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*Front cover: Lepidotrigona terminata* (Smith, 1878)  
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# BIODIVERSITAS

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### Book:

Rai MK, Carpinella C. 2006. Naturally Occurring Bioactive Compounds. Elsevier, Amsterdam.

### Chapter in book:

Webb CO, Cannon CH, Davies SJ. 2008. Ecological organization, biogeography, and the phylogenetic structure of rainforest tree communities. In: Carson W, Schnitzer S (eds) *Tropical Forest Community Ecology*. Wiley-Blackwell, New York.

### Abstract:

Assaeed AM. 2007. Seed production and dispersal of *Rhazya stricta*. 50th annual symposium of the International Association for Vegetation Science, Swansea, UK, 23-27 July 2007.

### Proceeding:

Alikodra HS. 2000. Biodiversity for development of local autonomous government. In: Setyawan AD, Sutarno (eds.) *Toward Mount Lawu National Park; Proceeding of National Seminary and Workshop on Biodiversity Conservation to Protect and Save Germplasm in Java Island*. Universitas Sebelas Maret, Surakarta, 17-20 July 2000. [Indonesian]

### Thesis, Dissertation:

Sugiyarto. 2004. Soil Macro-invertebrates Diversity and Inter-Cropping Plants Productivity in Agroforestry System based on Sengon. [Dissertation]. Universitas Brawijaya, Malang. [Indonesian]

**Information from internet:** Balagadde FK, Song H, Ozaki J, Collins CH, Barnett M, Arnold FH, Quake SR, You L. 2008. A synthetic *Escherichia coli* predator-prey ecosystem. *Mol Syst Biol* 4:187. [www.molecularsystembiology.com](http://www.molecularsystembiology.com)

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



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### Statistics

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 74,030	 14,821
 51,277	 11,903
 45,197	 10,941
 21,892	 9,532

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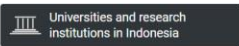
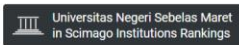
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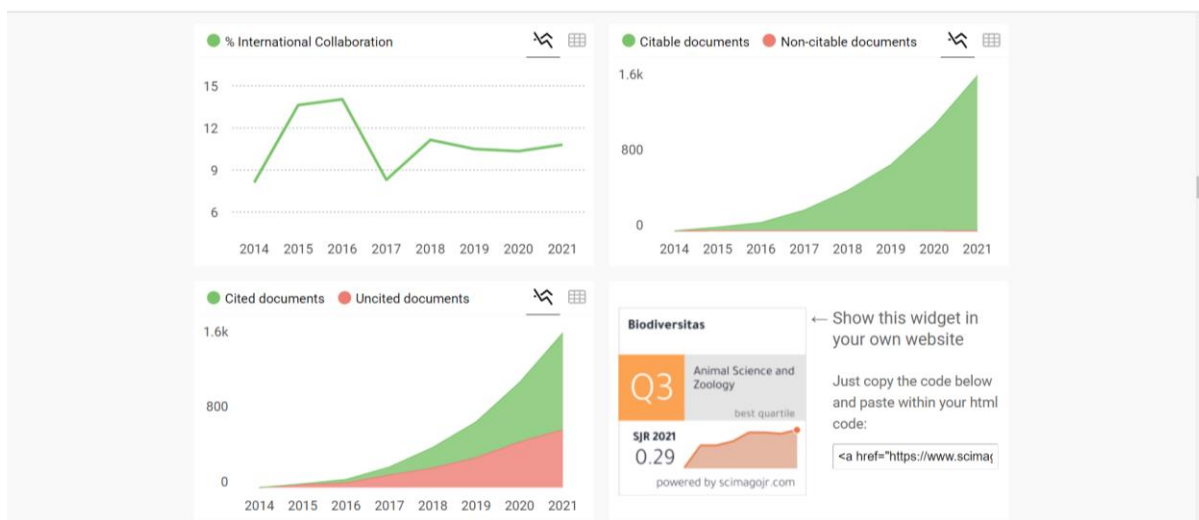
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# Ethnobotanical study of traditional steam bath *bafufu* in Lako Akediri Village, West Halmahera, Indonesia

