of the RFC and UV values [31,32].

Bray–Curtis similarity analysis was used to compare different ethnic groups that use medicinal plants. It was a nonparametric comparison between and within groups that take more than one factor into consideration. The similarity (R) ranges from -1 to 1, a value close to 0 indicates no similarities at all. $R < 0.25$, there are not many similarities between the groups, R (0.25–0.75), there are some similarities, but they overlap. $R > 0.75$, there are a lot of similarities, and R 1, the groups are the same. Ethnic clustering dendrogram obtained using the Unweighted Pair Group Mean Average algorithm based on the Bray–Curtis similarity index. A Non-Metric Multidimensional Scaling presented in two-dimensional graphics (scatterplot) was generated for calculating the degree of similarity between the ethnic maps based on the plants they use for medicine. Data were analyzed using The Paleontological Statistics (PAST) software version 3:20 [33].

3. RESULT AND DISCUSSION

Out of the 405 ethnic groups observed, respondents (traditional healers) who used medicinal plants to manage obesity were only from 30 different ethnic backgrounds. Interestingly, while comprising less than 30% of the entire

ethnic group, they are quite evenly spread throughout almost all of Indonesia's islands, i.e., on the islands of Java, Kalimantan, Sulawesi, and Papua (Fig. 1).

Ethnic groups with anti-obesity ingredients were spread across almost all major islands in Indonesia. However, only 18 of the 38 provinces, representing 30 ethnicities, employ medicinal herbs to manage obesity. The provinces with the highest ethnicities using anti-obesity concoctions were East Java, North Kalimantan, Papua, and Central Sulawesi, each with three ethnicities (Fig. 1). The ethnicity distribution, which has plant-derived potions for obesity, might have an association with the prevalence of overweight. Indonesia's Nutritional Status Survey (SSGI) held in 2022 revealed that the prevalence of toddlers' overweight in Papua, Central Kalimantan, East Kalimantan, West Kalimantan, and Banten was 6.7%, 5.6%, 4.0%, 3.9%, and 3.9%, respectively. West Java and East Java are at 3.6%, exceeding the national average of 3.5% [34]. Trends in the prevalence of overweight among toddlers in Indonesia have also increased in almost all provinces [35]. During the years 1993 to 2014, there was an increase of around 10% in overweight among adolescents aged 6–12 years and around 7% in overweight adults aged 13–18 years [36]. These ethnicities are spread across almost all the large islands in Indonesia. Madura and Java use a wider variety of plants to overcome these problems. The use of plant ingredients for treatment among the Java has been passed down from generation to generation, known as Jamu and recorded since the 5th century. Jamu means prayer or medicine to improve health [37].

Traditional healers who had anti-obesity remedies were 12% more women than males (Fig. 2A), which related to the gender perception of obesity. Women were more worried with the weight and body shape issue than males [38,39]. Furthermore, patients prefer to see medical practitioner of their same gender. This is especially relevant for women,



Figure 1. Distribution ethnic groups in Indonesia who use plants for overweight. 1: Pakpak; 2: Abung Seputih; 3: Banten; 4: Betawi; 5: Sunda Priangan; 6: Cirebon; 7: Jawa; 8: Madura; 9: Bawean; 10: Kanayan Mempawah; 11: Tobak; 12: Dayak Tabuyan; 13: Dayak Apokayan; 14: Putuk; 15: Lepo Tau; 16: Bulongan; 17: Kore; 18: Krowe Muhang; 19: Kole Susu; 20: To Badaya; 21: Tialo; 22: Mian Sea Sea; 23: Ratahan; 24: Buru; 25: Fordata; 26: Kao Dalam; 27: Wandamen; 28: Damal; 29: Yakai; 30: Demta.

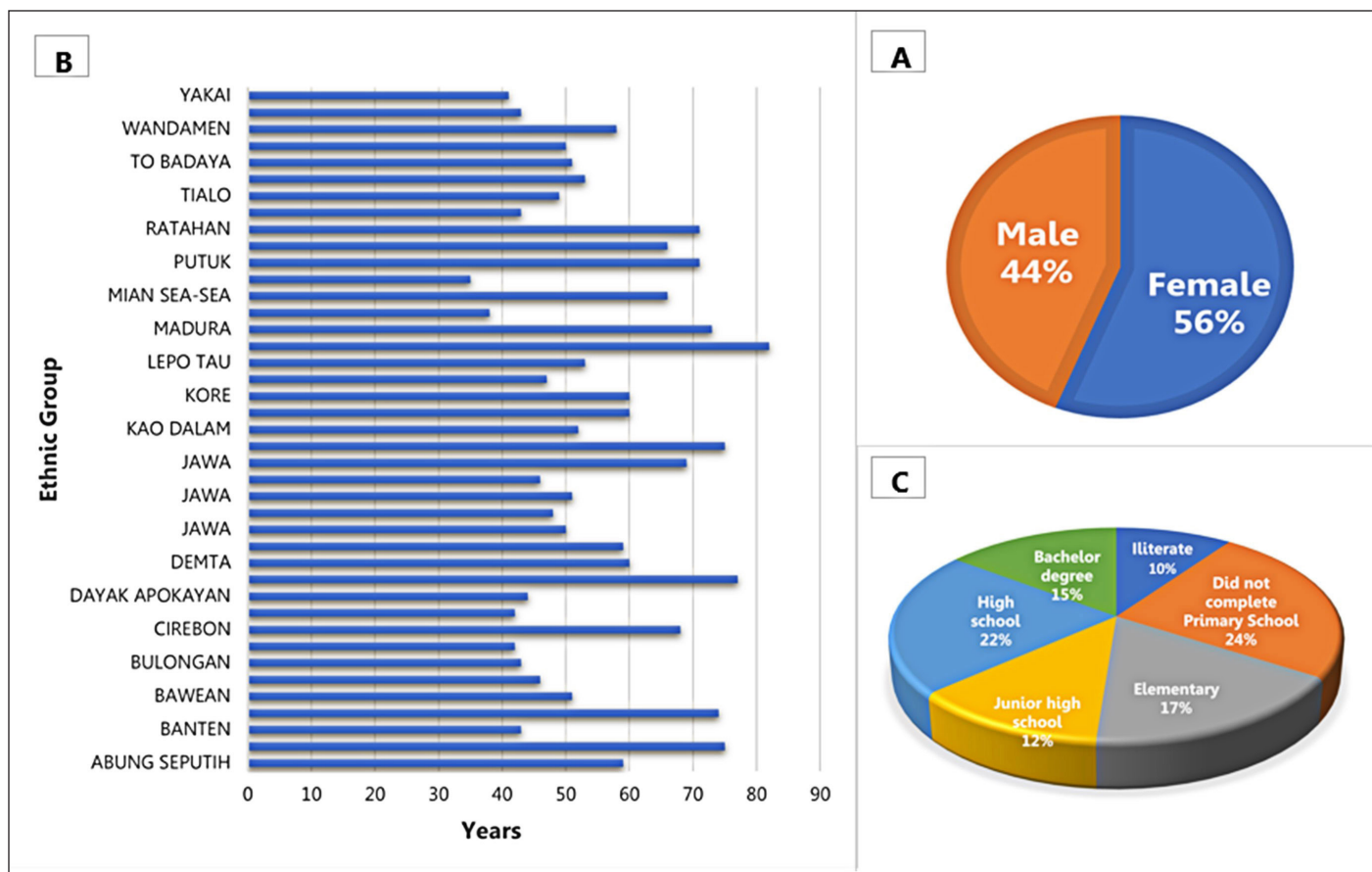


Figure 2. The characteristics of traditional healers. A: Gender of traditional healer; B: Age of traditional healer; C: Education level of traditional healer.

