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ETHNOMEDICINE OF MEDICINAL PLANTS USED BY TRADITIONAL HEALERS TO FACILITATE BONE INJURY HEALING IN WEST KALIMANTAN, INDONESIA

Etnomedisin Tumbuhan Obat yang Digunakan oleh Pengobat Tradisional untuk Mengatasi Cedera Tulang di Kalimantan Barat, Indonesia

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ABSTRAK

Tanaman obat telah banyak dimanfaatkan untuk mengatasi cedera tulang di berbagai komunitas di Indonesia. Kalimantan Barat kaya akan keanekaragaman tumbuhan obat dan kearifan lokal yang dimiliki oleh kelompok-kelompok etnisnya. Saat ini, kerusakan hutan dan alih fungsinya mengancam kepunahan beberapa spesies tanaman obat. Oleh karena itu, penting untuk mendokumentasikan jenis tumbuhan yang berkhasiat obat dan juga pengetahuan tradisional sebagai informasi berharga yang disampaikan secara turun temurun. Studi ini melibatkan 51 pengobat tradisional dari 28 kelompok etnis yang diseleksi secara *purposive sampling*. Pengamatan lapangan dan pengambilan spesimen dilakukan untuk keperluan identifikasi botani. Analisis kuantitatif dilakukan untuk mendapatkan proporsi tanaman, *Use Value* (UV), *Family Use Value* (FUV), dan *Informant Consensus Factor* (ICF). Studi ini mengungkapkan 134 spesies tanaman obat dari 53 familia yang terdapat pada delapan kabupaten di Kalimantan Barat. Sebelas spesies tanaman dilaporkan memiliki UV spesies setidaknya 0,10 (5 sitasi). *Zingiber officinale* merupakan spesies yang paling sering digunakan untuk mengatasi cedera tulang (22 sitasi; UV=0,43). Familia dengan jumlah spesies tertinggi adalah Rubiaceae (13 spesies) dan nilai FUV tertinggi adalah Acanthaceae (0,13). *Informant Consensus Factor* (ICF) untuk memfasilitasi cedera tulang adalah 0,48. Sebagian besar terapi diberikan secara eksternal (85,07%). Penggunaan daun sebagai bahan ramuan (66,67%) dan komposisi ramuan adalah campuran dari beberapa tanaman (93,28%). Penelitian lebih lanjut sangat diperlukan untuk memberikan bukti ilmiah tanaman obat dalam mengatasi cedera tulang, baik untuk komunitas lokal maupun global. Sebagian besar tanaman masih diperoleh dari alam tanpa upaya penanaman kembali, sehingga diperlukan edukasi terkait pengetahuan konservasi bagi pengobat tradisional.

Kata kunci: tumbuhan obat, pengobat tradisional, cedera tulang, Kalimantan Barat

ABSTRACT

Medicinal plants have been used to facilitate bone injury in many communities. West Kalimantan has many medicinal plant diversity and local knowledge performed by hundreds of ethnic groups. As forest destruction is getting increases, it leads to the extinction of certain medicinal plant species there. Thus, it is crucial to document plant species with medicinal properties and traditional knowledge as valuable information passed down by generation. A semi-structured questionnaire was employed to interview 51 traditional healers from 28 ethnic groups that were selected by purposive sampling method. Field observation and specimen collection were carried out for botanical identification. A quantitative analysis was calculated to obtain plant proportion, Use Value (UV), Family Use Value (FUV), and Informant's Consensus Factor (ICF). The result revealed there were 134 plant species of 53 botanical families from eight districts in West Kalimantan. Eleven species of plants reported having UV of species at least 0.10 (5 citations). Zingiber officinale was the most frequently used species to facilitate bone injury (22 citations; UV=0.43). The botanical family with the highest number of species was Rubiaceae (13 species) and the highest level of Family Use Value-FUV was Acanthaceae (0.13). The Informant Consensus Factor (ICF) for facilitating bone injury was 0.48. Most of the therapy in this study administered externally (85.07%), used leaves (66.67%), and a mixture composition from several plants (93.28%). The evaluation is critically required to support the medicinal plant's scientific evidence in facilitating bone injury

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for both local and global communities. Moreover, the traditional healers need education regarding conservation issues, since most of the plants are still obtained from the wild.

Keywords: *medicinal plants, traditional healer, bone injury, West Kalimantan*

INTRODUCTION

Many communities worldwide still rely on medicinal plants to maintain health. The fact is true for many remote areas, where both local knowledge, as well as medicinal plant resources, are available and affordable (Allkin, 2017). Medicinal plants have demonstrated their therapeutic effects in treating various ailments. The use of medicinal plants in treating bone injury was empirically found in many communities in Indonesia (Abd Jalil *et al*., 2012; Setyowati, 2010; Supiandi *et al*., 2019). Traditional healers play a critical role in bone injury healing for their local communities. They usually possessed the special skills to take care of the patients, such as massage and prayer (Kusnafizal *et al*., 2020). Factors that encourage people to visit traditional healers when getting bone injury are probably because of inhabiting a location that far from formal health service, low cost, and accessible. Related to cultural reasons, traditional beliefs, and clinical efficacy, many Asian people are still relying on traditional medicine in facilitating bone healing (Peng *et al*., 2010; Utami, 2015).

Bone injury is physical damage to the human bones as well as joints caused by an intense intolerable and unpredictable force (Badan Litbangkes Kemenkes RI, 2013). It is including fracture and dislocation and is usually escorted by soft tissue hemorrhage. These conditions can occur in all age levels, with the most susceptible groups are the elderly, people who are work with balance requirements, movement problems, people with degenerative diseases or neoplasms (Sudayasa *et al*., 2019).

The literature stated that medicinal plants help to accelerate bone formation and control inflammation in many injury cases. Anti-inflammation is one of the key standards within the treatment of the injury. It controls the inflammation and reduces the pain of the fractured part and the surrounding tissues. It promotes overall healing during inflammation by increasing the production of various mediators such as arachidonic acid metabolites and cytokines (Singh, 2017; Siu *et al*., 2015)

Dayak refers to indigenous people that inhabit Borneo Island (Kalimantan). This community consists of six major ethnic groups and is divided into 405 sub-ethnic groups. They live spread across Borneo including Sabah and Sarawak, Malaysia. West Kalimantan is the third widest province on the island after Central and East Kalimantan. Although it has heterogeneous inhabitants, still the most dominant ethnic groups are the Dayaks and Malays (Darmadi, 2017). The Dayak ethnics involved in this study applied medicinal plant remedies to facilitate bone injury healing for their local communities.

Based on National Health Survey 2018 in Indonesia, the proportion of bone fractures in West Kalimantan was not extremely high. It is reported that the proportion of fracture and dislocation toward all type of injures in this province respectively were 4.03 and 28.75. Those levels are lower than the national proportion for the same type of injuries respectively (5.5 and 32.8) (Badan Litbangkes Kemenkes RI, 2018). Nonetheless, the case is estimated to further rise due to the increase of global longevity, since these injuries commonly occur among elderly (Siu *et al*., 2015).