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**Abstract.** Wakhidah AZ, Silalahi M, Yudiyanto. 2021. Ethnobotanical study of traditional steam bath *bafufu* in Lako Akediri Village, West Halmahera, Indonesia. *Biodiversitas* 23: 765-774. Indonesia's high biological and cultural diversity has resulted in various plant uses for medicinal purposes, including for health steam bath or spa. *Bafufu* is a traditional steam bath performed by Lako Akediri villagers in West Halmahera, Indonesia using concoctions made from various plant species. It is usually used to maintain women's bodies after postpartum and treat menstrual pain. This study was conducted to study the local knowledge of Lako Akediri villagers about *bafufu* spa concoction, including the diversity of plant and plant parts used to make the concoction and the community's management of such plants, and the efficacy of the concoction. We conducted semi-structured interviews with 30 respondents, comprised of indigenous medical practitioners and local women. Additionally, we collected and identified the specimens of plants used in *bafufu*. We recorded 20 plant species used in *bafufu* with the most used parts of plants being leaves and fruits. The local community obtained plants from 3 sources, i.e., cultivation, semi-wild, or wild. As many as 7 species were cited more than 6 times with *kananga* [*Cananga odorata* (Lam.) Hook.f. & Thomson] is the most cited (10 citation). Those plants have been well studied regarding their phytochemical content in maintaining women's reproduction health. Such most used plants have chemical compounds including lirioidenine, punicalagins, curcumin, myristic acid, eugenol and citral a-citral b. The *bafufu* spa concoction has various benefits, such as maintaining the health of the reproductive organs reducing menstrual pain and body odor.

**Keywords:** *Bafufu*, Lako Akediri, postpartum, steam bath, West Halmahera

## INTRODUCTION

The utilization of plants for medicinal purposes is part of Indonesian culture passed down for generations (Indonesian Ministry of Health 2007; Kandowanko et al. 2018). Despite modern health facilities already existing in rural areas, local people still prefer to go to traditional healers rather than community health centers (*Puskemas*), as in the case of a Sundanese community in West Java (Rahayu et al. 2019). Many local communities prefer traditional medicine to cure minor ailments, usually medicinal plants. Silalahi and Nisyawati (2019) reported 59 plant species belonging to 37 genera and 25 families had been documented as medicinal plants for their use as steam-bathing materials by the Batak people. While Rahayu et al. (2019) also recorded 48 species used in postpartum care applications. The Dani Tribe in Jayawijaya, Papua used *Imperata cylindrica* (L.) P.Beauv. as medicine for influenza and tinea versicolor (Mabel et al. 2016); while the leaves of *Ceiba pentandra* (L.) Gaertn. is used as heartburn medicine by the local people of Maros, South Sulawesi (Hasmawati et al. 2020); or *Blumea balsamifera* (L.) DC. that was used as an appetite enhancer and bloating reliever by Way Kerab's community in Lampung (Wakhidah and Hayati 2020).

Despite the high diversity of plant species used and the ailments to cure, Indonesian people's ways of preparation

of medicinal plants are also varied. Some medications use only a single plant species, for example, *Curcuma longa* L. is the most important medicinal plants which is traditionally used as antiasthma (Paramita et al. 2018) and the use rhizomes of *C. longa* to cure postpartum (Rahayu et al. 2019), the people of Papua drink whole *Biophytum umbroculum* Welw. decoction to improve fertility in women (Riyadi et al. 2019), and the Simalungun people of North Sumatra drink leaf decoction of *Syzygium cumini* (L.) Skeels to treat diabetes mellitus (Simanjuntak 2018). Other modes apply the combination of more than one plant species as a concoction to treat certain diseases, for instance, *oke sou* herb drink which is used to relieve menstrual pain by the people of West Halmahera (Wakhidah et al. 2017a).

The application of traditional medicine is through ingestion and smeared, drained, washed, or evaporated on the sick body parts (Susiarti 2015; Wakhidah et al. 2017b). In particular, some medicinal herbs are evaporated to produce vapor used as a traditional spa or steam bath. A variety of traditional steam bath methods using plants concoctions are found in various regions in Indonesia, such as the palace princess spa from Madura (Astutik 2017), *oukup* or *marsidudu* from North Sumatra (Batubara et al. 2017; Silalahi and Nisyawati 2019), *betangas* from West Kalimantan (Putri et al. 2017), *molungudu* from Gorontalo (Halid and Novianti 2017), and *bafufu* from West Halmahera.