particularly when discussing gender-related health issues, such as reproductive organ health, body shape, and body weight. This may explain why female traditional healers are more likely to have a weight loss concoction. Most of the traditional healers who have anti-obesity herbs were 40–50 years old. There were 26.67% of traditional healers whose anti-obesity ingredients were more than 70 years old because to become a traditional healer, someone must have specific requirements that not everyone was able to fulfill [40]. More than 30% of traditional healers who have anti-obesity herbs did not have adequate education (Fig. 2C). People with low education do not receive much socialization or information regarding medical treatment, and their low level of education causes people to tend to use traditional medicine as an alternative treatment [41].

Table 1 shows that 73 plant species belonging to 32 families are used for tackling obesity. Zingiberaceae was the most widely used family to treat overweight comprising 10 plant species, including *Boesenbergia rotunda*, *Curcuma aeruginosa*, *Curcuma heyneana*, *Curcuma longa*, *Curcuma zanthorrhiza*, *Kalmia angustifolia*, *Kaempferia galanga*, *Zingiber officinale*, and *Zingiber zerumbet*. Three plant species from the Zingiberaceae family with the highest RUV and UF values are *C. zanthorrhiza*, *Z. officinale*, and *Z. zerumbet*. Compounds of *Z. officinale* are reported to be capable of activating transient receptor potential vanilloid type 1 and boosting adrenaline production. Gingerol and shogaol

are compounds found in *Z. officinale*, which are capable of increasing thermogenesis. Gingerol prevents adipocyte differentiation, preventing preadipocyte cells from developing into mature adipocytes. Other mechanisms include peroxisome proliferator-activated receptor delta, a basic regulator of energy metabolism in skeletal and adipose tissue 6-shogaol, and stimulation of lipid oxidation [42]. *Curcuma zanthorrhiza* consists mainly of xanthorrhizol, curcuminoids, and essential oils [43,44]. The primary active constituent of xanthorrhizol can inhibit adipogenesis in the formation of adipocytes [45]. Javanese turmeric (*C. zanthorrhiza*) essential oil lowered LDL cholesterol and body weight in rats; thus, *C. zanthorrhiza* affects lipid metabolism [46], which might be through inhibition of lipogenesis or enhancement of lipolysis [47]. *Zingiber zerumbet* has been studied and may indirectly improve metabolic health [48], and there is some evidence that some studies have reported that zerumbone is an important factor in weight management by inhibiting adipogenesis, the development of fat cells in 3T3-L1 cells [49]. The *Z. zerumbet* rhizome ethanol extract on improving testosterone levels and spermatogenesis and its possible role in obese induced reproductive dysfunction in high-fat-diet-induced obese rats has also been found [50].

Based on Table 1, various parts of plants used in preventing obesity include rhizomes, tubers, bark, flowers, leaves, fruit, stems, seeds, roots, and herbs. The most widely used are leaves (25 species), fruit (13 species), bark (12

Table 1. Plant parts used, local names, plant parts used, RFC, UV, and FUV of various medicinal plant used to overcome obesity in Indonesia.

Family	Botanical name	Vernacular name	Ethnic group	RFC	UV	FUV	Plant parts	Usage
Acoraceae	<i>Acorus calamus</i> L.	Ramakadip	Yakai	0.045	0.045	0.045	rhizome	Topical, inhaler
Amaryllidaceae	<i>Allium cepa</i> L.	Bawang merah	Pakpak	0.023	0.045	0.045	tuber	Oral
	<i>Allium sativum</i> L.	Bawang putih	Pakpak	0.023	0.045		tuber	Oral
Anacardiaceae	<i>Lannea coromandelica</i> (Houtt.) Merr.	Kaju jaran lakek	Madura	0.023	0.023	0.023	bark	Oral
Annonaceae	<i>Cananga odorata</i> (Lam.) Hook.f. & Thomson	Kenanga	Jawa, Madura	0.045	0.045	0.034	flower, bark	Oral
	<i>Annona muricata</i> L.	Sirsak	Damal	0.023	0.023		leaf	Oral
Apiaceae	<i>Centella asiatica</i> (L.) Urb.	Pegagan	Betawi	0.023	0.023	0.034	leaf	Oral
	<i>Foeniculum vulgare</i> Mill.	Adas	Madura	0.023	0.023		fruit	Oral
	<i>Pimpinella pruatjan</i> Mol.	Purwaceng	Jawa	0.023	0.023		leaf	Oral
Apocynaceae	<i>Alstonia scholaris</i> (L.) R. Br.	Lame	Sunda Priangan	0.023	0.023	0.028	bark	Oral
	<i>Alyxia stellata</i> (J.R.Forst. & G.Forst.) Roem. & Schult.	Pulosari	Madura	0.023	0.023		bark	Oral
	<i>Plumeria alba</i> L.	Cempaka	Madura, Kao Dalam	0.045	0.045		stem, bark	Oral
	<i>Urceola laevigata</i> (Juss.) D.J. Middleton & Livsh	Kayu rapet	Madura	0.023	0.023		bark	Oral
Arecaceae	<i>Areca catechu</i> L.	Penang	Madura	0.023	0.023	0.023	seed	Oral
	<i>Cocos nucifera</i> L.	Kelapa	Kao Dalam	0.023	0.023		fruit	Oral
Asteraceae	<i>Gymnanthemum amygdalinum</i> (Delile). Sch. Bip	Teh cina, Wau	Jawa, Lepo Tau, Damal	0.068	0.068	0.038	leaf	Oral
	<i>Pluchea indica</i> (L.) Less.	Beluntas	Kolesusu	0.023	0.023		leaf	Oral
	<i>Sonchus arvensis</i> L.	Tempuyung	Jawa	0.023	0.023		root	Oral
Bromeliaceae	<i>Ananas comosus</i> (L.) Merr.	Kennas	Pakpak	0.023	0.023	0.023	fruit	Oral
Calophyllaceae	<i>Calophyllum</i> sp.	Bintanggur	Buru	0.023	0.023	0.023	leaf	Oral
Clusiaceae	<i>Garcinia mangostana</i> L.	Manggis	Madura	0.023	0.023	0.023	bark	Oral
Combretaceae	<i>Terminalia chebula</i> Retz.	Majakeling	Madura	0.023	0.023	0.023	fruit	Oral
Cucurbitaceae	<i>Cucumis sativus</i> L.	Ketimun	Demta	0.023	0.023	0.023	fruit	Oral
	<i>Sicyos edulis</i> Jacq.	Labu jipang	Pakpak	0.023	0.023		fruit	Oral
Euphorbiaceae	<i>Croton tiglium</i> L.	Malakian, Kemenai	Kanayan Mempawah, Dayak Tabuyan	0.045	0.045	0.040	fruit	Oral
	<i>Euphorbia heterophylla</i> L.	Rumput kangkong, Lantoro, Kastroli	Mian Sea Sea, To Badaya, Fordata	0.068	0.068		leaf	Oral
	<i>Euphorbia hirta</i> L.	Upak kungku	Sasak	0.023	0.023		herb	Oral
	<i>Manihot esculenta</i> Crantz	Ambon jawe	Sasak	0.023	0.023		leaf	Oral
Fabaceae	<i>Cynometra cauliflora</i> L.	Jikeling	Madura	0.023	0.023	0.038	fruit	Oral