West Kalimantan is the province with the highest gross deforestation value on the island (125.1 thousand hectares) (Damarraya *et al*., 2018). Forest destruction due to land conversion for agricultural land, plantation, oil palm, mining, industrial, or over-exploitation on biodiversity led to the extinction of certain medicinal plant species in Kalimantan (Dengen *et al*., 2018). Therefore, it is crucial to document plant species with medicinal properties as well as traditional knowledge as valuable information that is passed down by generation (Olajuyigbe & Afolayan, 2012). Even though there were many studies on Dayak ethnomedicine (Diba *et al*., 2013; Gunadi *et al*., 2017; Setyowati, 2010; Supiandi *et al*., 2019), none of those were specifically discussed about medicinal plants for bone injury healing in West Kalimantan. This study aimed to explore various species of medicinal plants used by traditional healers as their ingredients to treat the bone injury in West Kalimantan, Indonesia. This data is expected to provide information on prospective medicinal plant species to facilitate bone injury healing. So that further research can be carried out to provide scientific evidence regarding its efficacy and safety.

METHODS

Study areas

The study was carried out in 2012, 2015, and 2017, located in the Province of West Kalimantan. It was a part of national ethnomedicine research based on communities in Indonesia. Among 52 ethnic groups involved in West Kalimantan, 28 ethnic groups possessed traditional healers who treated bone injuries with medicinal plants. Those ethnic groups were scattered all over the province, as shown at the following Figure 1 below.

The selected ethnic groups must be recorded at Population Census in the year 2000 by Statistics Indonesia and had a population greater than or equal to 1,000 people who live on the local community's location (island) of origin. The other requirements to consider were that they still hold indigenous healing knowledge and inhabited areas with limited access to health services.

Procedures

This study involved 51 traditional healers from 28 ethnic groups of Dayak as shown in Figure 1; selected by purposive sampling method. The inclusion criteria of the informants were: 1) Native traditional healers of the selected ethnic groups; 2) Employ medicinal plant remedies in the treatment of bone injury, and 3) Well-known by local communities due to their healing practices. In this national ethnomedicine research, the bone injury was defined as abnormalities conditions of bones, including sprains, fractures, cracks, as well as swollen.

The data were collected by interview, field observation, and specimen collection. A semi-structured questionnaire was set up to obtain the demographic data, species of medicinal plants to treat bone injury, plant part of used, preparation and used methods, cultivation status, as well as other non-plant material used in the remedies. The questionnaire was administered through a personal interview by the researchers. The collected plant specimens are stored at Herbarium Tawangmanguensis, Karanganyar, Central Java. They have been identified by the taxonomists team from Gadjah Mada University, Sebelas Maret University, Andalas University, Mulawarman University, and Research Centre for Biology, Indonesian Institute of Sciences.

The protocol and the informed consent forms were approved by the Ethics Commission of the National Institute of Health Research and Development, Ministry of Health. The informants were informed in detail about the current study and its purposes and were free to withdraw from this study at any time.

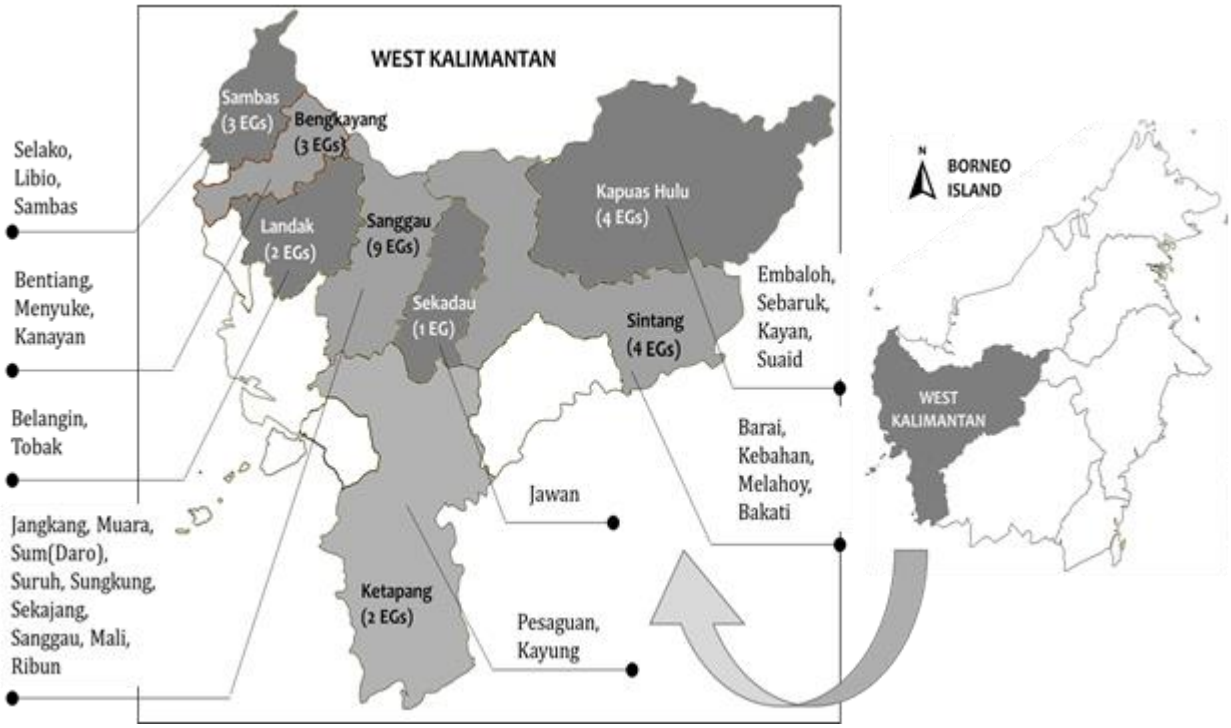

Figure 1. Distribution of 28 ethnic groups (EGs) in eight districts of West Kalimantan Province

Data analysis

The informant's characteristics and medicinal plant data employed by traditional healers to treat bone injury were analyzed descriptively. The other quantitative analysis was calculated to obtain Used Value (UV), Family Use Value (FUV), and Informants Consensus Factor (IFC), as described below.