*Bafufu* is a name of the stages in a ceremony to welcome girl maturity in the customary community of Lako Akediri, West Halmahera. In the *bafufu*, they used an herb which is called *bafufu* spa. The concoction is used to vaporize the girl's body, and then a tiny portion is drunk by the girl. A local community believes this process gives many health benefits to the reproductive organs. In Lako Akediri Village, the plant's composition in the *bafufu* spa concoction is only known by the women shaman (traditional herb practitioner). The inheritance of such knowledge is conducted verbally and only passed on to female lineage. This way of knowledge transfer is very vulnerable to degradation by time which might be worsened the influence of the pace of information and modernization which erodes traditional knowledge (Adiputra 2011; Mosaddegh et al. 2012). Moreover, there is no literature about ethnobotany research on the *bafufu* spa concoction. It would be unfortunate if that local knowledge is lost before being documented and reviewed. Therefore research is needed to study the knowledge of *bafufu* spa concoction. The purpose of this study is to document the local knowledge of Lako Akediri villagers about *bafufu* spa concoction, including the diversity of plant and plant parts used to make the concoction, the management of such plants by the community, and the efficacy of the concoction. This study might contribute to potentially new natural materials which can be used for the beauty products industry, including spa.

## MATERIAL AND METHODS

### Study area and period

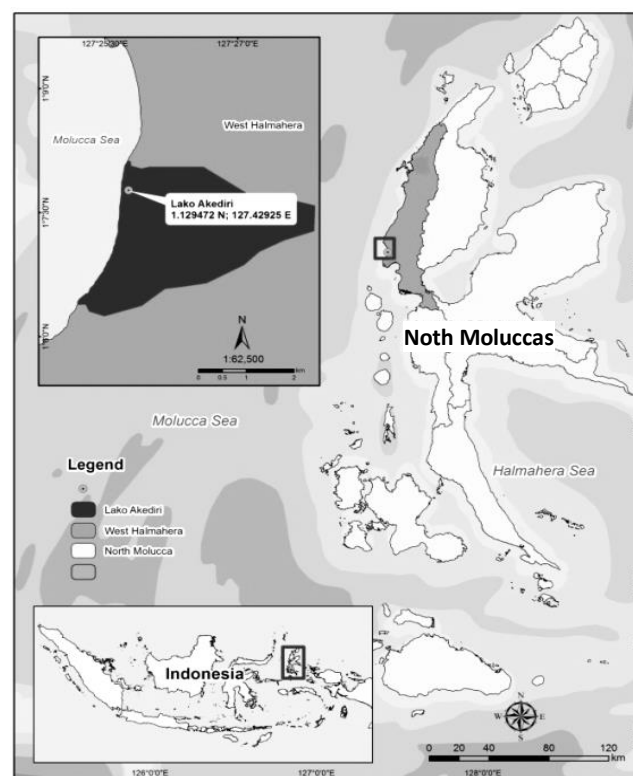
This research was conducted at Lako Akediri Village, Sahu Sub-district, West Halmahera District, North Maluku Province, Indonesia (Figure 1). Data collection was carried out from March to May 2014 and continued in September 2014. Geographically, Lako Akediri Village is located in a coastal area at coordinates of 1°07'46.1" N - 127°25'45.3" E with an extent of 1200 hectares. The village has an altitude of 31 m asl and an average rainfall of 15 mm/month. The distance of the village from the sub-district center is 21 km or about 1 hour travel time by a motorcycle. In contrast, the distance of the village from the district center is 5 km with a travel time of 30 minutes. The population of the village in 2014 was 344 people, consisting of 175 males and 169 females, with a total of 85 households. The people of Lako Akediri Village are 98% composed of local Sahu Ethnic, while the rest are outsiders from other ethnicities, namely Buton, Bugis and Sasak (Director-General of Village Development 2011).