Continued

Family	Botanical name	Vernacular name	Ethnic group	RFC	UV	FUV	Plant parts	Usage
	<i>Leucaena leucocephala</i> (Lam.) de Wit	Lamtoro, Petai Cina	Ratahan, Wandamen	0.045	0.045		leaf	Oral
	<i>Pleurolobus gangeticus</i> (L.) J.St.-Hil. Ex H. Ohashi & K. Ohashi	Kulapot	Mian Sea Sea	0.023	0.023		root	Oral
	<i>Pongamia pinnata</i> (L.) Pierre	Langin tobun	Mian Sea Sea	0.023	0.023		root	Oral
	<i>Senna alata</i> (L.) Roxb.	Uroq kop, Saga	Dayak Apokayan, Putuk	0.045	0.045		leaf	Oral
Fagaceae	<i>Tamarindus indica</i> L.	Asem	Jawa	0.023	0.068		fruit	Oral
	<i>Quercus infectoria</i> G. Olivier	Majaan, Majakani	Jawa, Madura	0.045	0.068	0.068	fruit	Oral
Lamiaceae	<i>Gmelina arborea</i> Roxb. ex Sm.	Jati putih	Krowe Muhang	0.023	0.023	0.028	leaf	Oral
	<i>Hyptis capitata</i> Jacq.	Bingkalo	To Badaya	0.023	0.023		leaf	Oral
	<i>Orthosiphon aristatus</i> (Blume.) Miq.	Kumis kucing	Jawa	0.023	0.023		herb	Oral
Lauraceae	<i>Tectona</i> sp.	Jati cina	Jawa, Betawi	0.045	0.045		leaf	Oral
	<i>Cinnamomum burmannii</i> (Nees & T.Nees) Blume	Manis janggan	Madura	0.023	0.023	0.045	bark	Oral
	<i>Cryptocarya massoy</i> (Oken) Kosterm.	Masoji	Madura	0.023	0.023		bark	Oral
	<i>Litsea cubeba</i> (Lour.) Pers.	Kerangean	Jawa	0.023	0.023		seed	Oral
Malvaceae	<i>Abelmoschus esculentus</i> (L.) Moench	Klongkang	Cirebon	0.023	0.023	0.030	fruit	Oral
	<i>Guazuma ulmifolia</i> Lam.	Jati belanda	Jawa	0.023	0.045		leaf	Oral
	<i>Hibiscus sabdariffa</i> L.	Teh rosela	Betawi	0.023	0.023		flower	Oral
Meliaceae	<i>Toona sureni</i> (Blume) Mer.	Soren	Madura	0.023	0.023	0.023	bark	Oral
Moraceae	<i>Artocarpus altilis</i> (Parkinson) Fosberg	Sukun	Banten	0.023	0.023	0.023	leaf	Oral
Myrtaceae	<i>Psidium guajava</i> L.	Gambu pare	To Badaya	0.023	0.023	0.023	leaf	Oral
	<i>Syzygium cumini</i> (L.) Skeels	Duwek	Madura	0.023	0.023		bark	Oral
	<i>Syzygium nervosum</i> DC	Salam	Bulongan	0.023	0.023		leaf	Oral
Oleaceae	<i>Nyctanthes arbor-tristis</i> L.	Sri gading	Jawa	0.023	0.023	0.023	leaf	Oral
Piperaceae	<i>Piper betle</i> L.	Sirih	Jawa	0.023	0.023	0.034	leaf	Oral
	<i>Piper retrofractum</i> Vahl.	Cabe jamu, Cabih jemu	Madura	0.023	0.045		fruit	Oral
Plantaginaceae	<i>Scoparia dulcis</i> L.	Kurus	Krowe Muhang	0.023	0.023	0.023	leaf	Oral
Poaceae	<i>Cymbopogon citratus</i> (DC.) Stapf	Padamalala	Muna Kobawo	0.023	0.023	0.023	stem	Oral
Polygonaceae	<i>Rheum officinale</i> Baill.	Kalembok	Madura	0.023	0.023	0.023	root	Oral
Rubiaceae	<i>Morinda citrifolia</i> L.	Kodduk	Madura	0.023	0.023	0.023	bark	Oral
Rutaceae	<i>Citrus hystrix</i> DC.	Jeruk purut	Jawa	0.023	0.023	0.028	leaf	Oral

Continued

Family	Botanical name	Vernacular name	Ethnic group	RFC	UV	FUV	Plant parts	Usage
	<i>Citrus x aurantiifolia</i> (Christm.) Swingle	Jeruk nipis	Bawean, Putuk	0.045	0.045		fruit	Oral
	<i>Clausena</i> sp.	Kemuni	Kore	0,023	0,023		leaf	Topical
	<i>Murraya paniculata</i> (L.) Jack	Kemuning	Jawa	0.023	0.023		leaf	Oral
Solanaceae	<i>Solanum americanum</i> Mill.	Leuh	Pakpak	0.023	0.045	0.045	leaf	Oral
Thymelaeaceae	<i>Phaleria macrocarpa</i> (Scheff.) Boerl.	Mahkota dewa	Betawi	0.023	0.023	0.023	leaf	Oral
Zingiberaceae	<i>Boesenbergia rotunda</i> (L.) Mansf.	Koncheh	Madura	0.023	0.023	0.036	rhizome	Oral
	<i>Curcuma aeruginosa</i> Roxb.	Temu ereng	Madura	0.023	0.023		rhizome	Oral
	<i>Curcuma heyneana</i> Valeton & Zijp	Temo giring	Madura	0.023	0.023		rhizome	Oral
	<i>Curcuma longa</i> L.	Kunyit	Tobal	0.023	0.023		rhizome	Oral
	<i>Curcuma zanthorrhiza</i> Roxb.	Temulawak, Temu Labek	Jawa, Madura	0.045	0.068		rhizome	Oral
	<i>Kaempferia angustifolia</i> Roscoe	Kunci pepet	Jawa	0.023	0.023		rhizome	Oral
	<i>Kaempferia galanga</i> L.	Kencur, Sulue	Banten, Tialo	0.023	0.045		rhizome	Oral
	<i>Zingiber montanum</i> (J.Koenig) Link ex A.Dietr.	Banglei	Putuk	0.023	0.023		rhizome	Oral
	<i>Zingiber officinale</i> Roscoe	Jahe merah, Jahe	Mesuji, Pakpak	0.045	0.045		rhizome	Oral
	<i>Zingiber zerumbet</i> (L.) Roscoe ex Sm.	Lempuyang, Lempojeng Wangi, Bangle	Abung Seputih, Madura, Banten	0.068	0.068		rhizome	Oral