1. Family Use Value (FUV) is calculated to find the relative importance of families to distinguish plant families that have more uses than would be expected by random chance (Hoffman & Gallaher, 2007). FUV was obtained by summing the use-values for all the species within a given family and dividing it by a total number of species within a given family (ns).

$$FUV = \sum UVs/ns$$

2. Use Value (UV) is the relative importance of a species used locally. It was calculated by the equation where U is the number of citations for each species and n is the total number of informants. Jaradat et al. (2016) used the following equation to calculated the UV of species employed for one specific ailment.

$$UV = \sum U/n$$

3. Informants Consensus Factor (ICF) indicates the homogeneity of information regarding the use of certain medicinal plants to treat bone injury (Ferrier et al., 2015; Jaradat et al., 2016; Yaseen et al., 2015). Nur is the number of use citations in bone injury treatment and Nt is the number of taxa used for the treatment of bone injury.

$$IFC = Nur - Nt/Nur - 1$$

RESULT AND DISCUSSION

Traditional healer characteristics

This study involved 51 traditional healers from 28 ethnic groups that spread on eight districts in West Kalimantan. A brief socio-cultural profile of informants is listed in Table 1 below.

Table 1. Traditional healer (informant) characteristics

Characteristic	Number of informants (n=51)	
	Freq.	%
Gender		
Male	36	70.59
Female	15	29.41
Age group (years old)		
31 - 50	12	23.53
51 - 70	25	49.02
71 – 91	14	27.45
Education		
Uneducated	13	25.49
Elementary (not completed)	16	31.37
Elementary	14	27.45
Secondary school	5	9.80
High school	2	3.92
Undergraduate/graduate	1	1.96
Main occupation		
Traditional healer	7	13.73
Farmer	34	66.67
Other	10	19.61

Most of the informants in this study were males (70.59%). They were more dominant in this healing practice area and were observed in other communities, as well. It is most likely based on the local tradition, in which men are in charge of providing for their families and handing down healing knowledge to the eldest son. Otherwise, in many cases, female healers usually played a role as traditional birth attendance (Semenya & Potgieter, 2014).

Nearly half of the informants were 51 – 70 years old (49.01%). There are only 23.53% of informants were between 31 – 50 years old, and none of them were under 30 years old. Previous research has revealed a similar gap between younger and older groups of traditional healers, which is most likely due to a lack of youth interest in this field and limited documentation for medicinal plant knowledge (Musa *et al*., 2011; Semenya & Potgieter, 2014). On the other hand, the elder group tends to uphold tradition in getting along with nature which was represented traditional knowledge (Cheikhyoussef *et al*., 2011). More than half of the informant number attended elementary school either complete or incompletely. More than quarter of informants never attended formal school (25.49%). Education related to literation competency. The ability to write provides the chance to document and disseminate their indigenous knowledge independently. The ability to read will lead to an opportunity in developing their healing practice from unlimited sources. Literation ability becomes important as well, regarding conservation issues of endangered medicinal plant species (Mathibela *et al*., 2015).

This study reported that a larger proportion of informants admitted that their main occupation were farmers. There are slightly more than 13% of informants revealed that healing practice is their main source of income. The fact indicates considerable economic benefits in the development of medicinal plant as traditional medicines (Cheikhyoussef *et al*., 2011). The local knowledge possessed by the healers in West Kalimantan seemed to be not specifically differentiated by their characteristics. Their knowledge in using the medicinal plant to facilitate bone injury healing generally consists of the plants chosen, mode of preparation and use, as well as cultivation status. That local knowledge was randomly applied among the traditional healers no matter the gender, ages, educational background, or occupation. However, a former study in Bahia, Brazil reported that women were more knowledgeable than men in identifying useful

medicinal plant species. That study revealed that older and female groups were the most proficient in identifying the sample plant pharmacopeia. Moreover, women are more reliable as custodians of local knowledge (Voeks, 2007).

Medicinal plant diversity and relative importance of the plants for bone injury treatment

This study reported at least 134 species of plants from 53 families employed by traditional healers in West Kalimantan as given in Table 2 below.

Table 2. Plant's name, part of use, modes of use, cultivation status, FUV, and UV

Family *Scientific name*	Vernacular name	Part of use	Modes of use	Cultivation status	FUV/ UV
Acanthaceae					**0.13**
1. *Dicliptera paniculata* (Forssk.) I.Darbysh.	Pengkela sawak	Leaves	External	Wild	0.02
2. *3Justicia gendarussa Burm. f.*	Ganaruse, gandaruse, tubalonyek, plopek pinggang, pelepe pinggang, tamberuse, bengkayang, pagar air, sambung tulang	Leaves, root	External, internal	Cultivated, wild	0.24
Acoraceae					**0.02**
3. *Acorus calamus* L.	Umbi kerenyak, jerangau putih	Rhizome	External	Wild	0.02
Actinidiaceae					**0.02**
4. *Saurauia* sp.	Daun bidek	Leaves	External	Wild	0.02
Alismataceae					**0.02**
5. *Limnocharis flava* (L.)	Genjer	Other	External	Wild	0.02
Amaryllidaceae					**0.07**
6. *Allium cepa* L.	Bawang merah	Tuber	External	Wild	0.02
7. *Crinum asiaticum* L.	Baul, menjuang	Leaves,	External	Cultivated	0.12
Anisophylleaceae					**0.04**
8. *Anisophyllea disticha*	Daun tulang belakang	Leaves	Internal	Wild	0.04
Apocynaceae					**0.02**
9. *Dischidia nummularia*	Kancing rebut	Leaves	External	Wild	0.02
10. *Leuconotis eugeniifolia* (Wall. ex G. Don) A. DC.	Mariaduh	Leaves	External	Wild	0.02
Araceae					**0.02**
11. *Syngonium podophyllum*	Perapat patah	Leaves	External	Cultivated	0.02
Arecaceae					**0.04**
12. *Areca catechu* L.	Pinang	Leaves	External	Cultivated	0.04
13. *Cocos nucifera* L.	Nyiur	Leaves	External	Cultivated	0.04
Asparagaceae					**0.02**
14. *Cordyli fruticosa* (L.) A.	Ranjuang	Leaves	External	Cultivated	0.02
Asteraceae					**0.04**
15. *Ageratum conyzoides* (L.)	Rumput ulan	Leaves	External	Wild	0.02
16. *Blumea balsamifera* (L.)	Kelimabo	Leaves	External	Wild	0.10
17. *Borreria* sp.	Pengkelas patah tulang	Leaves	External	Wild	0.02
18. *Elephantopus mollis* Kunth	Patah kembudi	Leaves	External	Cultivated, wild	0.06
19. *Elephantopus scaber* L.	Patah kembudi	Leaves	External	Cultivated, wild	0.04
20. *Sphaeranthus africanus* L.	Patah kemudi	Leaves	External	Cultivated	0.02
21. *Struchium sparganophorum* (L.)	Bunga ayo, lidah ular	Leaves, aerial	External	Wild	0.04
Bonnetiaceae					**0.02**