The Sahu Ethnic has a customary institution called *Ji'o Japung Malamo* in West Halmahera District, North Maluku Province. It consists of two indigenous groups, namely *Tala'I* and *Padusua*. These two groups have similarities in culture in the form of objects made by humans/folk architecture, for example, the traditional houses called *sasadu*, but there are differences in the dialects of the *Sahu* language, known as the *Tala'I* dialect and *Padusua* dialect (Alus 2014). Nevertheless, the Sahu people still practice their traditional rituals (Ipaenin 2018), for example, *oke sou*

ceremony which is still being carried out today (Wakhidah et al. 2017a). In addition, there are two social structures in the history of the Sahu Ethnic, namely the sultanate period (before the entry of the gospel message) and the present period. Both structures of society are explained in Table 1 (Beolado 2003). Generally, the Sahu Tribe has 3 social structure, including *Walasae*, *Walangatom*, and *Ngoarepe*. Meanwhile, other community structures reported, such as *Kapita*, *Jou ma bala*, *Gomater*, *Fomanyira*, are granted customary and legitimate from indigenous peoples.

### Data collection

Ethnobotanical data were collected using semi-structured interviews with key respondents and general respondents (Martin 1995). The key respondents were the elders and the women shaman of Lako Akediri Village, while the general respondents were the village community consisted of women aged 13 to 75 years totaling 30 people (Sheil et al. 2004). The selected respondents were only female because *bafufu* spa concoction was only used and processed by women. Plant diversity data were collected with key respondents, made into herbarium, then identified at the Laboratory of Plant Taxonomy, Departemen Biology, Universitas Indonesia. The voucher specimens were stored at the herbarium of the Department of Biology, Faculty Mathematics and Natural Science, Universitas Indonesia. The scientific names were verified by referring to [www.theplantlist.org](http://www.theplantlist.org). Besides, secondary data were also used in this study, namely in the form of Lako Akediri Village profile data and phytochemical contents of plants used in *bafufu* spa concoctions that were obtained from previous studies of pharmacological and phytochemical.



**Figure 1.** Map of study site in Lako Akediri Village, Sahu Sub-district, West Halmahera District, North Maluku Province, Indonesia

### Data analysis

The data obtained was divided into qualitative and quantitative formats. Qualitative data included village history, diversity of plants used in *bafufu* spa concoctions, plant local names, habitus, parts used, and plant sources. In contrast, quantitative data was the frequency of plant species mentioned by the people of Lako Akediri Village. The collected data were presented in tabulation and histogram form and analyzed qualitatively. The qualitative analysis included the diversity of plants used in the *bafufu* spa concoction, the most widely used plant parts, and how the Lako Akediri community-managed those plants. The quantitative analysis was also used to explain the importance of most mentioned plants species by the community and the phytochemical content of these plants.

## RESULTS AND DISCUSSION

The Lako Akediri Village was initially named Lako Ichi which means the estuary. The village name was then changed to Lako Akediri by the village elder. The word '*akediri*' originated from the local language (*Sahu*), which means the estuary of Akediri River. The Lako Akediri Village was formally established in 2004 with local customs as applicable custom. The beliefs held by the community influenced the enforcement of customs. Since most of the Lako Akediri people were Moslem, the community applied Ternate customs more influenced by Moslem culture. In West Halmahera District, two adjacent villages do not necessarily shared cultural acculturation, for example, if village A is predominantly Moslem and village B is primarily Christian, there is no strong acculturation between the two villages. Thus, the Lako Akediri community can keep the Ternate customs influenced by Moslem culture.

Traditionally, the Lako Akediri people are led by *vanira* or *fomanyira*. *Vanira* has to control introduced things in the community from conflict with local customs and maintain the existence of customs in the village for generations. *Vanira* has a subordinate named *kapita* who serves as head

of village security. *Kapita* himself has a subordinate named baru-baru whose job is to help the *vanira* maintain village security. The Sultan of Ternate originally chose the customary apparatus, but his successor is based on recommendations from the previous apparatus which usually come from his immediate family.