species), and rhizomes (11 species). The primary part of plants frequently used was leaves, considerably due to the availability of those parts for a whole year, especially in tropical regions, which makes them easier to obtain in sufficient amounts than other parts. Besides, they are easily regenerated, and harvesting leaves is considered to have less destructive effects and a minor negative impact on further plant growth and survival. They also contain many active compounds which have medicinal properties [51]. The most common plant part used by Zingiberaceae is the rhizome. This plant part is widely used as a pharmaceutical raw material because it contains various bioactive compounds such as polyphenols or volatiles [52].

The relative frequency of citation (RFC) is a widely employed method for calculating percentages in anthropology and the social sciences. Its intuitive and fundamental nature has made it a prevalent tool that does not necessitate conversion into a distinct index. A UV indicates how effectively certain plant species treat a particular condition locally [53,54]. The RFC and UV values of various medicinal plants used to overcome obesity in Indonesia were between 0.023 and 0.68 (Table 2). RFC and UV have a standard deviation that is smaller than the mean, indicating low variation between the

Table 2. Pearson for relative frequency citation (RFC) and use value (UV) of various medicinal plant used to overcome obesity in Indonesia.

	Mean	Standard deviation	Minimum	Maximum
RFC	0.028	0.012	0.023	0.068
UV	0.031	0.014	0.023	0.068
Pearson correlation coefficient				
r	0.7947			
r ²	0.6315			

maximum and minimum values. The highest RFV was obtained in *Gymnanthemum amygdalinum*, *Euphorbia heterophylla*, and *Z. zerumbet*. The RFC value showed that the informants mostly used these three species to treat obesity. Meanwhile, the highest UV was found in *G. amygdalinum*, *E. heterophylla*, *T. indica*, *Q. infectoria*, *C. zanthorrhiza*, and *Z. zerumbet*. The families with high FUV (family use value) were Fagaceae (FUV = 0.068), Acoraceae, Amaryllidaceae, Lauraceae, and Solanaceae

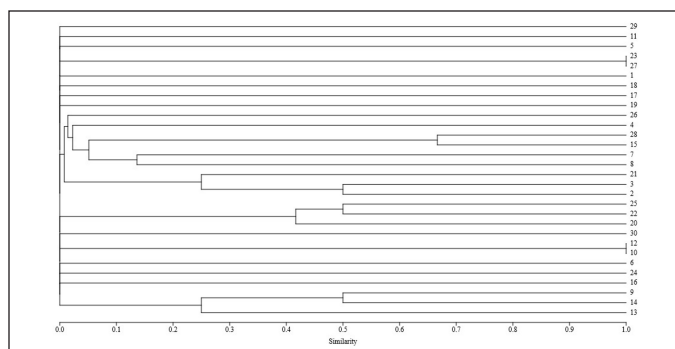


Figure 3. UPGMA bray curtis similarity index of ethnic clustering based on the utilization of medicinal plants to overcome overweight with the. 1: Pakpak; 2: Abung Seputih; 3: Banten; 4: Betawi; 5: Sunda Priangan; 6: Cirebon; 7: Jawa; 8: Madura; 9: Bawean; 10: Kanayan Mempawah; 11: Tobak; 12: Dayak Tabuyan; 13: Dayak Apokayan; 14: Putuk; 15: Lepo Tau; 16: Bulongan; 17: Kore; 18: Krowe Muhang; 19: Kole Susu; 20: To Badaya; 21: Tialo; 22: Mian Sea Sea; 23: Ratahan; 24: Buru; 25: Fordata; 26: Kao Dalam; 27: Wandamen; 28: Damal; 29: Yakai; 30: Demta.

(FUV = 0.045), as shown in Table 1. The FUV can be employed to ascertain the relative significance of plant families in terms of their utility, surpassing random estimations. This metric is present to underscore the families that denote a greater range of uses [55]. The main objectives of medicinal plants and their derived products are to hinder the activity of pancreatic lipase, reduce appetite, enhance thermogenesis and lipid metabolism, limit the breakdown of fats, and encourage the formation of fat cells [56]. With a p -value of less than 1% and a Pearson correlation coefficient of 0.7947 between RFC and UV, there is clear evidence of a strong positive significant relationship between the relative importance of plant use and the local significance of each species (Table 2). There are generally more usable therapeutic herbs when the informants' species are used more frequently [31]. Variation in species used in obesity: 63% of the variation in RFC can be explained by that of UV.

Traditional medicine in Indonesia is a method of therapy employing traditional procedures that have been passed down from generation to generation in accordance with community customs. It is the accumulation of knowledge, skills, and practices based on the theories, beliefs, and experiences of people with various cultural customs. These aspects underlie the basis of the variances between ethnic groups. The similarity analysis showed that most of the 30 ethnic groups had different knowledge of the ingredients for overcoming obesity (100% dissimilarity). Two ethnic clusters had 100% similarity in medicinal plants usage knowledge to overcome overweight: the Ratahan (no. 23) and Wandamen (no. 27) cluster and the Dayak Tabuyan (no. 12) and Kanayan Mempawah (no. 10) cluster (Fig. 3). The Ratahan and Wandamen ethnic groups only use the *Leucaena leucocephala* plant in medicine, while the Dayak Tabuyan and Kanayan Mempawah ethnic groups only use *Croton tiglium*. The *L. leucocephala* and *C. tiglium* are known to have a wide distribution, likewise in Indonesia [57–59], so it is easy to find even for ethnic groups that are ubiquitous. The representation of similarity between samples in the dendrogram of Bray–Curtis similarity index-based clustering in Figure 4 can