Family *Scientific name*	Vernacular name	Part of use	Modes of use	Cultivation status	FUV/ UV
22. *Ploiarium alternifolium* (Vahl) Melch.	Soma	Leaves	External	Wild	0.02
Cleomaceae					**0.04**
23. *Cleome rutidosperma* DC.	Pengkelas urat	Leaves	External	Wild	0.04
Clusiaceae					**0.02**
24. *Garcinia parvifolia* (Miq.)	Kandis	Fruit	External	Wild	0.02
25. *Garcinia xanthochymus* Hook.f. ex T. Anderson	Asam gandis	Fruit	External	Wild	0.02
Connaraceae					**0.03**
26. *Agelaea borneensis* (Hook.f	Akar malam	Leaves	External	Wild	0.04
27. *Rourea asplenifolia* (G. Schellenb.) Jongkind	Geramat sawa	Leaves	External	Wild	0.02
Convolvulaceae					**0.02**
28. *Merremia umbellata* (L.)	Akar nyanyat	Leaves	External	Wild	0.02
Crassulaceae					**0.02**
29. *Bryophyllum pinnatum* (Lam.) Oken	Timbun daun	Leaves	External	Wild	0.02
Cyperaceae					**0.02**
30. *Scleria sumatrensis* Retz.	Jenyalo	Leaves	External	Wild	0.02
Daphniphyllaceae					**0.02**
31. *Daphniphyllum himalayense* (Benth.) Mull.	Daun kanker	Leaves	External	Wild	0.02
Dilleniaceae					**0.07**
32. *Dillenia suffruticosa* (Griff.) Martelli	Daun buen, simpur, buant, beringin	Leaves, root	External	Wild	0.14
33. *Dillenia sumatrana* Miq.	Dangin	Leaves	Internal	Wild	0.02
34. *Tetracera scandens* (L.) Merr.	Pengkolas tapah, ampalas	Leaves, root	External, internal	Cultivated, wild	0.04
Dioscoreaceae					**0.02**
35. *Dioscorea* sp.	Ongkah pronggang	Leaves	External	Wild	0.02
Escalloniaceae					**0.02**
36. *Polyosma integrifolia*	Jenang	Leaves	External	Wild	0.02
Euphorbiaceae					**0.05**
37. *Codiaeum variegatum* (L.) Rumph. ex A.Juss.	Sambung tulang	Leaves	External	Wild	0.04
38. *Macaranga denticulata* (Blume) Mill.Arg.	Porak, remadi	Leaves	External	Wild	0.04
39. *Macaranga* sp.	Porakang	Leaves	External	Wild	0.02
40. *Mallotus rufidulus* (Miq.)	Daun lemak	Leaves	External	Wild	0.02
41. *Ricinus communis* L.	Korongan merah	Leaves	External	Cultivated, wild	0.12
Fabaceae					**0.03**
42. *Abrus precatorius* L.	Akar tumbi	Leaves	External	Wild	0.02
43. *Bauhinia semibifida* Roxb.	Klabamang	Root, stem	Internal	Wild	0.04
44. *Derris malaccensis* Prain	Daun seleo	Leaves	External	Wild	0.02
45. *Derris* sp. Cf.	Akar tulang	Root, leaves	External	Wild	0.06
46. *Desmodium triflorum* (L.) DC.	Uri isi	Leaves, stem, root	External	Wild	0.06
47. *Mimosa pudica* L.	Putri malu	Leaves	External	Wild	0.02
48. *Pithecellobium dulce* (Roxb.) Benth.	Jering	Leaves	External	Wild	0.02
Gleicheniaceae					**0.06**

Family *Scientific name*	Vernacular name	Part of use	Modes of use	Cultivation status	FUV/ UV
49. *Dicranopteris linearis*	Naman besi	Leaves	External	Wild	0.06
Lamiaceae					**0.03**
50. *Anisomeles indica* (L.)	Bunga rayan	Leaves	External	Wild	0.02
51. *Callicarpa longifolia* Lam.	Tabarbasi	Leaves, root, stem	External	Wild	0.06
52. *Callicarpa* sp.	Raja kani	Leaves	External	Wild	0.02
53. *Clerodendrum*	Salusu sawah	Leaves	External	Wild	0.02
54. *Leucas aspera* (Willd.)	Kacang ma	Root	Internal	Cultivated	0.02
55. *Ocimum gratissimum* L.	Selaseh	Root	Internal	Cultivated	0.02
56. *Plectranthus ciliatus* E.	Makso	Root	Internal	Cultivated	0.02
57. *Vitex negundo* L.	Labantunsan	Leaves, root, stem	External, internal	Wild	0.10
58. *Vitex pinnata* L.	Leban	Leaves	External	Wild	0.02
Linderniaceae					**0.02**
59. *Lindernia ciliata* (Colsm.)	Pengkelas darah	Leaves	External	Wild	0.02
Loranthaceae					**0.06**
60. *Macrosolen retusus* Blume	Balanalu merah	Leaves	External	Wild	0.06
Lycopodiaceae					**0.02**
61. *Lycopodiella cernua* (L.)	Tamparigu	Leaves	External	Wild	0.02
Lygodiaceae					**0.02**
62. *Lygodium circinatum* (Burm. F.) Sw.	Akar perut ayam	Leaves	External	Wild	0.02
63. *Lygodium flexuosum* (L.)	Akar perut ayam	Leaves	External	Wild	0.02
64. *Lygodium microphyllum*	Akar kancing	Leaves	External	Wild	0.02
Malvaceae					**0.03**
65. *Ceiba petandra* (L.) Gaetrn.	Kabu	Stem,	External	Wild	0.02
66. *Durio zibethinus* L.	Durian	Leaves	External	Cultivated	0.02
67. *Leptonychia caudata* Burret.	Tanaman hutan	Leaves	External, internal	Wild	0.04
68. *Sida acuta* Burm.f.	Daun patah tulang	Root, fruit,	Internal	Cultivated, wild	0.1
69. *Sida cordifolia* L.	Sinaguri	Root	Internal	Cultivated	0.02
70. *Sida* sp.	Potah pengayuh	Leaves	External	Wild	0.04
71. *Tilia cordata* Mill.	Ansiap, kulang	Root	Internal	Wild	0.02
72. *Urena lobata* L.	Empulut	Leaves	External	Wild	0.02
73. *Waltheria indica* L.	Liuminjok	Root	Internal	Cultivated	0.02
Melastomataceae					**0.02**
74. *Bellucia grossularioides* (L.) Triana	Urok kiro	Leaves	Internal	Wild	0.02
75. *Bellucia* sp.	Jambu monyet	Leaves	External	Cultivated	0.02
76. *Melastoma malabathricum*	Lengkodok	Leaves	External	Wild	0.02
Musaceae					**0.06**
77. *Musa paradisiaca* L.	Pisang merah ieronang	Stem, bark	External	Cultivated, wild	0.06
Myrtaceae					**0.02**
78. *Syzygium polyanthum* (Wight) Walp.	Salam	Leaves	External	Cultivated	0.02
Nephrolepidaceae					**0.06**
79. *Nephrolepis biserrata*	Kijang, paku kasa	Leaves	External	Wild	0.06
Onagraceae					**0.04**
80. *Ludwigia hyssophifolia* (G.Don.) Exell	Pembodok, bujang semalam	Leaves	External	Wild	0.06
81. *Ludwigia suffruticosa*	Bujang semalam	Leaves	External	Wild	0.02
Orchidaceae					**0.02**
82. *Galeola* sp.	Poto'	Stem,	External	Wild	0.04