### Diversity of plant used in Bafufu

We recorded 20 plant species belonging to 19 genera and 15 families used in *bafufu* spa concoction. Most plants species used in *bafufu* belong to Zingiberaceae (4 species) (Table 1), followed by Acanthaceae, Myrtaceae, and Poaceae with 2 species in each family, while 11 other families consist of a single species. The number of plant species used in *bafufu* is lower than the plant species used in the *oukup* steam bath concoction from North Sumatra. *Oukup* concoction made from 69 species of plants belonging to 28 families. The most widely used family in *oukup* is similar to the *bafufu* spa concoction, i.e., Zingiberaceae with 14 species. However, the number of species in *bafufu* is higher than *betangas* steam bath concoction from West Kalimantan and *betimun* steam bath from Saibatin Sub-tribe, Lampung. *Betangas* concoction only used 10 species belonging to 10 families (Putri et al. 2017), while *betimun* steam bath only used 6 species from 3 families (Wakhidah and Silalahi 2020). The plants habitus used in *bafufu* spa concoction consists of herbs (9 species), trees (8 species), shrubs (2 species), and climbers (1 species). The parts most used in *bafufu* spa concoction are leaves and fruits (5 species each), followed by seeds, bark, and rhizomes (4 species), and stems (2 species).

Plant species that belong to Zingiberaceae are tumbukunci [*Boesenbergia rotunda* (L.) Mansf.], kuning (*C. longa*), tumbulawak (*Curcuma zanthorrhiza* Roxb.), and bataka (*Kaempferia galanga* L.) (Figure 2). *Curcuma longa* has the highest frequency of being mentioned by the people of Lako Akediri Village (8 citations), followed by *K. galanga* (7 citations). This indicates that *C. longa* and *K. galanga* might have more effective medicinal content than other herbs used in *bafufu* spa concoctions. *Curcuma longa* contains chemical compounds, including curcumin, antibacterial, antitumor, and antioxidant activity.

**Table 1.** The social structure of Sahu Ethnic, Lako Akediri Village, West Halmahera, Indonesia, during the sultanate period and the present period (Beolado 2003)

Sultanate period		Present period	
Social structure	Duty	Social structure	Duty
<i>Walasae</i>	Village leader	<i>Fomanyira</i>	Village leader; regulate people's lives and welfare
<i>Kapita/momole</i>	Warlord	<i>Gam Makale</i>	Traditional custom chief ( <i>walasae</i> dan <i>walangatom</i> ); enforce and regulate customary law; take part in a traditional party in a traditional house
<i>Walangatom</i>	Soldier executing commands from the <i>kapita</i> ; in charge of defense and security	<i>Baba ma soi</i>	The elders; participate in deliberation with <i>gam ma kale</i> to enforce the implementation of customary law
<i>Jou ma bala</i>	Collect tribute to the sultan every year to	<i>Tua Tua kampung</i>	They assist and give legitimacy to Gam Makale in regulating and enforcing customary law.
<i>Gomater</i>	Serving the religious field; maintain the sacredness of religious ceremonies	<i>Ngoa repe</i>	General society
<i>Khalifa</i>	<i>Guru</i> assistant; assisting in taking medicines for sacred ceremonies		
<i>Ngoa repe</i>	General society		

Additionally, it contains dimethoxy curcumin and bisdemethoxycurcumin compounds that have the role of an antioxidant (Zhang et al. 2019). Meanwhile, *K. galanga* contains high levels of tricyclene,  $\alpha$ -pinene, camphene,  $\delta$ -3-carene,  $\beta$ -cymene, 1,8-cineole, chrysanthenone, transpinocarveol, camphor, borneol (Liu et al. 2014) as well as antibacterial activities and antituberculosis properties (Lakshmanan et al. 2011). Furthermore, other active compounds in *K. galanga* are ethyl-cinnamate which has a vasorelaxant activity. This vasorelaxant's role is to inhibit the flow of calcium into blood vessel cells by releasing nitric oxide and prostaglandin from the subendothelium (Umar et al. 2011) (Table 2).