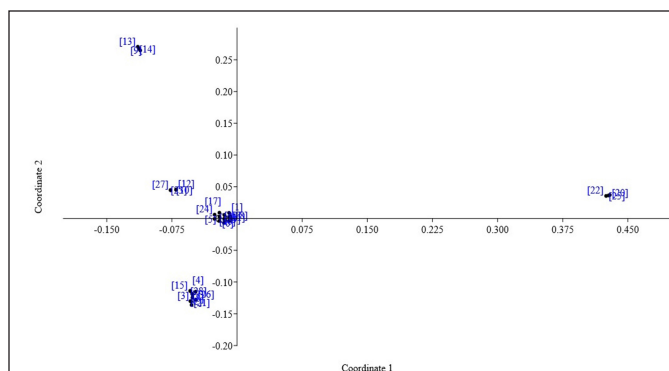


Figure 4. Scatterplot NMDS ordination in bray-curtis similarity index between ethnic groups based on medicinal plants knowledge to overcome obesity. 1: Pakpak; 2: Abung Seputih; 3: Banten; 4: Betawi; 5: Sunda Priangan; 6: Cirebon; 7: Jawa; 8: Madura; 9: Bawean; 10: Kanayan Mempawah; 11: Tobak; 12: Dayak Tabuyan; 13: Dayak Apokayan; 14: Putuk; 15: Lepo Tau; 16: Bulongan; 17: Kore; 18: Krowe Muhang; 19: Kole Susu; 20: To Badaya; 21: Tialo; 22: Mian Sea Sea; 23: Ratahan; 24: Buru; 25: Fordata; 26: Kao Dalam; 27: Wandamen; 28: Damal; 29: Yakai; 30: Demta.

be excellent. This is indicated by the coefficient of phylogenetic similarity, which is 0.96. The coefficient of coefficients has a function to measure the distance in the classification of data sets and the efficiency of clustering techniques, with a value of 0–1. A value closer to 1 indicates that the clustering and distance are more accurate [60]. People also widely use herbs and spices that contain therapeutic ingredients that are beneficial to their diet [61]. Previous research states that ethnicity, dietary habits, and geographical origin are closely interrelated, and are key factors in determining the diversity of the gut microbiome. Knowledge of benefits, cultivation techniques, and creativity in handling, processing, and cooking is needed to empower communities to utilize local biodiversity [62]. The use of medicinal plants for a particular problem carried out in a large area shows a low level of similarity, because traditional healers have local wisdom that is specific to their respective regions by utilizing the natural resources around them [25].

Most ethnicities shared similarities in the types and applications of medicinal plants used to treat obesity (93.15% of medicinal plants were alike). Ethnic Mian Sea-sea (no. 22)-To Badaya (no. 20)-Fordata (no. 25) differed from other ethnicities because they had a variety of medicinal plants for obesity, which were substantially distinct from other ethnicities; those three ethnicities were located at different coordinates from practically every other ethnicity (Fig. 4). Plants such as *E. heterophylla* L. (Fig. 5A) were only used by the Mian Sea-sea, To Badaya, and Fordata ethnicities. *Pleurolobus gangeticus* (L.) DC. (Fig. 5B) and *Pongamia pinnata* (L.) Pierre (Fig. 5D) were used only by the Mian Sea-sea ethnicity, as well as *Hyptis capitata* Jacq. (Fig. 5C), and *Psidium guajava* L. (Fig. 5E) was used only by the To Badaya ethnic (Table 1).

Previous research stated that one species of medicinal plant could be used to cure more than one disease, whereas one disease could be treated by using more than one medicinal plant. The part widely used as an ingredient in the present study was



Figure 5. Some of medicinal plants used as anti-obesity. A: *Euphorbia heterophylla* L.; B: *Pleurolobus gangeticus* (L.) J.St.-Hil. Ex H. Ohashi & K. Ohashi; C: *Hyptis capitata* Jacq.; D: *Pongamia pinnata* (L.) Pierre; E: *Psidium guajava* L.

the leaves. Local people select medicinal plants based on their understanding of efficacy [63]. Besides, previous research has stated that medicinal plants used as raw materials for drugs are relatively safe to use, have no side effects, are easily absorbed and digested by the body, and are not toxic [64]. In addition, there are similarities in the therapeutic activity of several medicinal plants from one region to another region. In Indonesia, the wealth of medical knowledge for overweight people is very diverse. Given that different cultures have diverse knowledge, we found similarities in the choice of plants and patterns of use of these plants in several ethnic groups. In addition, it was discovered that these ethnicities had different strategies [65]. The usage of wild plants for a variety of purposes, particularly medicinal plants for the treatment of excess weight, can lead to extinction if not balanced with significant awareness and strong commitment to conserving local resources. The primary causes of the decline of knowledge included the interruption of oral-based information transfer, the extinction of medicinal plant species owing to over-harvesting, other detrimental human factors, and contemporary drug system [66].

The level of vegetation and plants typically found around these ethnic groups, as well as the similarity ecology, influence the similarity of plant types used as traditional medicine to treat obesity at the tribal level in Indonesia. The ethnobiological similarities found, based on local knowledge regarding the use of medicinal plants to treat obesity, can be used as a utilitarian tool/index for future research, especially for assessing the quantitative ethnobiological data studied [67]. Studies related to the diversity of ethnobotanical knowledge in each ethnicity can be used to increase awareness about

conserving natural resources regarding medicinal plants [68]. More study is needed concerning the chemical composition and biological activity of plants frequently utilized by various ethnic groups [69]. The fact is that many traditional healers still harvest plants from nature's habitat without cultivating them, so thus conservation measures are urgently needed to prevent the extinction of these medicinal plants [70].

4. CONCLUSION

This study showed that there were many medicinal plants to treat obesity. It has been documented that 30 ethnic groups from 19 provinces in Indonesia use medicinal plants to treat obesity. Species from the Zingiberaceae family are most widely used to treat obesity. *G. amygdalinum*, *E. heterophylla*, and *Z. zerumbet* were identified as the species most commonly used by traditional healers. The most widely used plant family was Fagaceae, with a percentage of 6.8%. There was a strong positive significant relationship between the relative importance of plant use and the local significance of each anti-obesity plant species used by ethnicities in Indonesia. Most ethnicities that use plants to treat obesity have different knowledge about herbs to treat excess weight (100% dissimilarity). The typical level of vegetation and plants found around the tribe, as well as ecological similarities, influence the similarity of plant types used as traditional medicine to treat obesity at the tribal level in Indonesia. Studies related to the diversity of ethnobotanical knowledge in each ethnic group can be used to increase awareness of conserving natural resources related to medicinal plants. The most widely used traditional medicinal plants, such as *G. amygdalinum*, *E. heterophylla*, and *Z. zerumbet*, can be researched and developed to be utilized by the wider community as anti-obesity.

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6. AUTHORS CONTRIBUTION

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the International Committee of Medical Journal Editors (ICMJE) requirements/guidelines.

7. CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

8. ETHICAL APPROVAL

The ethical approval was obtained from the Chair of the Health Research Ethics Committee, Health Research and Development Agency, Ministry of Health, Republic of Indonesia, with approval numbers LB.02.01/5.2/KE.318/2015 and LB.02.01/2.Ke.107/2017.

9. DATA AVAILABILITY

All data collected and analyzed are incorporated in this study article.

10. PUBLISHER'S NOTE

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11. USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that they did not utilize artificial intelligence (AI) techniques for authoring and editing the work, and no pictures were modified using AI.