Family *Scientific name*	Vernacular name	Part of use	Modes of use	Cultivation status	FUV/ UV
Pentaphylacaceae					**0.02**
83. *Adinandra cordifolia* Ridl.	Pakunguk	Leaves	External	Wild	0.02
84. *Eurya acuminata* DC.	Ansamat	Leaves	External	Wild	0.02
Phyllanthaceae					**0.05**
85. *Breynia vitisidaea* (Burm.f.) C.E.C.Fisch.	Mayam tidur	Leaves	External	Wild	0.04
86. *Phyllanthus niruri* L.	Badi, pengkolas beras, lilin sirih, meniran	Aerial part, leaves	External	Wild	0.06
87. *Phyllanthus urinaria* L.	Kelapa ayam	Leaves	External	Wild	0.04
Piperaceae					**0.03**
88. *Piper betle* L.	Daun sirih, sirih punan	Leaves	External	Cultivated, wild	0.04
89. *Piper nigrum* L.	Lada	Fruit	External	Wild	0.02
90. *Piper sarmentosum* Roxb.	Sirih angin	Leaves	External	Wild	0.02
Plantaginaceae					**0.04**
91. *Limnophila aromatica* (Lam.) Merr.	Kayap, puring hutan	Leaves	External	Wild	0.04
Poaceae					**0.06**
92. *Cymbopogon citratus* (DC.) Stapf	Serai	Stem, leaves	External	Cultivated	0.14
93. *Cymbopogon nardus* (L.)	Serai merah	Stem	External	Cultivated	0.02
94. *Gigantochloa apus* (Schult. & Schult. f .) Kurz.	Bambu buluh	Stem	External	Wild	0.02
Polygonaceae					**0.02**
95. *Persicaria barbata* (L.) H.	Hara bekiking	Leaves	External	Wild	0.02
Primulaceae					**0.02**
96. *Embelia ribes* Burm.f.	Akar asam	Leaves	External	Wild	0.02
97. *Marantodes pumilum* (Blume) Kuntze	Tutup periuk	Leaves	External	Wild	0.02
Rosaceae					**0.02**
98. *Rubus mollucanus* L.	Peringat	Leaves	External	Wild	0.02
Rubiaceae					**0.03**
99. *Hedyotis costata* R. Br. ex	Pengkelas besi	Leaves	External	Wild	0.02
100. *Morinda citrifolia* L.	Mengkudu	Leaves	External	Wild	0.02
101. *Neonauclea media*	Bangkal	Leaves	External	Wild	0.02
102. *Oldenlandia corymbosa* L.	Rumput mutiara	Leaves	External	Wild	0.02
103. *Oldenlandia cristata* (Willd. ex Roem. & Schult.) ined.	Pengkelas	Leaves	External	Wild	0.04
104. *Ophiorrhiza communis*	Taba'ang	Leaves	External	Wild	0.02
105. *Ophiorrhiza mungos* L.	Pengkelas	Leaves	External	Wild	0.02
106. *Pavetta celebica* Bremek.	Tuba'ang	Root	Internal	Wild	0.02
107. *Pavetta* sp. Cf	Tabaak	Leaves	External	Wild	0.02
108. *Psychotria sarmentosa*	Pengekelas sembe	Leaves	External	Wild	0.02
109. *Timonius borneensis*	Kulang buntak	Leaves	External	Wild	0.08
110. *Timonius wallichianus* (Korth.) Valeton	Cabik	Leaves	Internal	Wild	0.02
111. *Timonius timon* (Spreng.)	Kebak	Leaves	External	Wild	0.04
Rutaceae					**0.02**
112. *Melicope semecarpifolia* (Merr.) T.G. Hartley	Daun giref	Leaves	External	Wild	0.02
Selaginellaceae					**0.02**
113. *Selaginella doederleinii*	Ceker ayam	Leaves	External	Wild	0.02
Simaroubaceae					**0.02**

Family *Scientific name*	Vernacular name	Part of use	Modes of use	Cultivation status	FUV/ UV
114. *Eurycoma longifolia* Jack	Pasak bumi	Root	External	Wild	0.02
Urticaceae					**0.02**
115. *Conocephalus scabrinervius* Barg.-Petr.	Akar bangaram	Leaves	External	Wild	0.02
116. Elatostema lineolatum	-	Leaves	External	Wild	0.02
Verbenaceae					**0.02**
116. *Duranta erecta* L.	Srigundi	Leaves	External	Cultivated	0.02
Vitaceae					**0.04**
117. *Ampelocissus spicifer* (Griff.) Planch.	Jajilah	Leaves	External	Wild	0.02
118. *Cayratia japonica* (Thunb.) Gagnep.	Perapat patah	Leaves	External	Wild	0.04
119. *Cayratia trifolia* (L.)	Lambe	Root	External	Wild	0.02
120. *Leea angulata* Korth. ex	Loli	Leaves	Internal	Wild	0.02
121. *Leea indica* (Burm. f.) Merr.	Bamali, mali, pemburu, gembali	Leaves, root	External	Cultivated, wild	0.12
122. *Leea rubra* Blume ex	Bamali merah	Leaves	External	Wild	0.02
123. *Vitis* sp.	Kerorompes	Leaves	External	Wild	0.02
Zingiberaceae					**0.08**
124. *Alpinia galanga* (L.)	Lengkuas	Rhizome	External	Cultivated	0.04
125. *Amomum* sp.	Gang ngiaw	Rhizome	External	Wild	0.04
126. *Curcuma heyneana*	Temu	Rhizome	External	Cultivated	0.02
127. *Curcuma longa* L.	Kunyit	Rhizome	External	Wild	0.1
128. *Curcuma zedoaria* (Christm.) Roscoe	Banglai	Rhizome	External	Wild	0.02
129. *Etlingera elatior* (Jack)	Asam patah	Flower	External	Wild	0.02
130. *Kaempferia galanga* L.	Cakur, kencur, sio	Rhizome	External	Cultivated	0.06
131. *Kaempferia rotunda* L.	Siu Budo'	Rhizome	External	Cultivated	0.02
132. *Zingiber officinale* Roscoe	Jahe, bateh biasa, laya, liak	Rhizome	External, internal	Cultivated, wild	0.43
133. *Zingiber zerumbet* (L.) Roscoe ex Sm.	Lempuyik, sengkuyang	Leaves, rhizome	External	Cultivated, wild	0.04

Those 134 species of medicinal plants in Table 2 showed various vernacular names, some of them have similar ones for different species of plants. Table 2 mentioned part of use, modes of use, cultivation status, FUV, and UV of each species that will be further explained.