REFERENCES

- WHO. Obesity and Overweight [Internet]. Geneva, Switzerland: WHO; 2021. Available from: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>
- Linauskas A, Overvad K, Symmons D, Johansen MB, Stengaard-Pedersen K, de Thurah A. Body fat percentage, waist circumference, and obesity as risk factors for rheumatoid arthritis: A Danish Cohort Study. *Arthritis Care Res (Hoboken)*. 2019;71(6):777–86. doi: <https://doi.org/10.1002/acr.23694>
- Mohajan D, Mohajan HK. Body mass index (BMI) is a popular anthropometric tool to measure obesity among adults. *J Innov Med Res*. 2023;2(4):25–33. Available from: <https://www.paradigmexpress.org/jimr/article/view/578>
- Lemmens HJM, Brodsky JB, Bernstein DP. Estimating ideal body weight – a new formula. *Obes Surg*. 2005;15(7):1082–3. doi: <https://doi.org/10.1381/0960892054621350>
- Nishida C. Appropriate body mass index for Asian populations and its implications. *Lancet*. 2004;363:157–63.
- CDC. Centers for Disease Control and Prevention. Adult obesity facts [Internet]. Atlanta, Georgia: CDC; 2021. Available from: <https://www.cdc.gov/obesity/data/adult.html>
- Cohen SA, Cook SK, Kelley L, Foutz JD, Sando TA. A closer look at rural–Urban health disparities: associations between obesity and rurality vary by geospatial and sociodemographic factors. *J Rural Heal*. 2017;33(2):167–79. doi: <https://doi.org/10.1111/jrh.12207>
- Johnson JA, Johnson AM. Urban-rural differences in childhood and adolescent obesity in the United States: a systematic review and meta-analysis. *Child Obes*. 2015; 11(3):233–41. doi: <https://doi.org/10.1089/chi.2014.0085>
- Arifin H, Chou KR, Ibrahim K, Fitri SUR, Pradipta RO, Rias YA, *et al.* Analysis of modifiable, non-modifiable, and physiological risk factors of non-communicable diseases in Indonesia: evidence from the 2018 Indonesian basic health research. *J Multidiscip Healthc*. 2022;15:2203–21. Available from: <https://www.dovepress.com/analysis-of-modifiable-non-modifiable-and-physiological-risk-factors-o-peer-reviewed-fulltext-article-JMDH>
- Kemenkes RI. Hasil Riset Kesehatan Dasar Tahun 2018. Jakarta; 2018.
- Kemkes RI. Laporan Nasional Eksplorasi Pengetahuan Lokal Etnomedisin dan Tumbuhan Obat di Indonesia Berbasis Komunitas. Jakarta, Indonesia: Balitbang Kemkes; 2013.
- Tim Riskesdas. Laporan Nasional Riskesdas 2018. Jakarta, Indonesia;2018.
- Crewe C, An YA, Scherer PE. The ominous triad of adipose tissue dysfunction: inflammation, fibrosis, and impaired angiogenesis. *J Clin Invest*. 2017;127(1):74–82. Available from: <https://www.jci.org/articles/view/88883>
- Fitch AK, Bays HE. Obesity definition, diagnosis, bias, standard operating procedures (SOPs), and telehealth: an Obesity Medicine Association (OMA) Clinical Practice Statement (CPS) 2022. *Obes Pillars*. 2022;1:100004. doi: <https://doi.org/10.1016/j.obpill.2021.100004>
- Perez CF, Xi K, Simha A, Shah NS, Huang RJ, Palaniappan L, *et al.* Leading causes of death in Asian Indians in the United States (2005-2017). *PLoS One*. 2022;17(8 August):1–15. doi: <https://doi.org/10.1371/journal.pone.0271375>
- Al-Kuraishy HM, Al-Gareeb AI, Alsayegh AA, Hakami ZH, Khamjan NA, Saad HM, *et al.* A potential link between visceral obesity and risk of Alzheimer's disease. *Neurochem Res*. 2023;48(3):745–66. doi: <https://doi.org/10.1007/s11064-022-03817-4>
- Saltiel AR, Olefsky JM. Inflammatory mechanisms linking obesity and metabolic disease. *J Clin Invest*. 2017;127(1):1–4. Available from: <https://www.jci.org/articles/view/92035>
- Tahergorabi Z, Khazaei M, Moodi M, Chamani E. From obesity to cancer: a review on proposed mechanisms. *Cell Biochem Funct*. 2016;34(8):533–45. doi: <https://doi.org/10.1002/cbf.3229>
- Chung S, Park SH, Park JH, Hwang JT. Anti-obesity effects of medicinal plants from Asian countries and related molecular mechanisms: a review. *Rev Cardiovasc Med*. 2021;22(4):1279. Available from: <https://impress.com/journal/RCM/22/4/10.31083/j.rcm2204135>
- Law SK, Wang Y, Lu X, Au DCT, Chow WYL, Leung Awn, *et al.* Chinese medicinal herbs as potential prodrugs for obesity. *Front Pharmacol*. 2022;13(October):1–16. doi: <https://doi.org/10.3389/fphar.2022.1016004/full>
- Sulaiman, Shah S, Khan S, Bussmann RW, Ali M, Hussain D, *et al.* Quantitative ethnobotanical study of indigenous knowledge on medicinal plants used by the tribal communities of Gokand Valley, District Buner, Khyber Pakhtunkhwa, Pakistan. *Plants*. 2020;9(8):1001. Available from: <https://www.mdpi.com/2223-7747/9/8/1001>
- Buchholz T, Melzig MF. Medicinal plants traditionally used for treatment of obesity and diabetes mellitus—screening for pancreatic lipase and α -amylase inhibition. *Phyther Res*. 2016;30(2):260–6. doi: <https://doi.org/10.1002/ptr.5525>
- Mopuri R, Islam MS. Medicinal plants and phytochemicals with anti-obesogenic potentials: a review. *Biomed Pharmacother*. 2017;89:1442–52. doi: <https://doi.org/10.1016/j.biopha.2017.02.108>
- Farrington R, Musgrave IF, Byard RW. Evidence for the efficacy and safety of herbal weight loss preparations. *J Integr Med*. 2019;17(2):87–92. doi: <https://doi.org/10.1016/j.joim.2019.01.009>
- Adi M, Susanti D, Wijaya N. Antifever medicinal plants on native ethnics on Sumatra Island. *J Complement Med Res*. 2020;11(1):19. Available from: <https://ejmanager.com/fulltextpdf.php?mno=115984>
- Maruzay A, Mujahid R. Conservation status of medicinal plants from Papua and West Papua Province (Indonesia). *Media Konserv*. 2019;24(2):114–23. Available from: <https://journal.ipb.ac.id/index.php/konservasi/article/view/27749>
- Leonti M. The relevance of quantitative ethnobotanical indices for ethnopharmacology and ethnobotany. *J Ethnopharmacol*. 2022;288(January):1–5. doi: <https://doi.org/10.1016/j.jep.2022.115008>