Figure 2(a) showed 11 species of medicinal plants to treat a bone injury that each has at least five citations. *Zingiber officinale* was the most frequently used species that included in 22 concoctions for bone injury treatment. The most relatively important species used for bone injury treatment were represented by use value (UV) as also given in the following Figure 2.

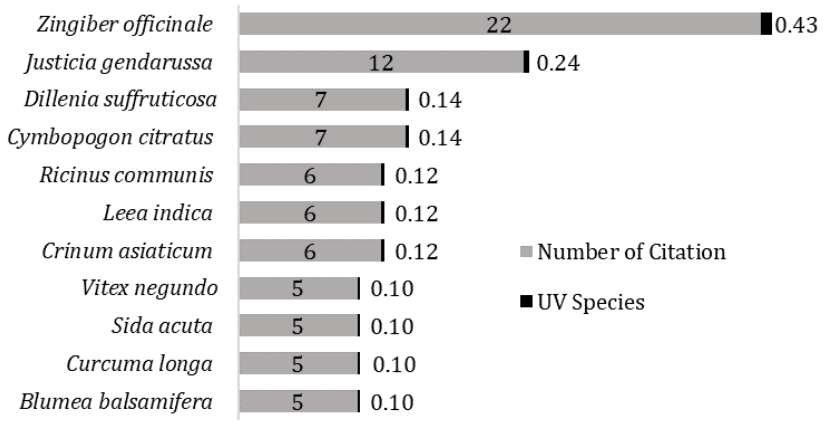

Figure 2. Number of species citation and Use value (UV) of plant species

Use value (UV) designates the relative importance of plant species to treat certain ailments locally (Jaradat *et al*., 2016; Kusnafizal *et al*., 2020; Musa *et al*., 2011). The highest UV reported from this study was 0.43 and the lowest was 0.02. The seven highest value of UV were *Z. officinalle* (0.43), *J. gendarussa* (0.24), *C. citratus* and *D. suffruticosa* (0.14)*, C. asiaticum, L. indica.* and *R. communis* (0.12). Those high values indicate the extensive use of the plants for bone injury treatment in West Kalimantan. The facts might be related to their wide distribution and consciousness of informants to employ them as the main choices for bone injury treatment (Adnan *et al*., 2014). On the contrary, the low citation for certain species does not constantly mean that it has fewer medicinal properties. It might be caused by other considerations due to the loss of related knowledge or inaccessibility of the plants (Upadhya *et al*., 2012).

Since this study focused on a single ailment, there is reported merely one Informant Consensus Factor (ICF) for bone injury treatment. The ICF was calculated for medicinal plants used for treatment of bone injury in this study were 0.48. The factor describes the degree of shared knowledge among informants for the treatment of an ailment by certain medicinal plants. ICF values are low (approach to zero) if plants are selected randomly, and either few or none of information has been shared among informants. The ICF approaches to one (1) if there are specific criteria has been well-defined and information has been well-shared (Ferrier *et al*., 2015; Jaradat *et al*., 2016; Yaseen *et al*., 2015). The factor that was obtained from this study was categorized as moderate. That ICF (0.48) was slightly approached to 0.5, which indicated that the information in employing selected medicinal plants for bone injury treatment has been quite exchanged among informants in West Kalimantan.

Figure 3(a) revealed eight families consist of at least five species of plants used in bone injury treatment. Rubiaceae possessed 13 species of plants from eight generas, i.e., *Hedyotis. Morinda, Neonauclea,* and *Psychotria* (one species each); *Oldenlandia, Ophiorrhiza, Pavetta* (two species each), and *Timonius* (three species). Zingiberaceae consists of ten species, spread on six generas, i.e., *Alpinia, Amomum*, and *Etlingera* (one species each); *Kaempferia* and *Zingiber* (two species each); and *Curcuma* (three species).

The family use value (FUV) was given in Figure 3 (b), indicates the relative importance of family to highlight plant families that have more uses than randomly estimated. The FUV ranged between the lowest value (0.02) and the highest value (0.13). The Acanthaceae (0.13) was the highest FUV recorded followed successively by Zingiberaceae (0.08), Amaryllidaceae (0.07), and Dilleniaceae (0.07).

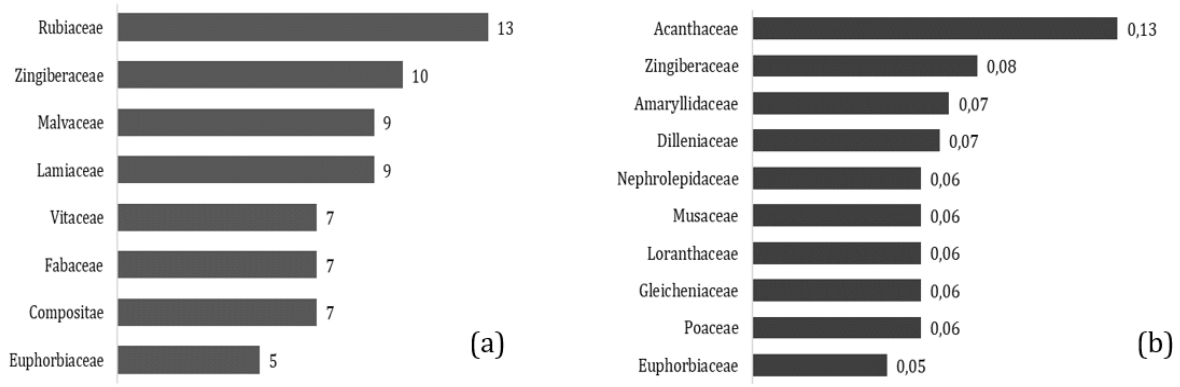

Figure 3. Families with the highest number of species (a); the highest level of Family Use Value-FUV (b)

Acanthaceae might not have many species like Rubiaceae, however, the high UV level from one of its species (*J. gendarussa*) contributed to the FUV level (Figure 3(b)). Zingiberaceae showed a high level of FUV as well as a large number of species. Still, the FUV of Zingiberaceae was in second place after Acanthaceae. This condition probably because among ten species of Zingiberaceae, there was merely *Z. officinale* which has high UV (0.43). This high proportion could be explained by the high representation of these families in a certain area which has favorable ecological factors for the growth and adaptation of the majority of their species (Chaachouay *et al*., 2019).

The high values of UV, FUV, and ICF indicate that species of plants are best known and have long been used by most of the informants, and it may represent a source of reliability plants. The literature revealed many assessments on biological activity and phytochemical have been performed on such plants. These species are particularly important for new medicinal properties discovery (Zougagh *et al*., 2019).