28. Nurhayati APD, Rihandoko A, Fadlan A, Ghaissani SS, Jadid N, Setiawan E. Anti-cancer potency by induced apoptosis by molecular docking P53, caspase, cyclin D1, cytotoxicity analysis and phagocytosis activity of trisindoline 1,3 and 4. *Saudi Pharm J*. 2022;30(9):1345–59. doi: <https://doi.org/10.1016/j.jsps.2022.06.012>
29. Mirzaman Z, Kayani S, Manzoor M, Jameel MA, Waheed M, Gillani SW, *et al.* Ethnobotanical study of Makra Hills district Muzaffarabad, Azad Jammu and Kashmir, Pakistan. *Ethnobot Res Appl*. 2023;26(10):1–17. Available from: <https://ethnobotanyjournal.org/index.php/era/article/view/5405>
30. Rehman S, Iqbal Z, Qureshi R. Ethnomedicinal plants used for the treatment of gastrointestinal disorders in Tribal District North Waziristan, Khyber Pakhtunkhawa, Pakistan. *Ethnobot Res Appl*. 2023;26(63):1–22. Available from: <https://ethnobotanyjournal.org/index.php/era/article/view/5277/1843>
31. Bano A, Mushtaq A, Taibi BH, Saboor A, Shazia S, Zafar M, *et al.* Quantitative ethnomedicinal study of plants used in the skardu valley at high altitude of Quantitative ethnomedicinal study of plants used in the skardu valley at high altitude of. *J Ethnobiol Ethnomed*. 2014;10(43):1–17. Available from: <http://www.ethnobiomed.com/content/10/1/43>
32. Umair M, Altaf M, Bussmann RW, Abbasi AM. Ethnomedicinal uses of the local flora in Chenab riverine area, Punjab province Pakistan. *J Ethnobiol Ethnomed*. 2019;15(1):7. doi: <https://doi.org/10.1186/s13002-019-0285-4>
33. Hammer Ø, Harper DAT, Ryan PD. PAST : paleontological Statistics Software Package for Education and Data Analysis PAST : even a cursory glance at the recent paleontological literature should convince anyone tha. *Palaeontol Electron*. 2001;4(1):1–9.
34. Kementrian Kesehatan RI. Buku Saku Hasil Studi Status Gizi Indonesia (SSGI) Tingkat Nasional, Provinsi, dan Kabupaten/ Kota Tahun 2021. Jakarta, Indonesia: Balitbang Kemkes; 2022.
35. Rachmi CN, Li M, Alison Baur L. Overweight and obesity in Indonesia: prevalence and risk factors—a literature review. *Public Health*. 2017;147:20–9. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0033350617300434>
36. Oddo VM, Maehara M, Rah JH. Overweight in Indonesia: an observational study of trends and risk factors among adults and children. *BMJ Open*. 2019;9(9):e031198. Available from: <https://bmjopen.bmj.com/lookup/doi/10.1136/bmjopen-2019-031198>
37. Andriati A, Wahjudi RMT. Tingkat penerimaan penggunaan jamu sebagai alternatif penggunaan obat modern pada masyarakat ekonomi rendah-menengah dan atas. *Masyarakat, Kebud dan Polit*. 2016;29(3):133. Available from: <http://e-journal.unair.ac.id/index.php/MKP/article/view/2547>
38. Ashgarie RIA, Ikhsan MFF, Amelia PC, Nurmalitasari F. Body appreciation Pada Perempuan Dewasa Awal yang Aktif Menggunakan Media Sosial. *Flourishing J*. 2023;2(6):457–67. Available from: <http://journal3.um.ac.id/index.php/psi/article/view/3052>
39. Rengga OL, Soetjningsih CH. Body image Ditinjau dari Jenis Kelamin pada Masa Dewasa Awal. *Philanthr J Psychol*. 2022;6(1):1. Available from: <https://journals.usm.ac.id/index.php/philanthropy/article/view/4851>
40. Efrianto E. Klasifikasi Dan Sistim Pewarisan Dalam Pengobatan Tradisional Pada Masyarakat Kaur Provinsi Bengkulu. *Suluah*. 2018;21(1):19–29. Available from: <https://suluah.kemdikbud.go.id/index.php/SULUAH/article/view/71/33>
41. Adiyasa MR, Meiyanti M. Pemanfaatan obat tradisional di Indonesia: distribusi dan faktor demografis yang berpengaruh. *J Biomedika dan Kesehat*. 2021;4(3):130–8. Available from: <https://jbiomedkes.org/index.php/jbk/article/view/163>
42. Icer MA, Tek NA. Effects of red pepper, ginger, and turmeric on energy metabolism: review of current knowledge. *Altern Ther Health Med*. 2023;29(3):81–7.
43. Kim MB, Kim C, Song Y, Hwang JK. Antihyperglycemic and anti-inflammatory effects of standardized *Curcuma xanthorrhiza* Roxb. Extract and its active compound xanthorrhizol in high-fat diet-induced obese mice. *Evidence-based Complement Altern Med*. 2014;2014:205915.
44. Zhang HA, Kitts DD. Turmeric and its bioactive constituents trigger cell signaling mechanisms that protect against diabetes and cardiovascular diseases. *Mol Cell Biochem*. 2021;476(10):3785–814. doi: <https://doi.org/10.1007/s11010-021-04201-6>
45. Oon SF, Nallappan M, Tee TT, Shohaimi S, Kassim NK, Sa'ariwijaya MSF, *et al.* Xanthorrhizol: a review of its pharmacological activities and anticancer properties. *Cancer Cell Int*. 2015;15(1):100. doi: <https://doi.org/10.1186/s12935-015-0255-4>
46. Darmawan E, Pramono S. Essential oil of Javanese turmeric (*Curcuma xanthorrhiza*, Roxb) decrease level of LDL-cholesterol and body weight in rats. *Indones J Cancer Chemoprevention*. 2017;7(1):6. Available from: <http://ijcc.chemoprev.org/index.php/ijcc/article/view/96>
47. Yasni S, Imaizumi K, Nakamura M, Aimoto J, Sugano M. Effects of *Curcuma xanthorrhiza* Roxb. and curcuminoids on the level of serum and liver lipids, serum apolipoprotein A-I and lipogenic enzymes in rats. *Food Chem Toxicol*. 1993;31(3):213–8. Available from: <https://linkinghub.elsevier.com/retrieve/pii/027869159390096H>
48. Tan JW, Israif DA, Tham CL. Major bioactive compounds in essential oils extracted from the rhizomes of *Zingiber zerumbet* (L) smith: a mini-review on the anti-allergic and immunomodulatory properties. *Front Pharmacol*. 2018;9(JUN):1–8. Available from: <https://www.frontiersin.org/article/10.3389/fphar.2018.00652/full>
49. Ahn J, Lee H, Jung CH, Choi WH, Ha TY. Zerumbone ameliorates high-fat diet-induced adiposity by restoring AMPK-regulated lipogenesis and microRNA-146b/SIRT1-mediated adipogenesis. *Oncotarget*. 2017;8(23):36984–95. Available from: <https://www.oncotarget.com/lookup/doi/10.18632/oncotarget.16974>
50. Jani NHM, Daud D, Sharkawi N, Hashim H, Ismail NHILWANI, Salleh A, *et al.* The effect of *Zingiber zerumbet* rhizome ethanol extract (Zzree) on testosterone level and testes histoarchitecture in high fat diet-induced obese rats. *Malaysian Appl Biol*. 2018;47(5):181–7.
51. Mawadha NR, Febryano IG, Tsani MK, Duryat D. Utilization of medicinal plants by the lintang tribe community in Talang Baru Village, Empat Lawang District, Indonesia. *Asian J Ethnobiol*. 2023;6(1):20–5. Available from: <https://smujo.id/aje/article/view/12883>
52. Zagórska J, Kukula-Koch W, Czop M, Howiecka K, Koch W. Impact of thermal processing on the composition of *Curcuma longa* rhizome. *Foods*. 2023;12(16):3086. Available from: <https://www.mdpi.com/2304-8158/12/16/3086>
53. Kusnafizal T, Azis A, Iswanto S, Tabib Family's role on fracture treatment in Aceh, 1950-2020: a historical reconstruction. *Indones Hist Stud*. 2020;4(2):186–95. Available from: <https://ejournal2.undip.ac.id/index.php/ihis/article/view/9497>
54. Mustofa FI, Rahmawati N, Saryanto S. Ethnomedicine of medicinal plants used by traditional healers to facilitate bone injury healing in West Kalimantan, Indonesia. *J Tumbuh Obat Indones*. 2021;14(1):36–54. Available from: <http://ejournal2.litbang.kemkes.go.id/index.php/toi/article/view/4766>
55. Nisa U, Triyono A, Ardiyanto D, Novianto F, Fitriani U, Jannah WDM, *et al.* Ethnopharmacological study of medicinal plants indigenous knowledge about low back pain therapy in Sumatra, Indonesia. *J Appl Pharm Sci*. 2022;12(9):178–88. Available from: https://japsonline.com/abstract.php?article_id=3644&sts=2
56. Saad B. The molecular mechanisms of anti-obesity medicinal plants subjects: cardiac the molecular mechanisms of anti-obesity medicinal plants. *Encyclopedia*. 2023;(August):1–10. Available from: <https://www.aup.edu/sites/default/files/2023-08/the-molecular-mechanisms-of-anti-obesity-medicinal-plants-2.pdf>
57. Beyer J, Esser HJ, Eurlings MCM, Vanwelzen PC. A revision of the genus *Croton* (Euphorbiaceae) in Sumatra (Indonesia). *Blumea—Biodiversity, Evol Biogeogr Plants*. 2023;68(1):1–25.