Medicinal properties of several plants used in bone injury treatments

Bone injury healing is generally facilitated by relocating fractured or dislocated bone back to its place with or without anesthesia, setting up its position, and then keeping the natural healing process to occur. It can completely restore its normal structure under ideal conditions. Several aspects are involved in the healing process, and anti-inflammation is one of the critical keys in the treatment of fractures (Singh, 2017; Siu *et al*., 2015). The role of medicinal plants in bone injury therapy was for bone strengthening, pain-relieving, and inflammation lessening (Upadhya *et al*., 2012). The topical medicinal plants paste probably may reduce the fracture risks during the healing, act as anti receptive pharmaceutical agents in promoting bone density and strength to avoid refracture (Siu *et al*., 2015).

This study reported 11 species of plants that showed a high level of UV (Figure 2). The fact described their importance for local communities. Thus it is necessary to find out their medicinal properties that responsible for facilitating bone injury healing.

Figure 2 exhibited whether *Z. officinale* was recognized as the most leading species utilized by traditional healers for the treatment of bone injury in West Kalimantan, followed by *J. gendarussa, D. suffructicosa,* and other species. This is in accordance with some previous scientific data related to bone injury treatments*. Zingiber officinale* demonstrated to show analgesic and anti-inflammatory properties due to its major compositions, namely 6-shogaol and 6-gingerol with the mechanism of prostaglandin synthetase and 5-lipoxygenase inhibition (Sharifi-Rad *et al*., 2017). Various chemical compositions contained in *Z. officinale* contribute to the stopping bone

destruction activity in rheumatoid arthritis cases (Al-Nahain *et al*., 2014). It is reported whether ginger hexane extract is found to be used to prevent and overcome osteoporosis due to the mechanism of osteoclast differentiation suppression (Ito *et al*., 2016).

Ethnopharmacologically, the decoction of *J. gendarussa* leaves was utilized in Malaysia for fractured bone treatment. Apigenin and vitexin reported being responsible composition of this plant (Corrêa & Alcântara, 2012). Due to the content of flavonoids and β-sitosterol, ethanol extract of *J. gendarussa* leaves reported to have an anti arthritic effect against Freund's complete adjuvant induced-rats through an anti inflammation mechanism of action (Jaijesh *et a*l., 2009; Zhang et al., 2020). *Justicia gendarussa* extract of 37.5 µg/ml has the potential in enhancing bone mineralization during the bone repair process (Supparmaniam & Mohd Bohari, 2015).

Dillenia suffruticosa with various phytochemical constituents, as well as biological activities has been traditionally used in Brunei Darussalam and other countries for multiple health purposes (Goh *et al*., 2017). In Indonesia, *D. suffruticosa* has pointedly grown in Sambas Botanical Garden, Borneo Island, and revealed the immune system stimulation through antibody production whereas saponins are responsible for its effect (Sudarmono, 2018). Saponin, especially aspero saponin VI showed increased activity of bone formation through osteoblasts differentiation and maturation (Goh *et al*., 2017). Another former study informed that the anti-inflammatory properties of *D. suffruticosa* are related to the chemical compound content, namely triterpenoids which can inhibit peroxidase reactions, and flavonoids which inhibit the cyclooxygenase-1 enzyme (Abubakar *et al*., 2019). Orally administration of hot water extract of *C. citratus* leaves revealed anti-inflammation activity against carrageenin-induced oedema rats (Shah *et al*., 2011). Flavonoids, essential oils, phenolic compounds were some chemical compositions of *C. citratus* (Oladeji *et al*., 2019). Based on the previous research, 50% and 100% of *C. citratus* extract can accelerate the healing of mice's labial mucosa wounds seen from the length of the wound (Hairi *et al*. 2016).

Polyphenols and flavonoids are the major compounds found in *R. communis* and have anti-inflammatory and antioxidant activities (Bhakta *et al*., 2015). Oral administration of *L. indica* extract significantly suppressed the pain response and inhibited the writhing response of the test mice induced by acetic acid (Kekuda *et al*., 2018). The aqueous extract of *L. indica* leaves contained flavonoid compounds which related to its anti-inflammatory activity (Nasution *et al*., 2017).

Total lignans in *V. negundo* seeds can be responsible for the anti-arthritic activity. Phenylnaphthalene-type lignans were proved to be effective as an analgesic and anti-inflammatory agents (Zheng *et al*., 2014). *Sida acuta* has ascorbic acid (vitamin C) that has an essential role in connective tissue maintenance, bone formation, and wound healing (Shittu & Alagbe, 2020).

Curcuminoids are determined as active compounds contained in *C. longa* which consists of curcumin and several other components. Studies regarding the activity of curcumin as an anti-inflammatory agent have been reported. Some of the anti-inflammatory mechanisms of curcumin include suppression of COX-2 expression and nitric oxide generation, also by blocking the activation of inflammatory mediators of NF-κB through inhibition of AKT and IκBα kinases (Boroumand *et al*., 2018; Jacob *et al*., 2007). Lycorine is the main phytochemical contents in *C. asiaticum* that responsible for anti-inflammatory activities (Kongkwamcharoen *et al*., 2021).

The last top ten species cited by traditional healers in West Kalimantan was *B. balsamifera. B. balsamifera* was identified to have sesquiterpene and flavonoids, while the essential oil of this plant reported showing injury healing effect through growth factors expressions increase (Saifudin *et al*., 2012; Fan *et al*., 2015). *B. balsamifera* oil in combination with olive oil compared

to standard and control group exhibited to induce granular tissue formation, capillary regeneration, blood circulation, collagen deposition, and wound contraction (Pang *et al*., 2014).

Plant part of used, modes of preparation and administration, and plant cultivation status

Leaves are the most frequently used of the plant part, followed by root, stem, rhizome, fruit, tuber, bark, and flower, as given in Figure 4(a). The preference of leaves was also found in many other communities, since they are abundant, easy to harvest, to dry, to store, and to prepare before they are consumed (Chaachouay *et al*., 2019; Ferrier *et al*., 2015; Zougagh *et al*., 2019). Leaves provide the major proportion of alkaloids, glycosides, and essential oils that responsible for their medicinal properties. Moreover, they are the center of phytochemical reactions as well as reservoirs of organic matter (Zougagh *et al*., 2019). On the other hand, the use of stems or roots causes unsustainability of plants, especially those taken from the wild. (Uddin & Hassan, 2014).