- Available from: <https://www.ingentaconnect.com/content/10.3767/blumea.2023.68.01.01>
58. Sharma P, Kaur A, Batish DR, Kaur S, Chauhan BS. Critical insights into the ecological and invasive attributes of *Leucaena leucocephala*, a tropical agroforestry species. *Front Agron.* 2022;4(May):1–15. Available from: <https://www.frontiersin.org/articles/10.3389/fagro.2022.890992/full>
 59. Wardatun S, Harahap Y, Mun'im A, Saputri FC, Sutandyo N. *Leucaena leucocephala* (Lam.) de Wit Seeds: a new potential source of Sulfhydryl compounds. *Pharmacogn J.* 2020;12(2):298–302. Available from: <https://www.phcogj.com/article/1098>
 60. Maruzy A, Adi MBS, Safrina D, Putra ADP, Wijaya NR, Subositi D. Genetic variations of fennel (*Foeniculum vulgare* Mill.) based on inter-simple sequence repeats (ISSR) marker. *J Biota.* 2024;10(1):15–23. Available from: <http://jurnal.radenfatah.ac.id/index.php/biota/article/view/20667>
 61. Debbarma A, Nilabh T. Medicinal plants and its role in human diet. *Front Food Sci Nutr.* 2024;5(1):15–24.
 62. Afrianto WF, Tamnge F, Hidayatullah T, Hasanah LN. Local knowledge of plant-based nutrition sources from forgotten foods in Datengan Village, East Java, Indonesia. *Asian J Ethnobiol.* 2021;4(1):53–64. Available from: <https://smujo.id/aje/article/view/8116>
 63. Assefa B, Megersa M, Jima TT. Ethnobotanical study of medicinal plants used to treat human diseases in Gura Damole District, Bale Zone, Southeast Ethiopia. *Asian J Ethnobiol.* 2021;4(1):42–52. Available from: <https://smujo.id/aje/article/view/7094>
 64. Boy HIA, Rutilla AJH, Santos KA, Ty AMT, Yu AI, Mahboob T, *et al.* Recommended medicinal plants as source of natural products: a review. *Digit Chinese Med.* 2018;1(2):131–42. doi: [https://doi.org/10.1016/S2589-3777\(19\)30018-7](https://doi.org/10.1016/S2589-3777(19)30018-7)
 65. Panmei R, Gajurel PR, Singh B. Ethnobotany of medicinal plants used by the Zeliangrong ethnic group of Manipur, northeast India. *J Ethnopharmacol.* 2019;235:164–82. doi: <https://doi.org/10.1016/j.jep.2019.02.009>
 66. Haq SM, Hassan M, Bussmann RW, Calixto ES, Rahman IU, Sakhi S, *et al.* A cross-cultural analysis of plant resources among five ethnic groups in the Western Himalayan Region of Jammu and Kashmir. *Biology (Basel).* 2022;11(4):491. Available from: <https://www.mdpi.com/2079-7737/11/4/491>
 67. Rahman IU, Hart R, Afzal A, Iqbal Z, Ijaz F, Abd_Allah EF, *et al.* A new ethnobiological similarity index for the evaluation of novel use reports. *Appl Ecol Environ Res.* 2019;17(2):2765–77. Available from: http://aloki.hu/pdf/1702_27652777.pdf
 68. Panyadee P, Balslev H, Wangpakattanawong P, Inta A. Medicinal plants in homegardens of four ethnic groups in Thailand. *J Ethnopharmacol.* 2019;239(April):111927. doi: <https://doi.org/10.1016/j.jep.2019.111927>
 69. Cheng Z, Lu X, Lin F, Naeem A, Long C. Ethnobotanical study on wild edible plants used by Dulong people in northwestern Yunnan, China. *J Ethnobiol Ethnomed.* 2022;18(1):1–21. doi: <https://doi.org/10.1186/s13002-022-00501-3>
 70. Susanti D, Rahmawati N, Sholikhah IYM, Mujahid R, Subositi D, Widodo H, *et al.* Medicinal plants utilized for fitness disorders treatment by ethnic groups in Papua and West Papua Province, Indonesia. *J Appl Pharm Sci.* 2023;13(9):149–60. Available from: https://japsonline.com/abstract.php?article_id=4028&sts=2

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