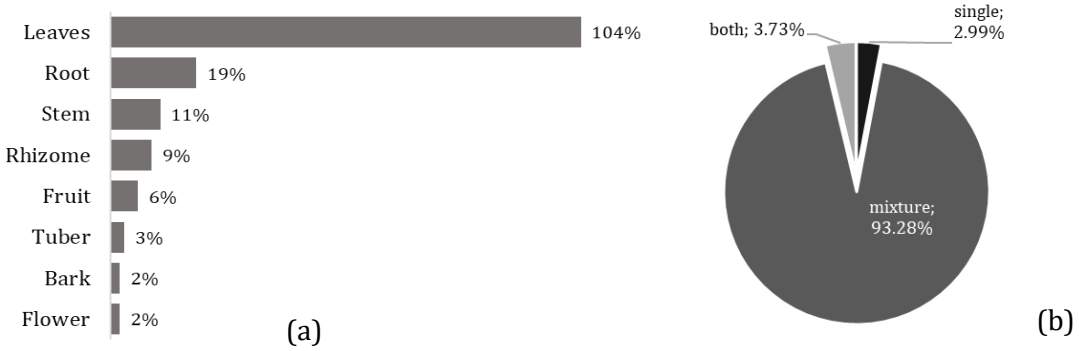

Figure 4. The proportion of plant part of used (a) and composition of medicinal plant (b)

The majority form of traditional medicines to facilitate bone injury healing was a mixture that consists of at least two species of plants as given in Figure 4(b) (93.28%). The rest are employed as single composition (2.99%), as well as both single and mixture (3.73%). Another study reported that based on traditional healers, a combination of two or more plant species in medicines is more potent than those consist of a single species. That study also stated that the use of numerous remedies based on combining medicinal plants has recently been reported to rise the efficacy of some traditional medicines (Adnan *et al*., 2014).

There were additional materials include in many concoctions, i.e., chicks, egg, wine/liquor, coconut oil, and honey. Dayak communities believed that chick's meat help treating bone injury in several cases. The meats along with other ingredients are pasted to the injury part. The nutrients contained in the meat improve the body metabolism (Aprillia *et al*., 2020).

In facilitating bone injury, some traditional healers use additional method like massage. The characteristics of the diagnosis of fracture therapy by traditional healers are by: 1. Checking for abnormalities; 2. Using clean logs for support; 3. Performing surface pressure massage; 4. Repositioning and fixing the fracture abnormalities with the help of plant stem materials; 5. Examining the clinical condition of the patient to determine a cure; 6. Delivering spells or prayers; and 7. Applicating special plants ingredients to relieve the pain (Sudayasa *et al*., 2019). Several traditional healers in West Kalimantan used the help of stems, like bamboo to immobilize the dislocated bone. This practice will support in proper joining the fracture (Upadhya *et al*., 2012).

The most common method of used for treating bone injury in this study were applicated externally (85.07%) as shown in Figure 5(a). The informants pasted the concoctions topically to the injury part of the body, and usually were added specific treatment like massage, swab or rub.

There were only 10.45% internal method that recommended by the informants, and 4.48% employed both. Other common ailments are more likely predominance by internal method through oral administration (Chaachouay *et al*., 2019). However, in the bone injury cases the major proportion of traditional used methods are externally through topical administration (Peng *et al*., 2010; Siu *et al*., 2015). Previous study revealed that the external route of administration was useful to relieve the pain or reduce inflammation; while the internal administration was preferred to strengthen the bone and fasten the healing process (Upadhya *et al*., 2012).

In the traditional practices of bone injury therapy, they usually relied on topical agent. The application of topical herbal pastes is believed work straight into the targeted tissues and initiating metabolic of tissue repairs (Peng *et al*., 2010; Siu *et al*., 2015). Instead of the conventional oral administration, topical herbal paste has many benefits. It prevents the early hepatic screening, works constantly as absorption of the medicine occurs, decreases potential systemic side effect and it does not implicate offensive movement (Peng *et al*., 2010). Scientific evidence revealed the effectiveness of topical herbal paste to ease inflammation and accelerate bone regeneration. Its efficacy in stimulating cortical bone repair was also demonstrated in rat experiments. This study delivered an adequate evidence for the promising agent in bone injury therapy under special condition (Siu *et al*., 2015).

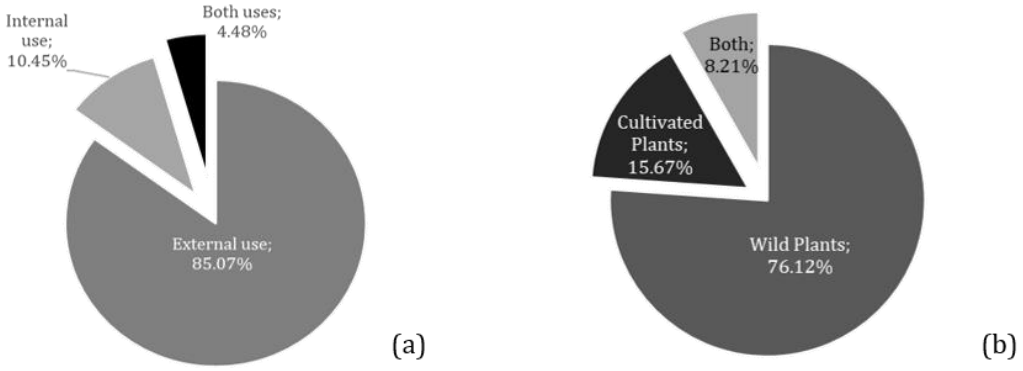

Figure 5. Proportion of modes of use (a) and cultivation status (b)

As given in Figure 5(b), the majority of plant species employed for bone injury therapy in West Kalimantan was taken from the wild (76.12%), and merely 15.67% were cultivated. The rest of the plants were obtained from both the wild and cultivation products (8.21%). The facts demonstrated the dependency of the traditional healer to the wild plant's availability in their surrounding environment. They obtained plant materials from the forest or yard, without conducted replanted efforts. The other reason is the healer's opinion that wild-grown plants are more powerful than cultivated ones (Mathibela *et al*., 2015). Overharvested of medicinal plants affects to the species rarity, and finally leads to species extinction (Chen *et al*., 2016). The traditional healers should be aware since this condition threatens the availability of plant material for medicinal purposes. Traditional healers are expected to act as indigenous knowledge custodians and conservation partners in their communities.

CONCLUSION

More than a hundred medicinal plants were employed by traditional healers to facilitate bone injury healing in West Kalimantan. Nonetheless, only a few plant species have been already

well investigated to find out scientific evidence. Moreover, the medicinal plants for bone injury treatment in West Kalimantan are too varied as yet. However, there were reported eleven important species of plants that have at least 5 citations each (UV level at least 0.10). *Zingiber officinale* was demonstrated the highest relative importance in the local community (22 citations; UV=0.43), and Acanthaceae was the most relatively important botanical family among traditional healers. The scientific evaluation is critically required to provide the safety and efficacy evidence of the plants in facilitating bone injury healing for both local and global communities. Another matter to be concerned about is plant conservation, due to the massif practices of plant collection from the wild. Conservation knowledge should be shared with the traditional healer regarding this issue. This would provide them with the skills to contribute to both environment and communities. Furthermore, they can play a role as the local knowledge custodian as well as a conservation partner.

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