Leaves and fruit are the most used plants in *bafufu* spa concoction and stem is the least used part of plants (Figure 3). Leaves are the most used part of plants due to their accessibility and abundance (Amiri et al. 2012). Besides, the leaves contain various medicinal content and antioxidant properties that originated from secondary metabolites (phytochemicals) (Nahdi et al. 2016), for example, daun mangkok [*Polyscias scutellarium* (Burm.f.) Fosberg], giawas (*Psidium guajava* L.), and surai (*Coriandrum sativum* L.). The Indigenous community of Tripura, India (Deb et al. 2016) and communities in the Asgede Tsimbila region, Ethiopia (Zenebe et al. 2012) mostly use leaves for medication. Presumably, fruit contains important nutrients and properties to be used as medicine as it is one of the primary metabolites storage organs in plants (Taiz and Zeiger 2002), as a result, fruits are also widely utilized. Furthermore, stem is only used from two plant species, namely puli (*Ruellia simplex* Wright) and gramakusu [*Cymbopogon citratus* (DC.) Stapf]. The use of stem may threaten the conservation of

particular species. However, the potential threat can be reduced since *R. simplex* and *C. citratus* tend to grow easily. *Ruellia simplex* can be propagated using seed and stem cuttings, while *C. citratus* is easily propagated vegetatively by budding. Therefore stem utilization as one of the ingredients in the *bafufu* spa concoction can be stated not to be threatening.

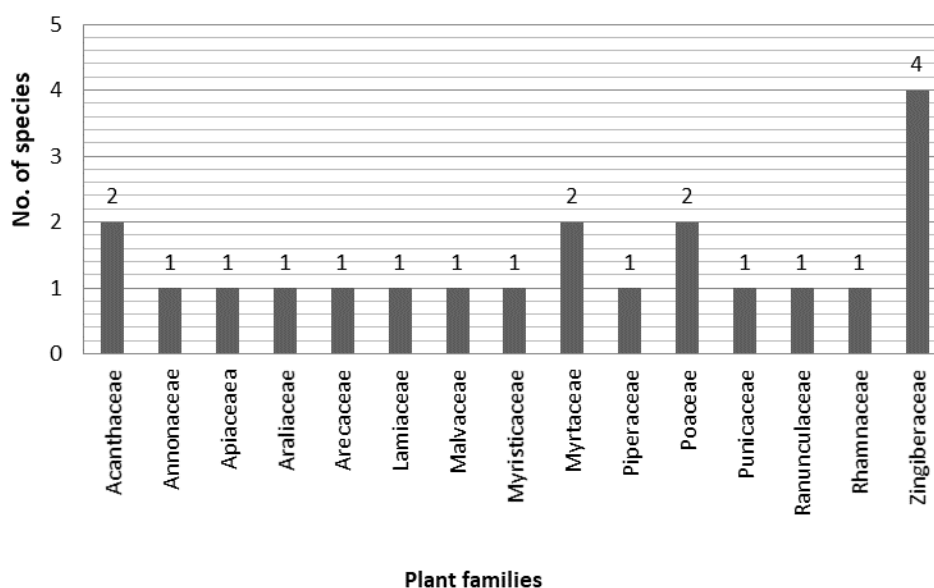
### **Bafufu traditional steam bath, preparation and utilization**

*Bafufu* comes from the local language (*Sahu* language) with the basic word of 'fufu' which means to be steamed. At Lako Akediri Village, *bafufu* is not only one practiced on *oke sou* ceremony (Wakhidah et al. 2017c) but also on the treatment of postpartum women. As one of the stages in the *oke sou* ceremony, *bafufu* consists of a series of processions, namely *bafufu*, *kasih kapas*, drinking herbs, and eating pills (Wakhidah et al. 2017c). As for the treatment of postpartum women, the implementation is more or less similar to the sauna's body treatment but with traditional equipment. The process of having *bafufu* is as follows, the girl or the postpartum woman wearing a cloth that covers the chest and not allowed to wear underwear. Then she bath ing within the steam of a *bafufu* spa concoction. First, *bafufu* vapor is produced by heating the herbs concoction on a small stove (Figure 4A). Next, *bafufu* concoction is poured into a small jug (Figure 4B), then the jug is placed just below the woman's genitals while she crouches. The woman is covered by sarong during the steam bath period for about 10 minutes. The *bafufu* steam is performed before bath every morning and evening to refresh the body and relax the mind from stress.

**Table 2.** Diversity of plants used in *bafufu* traditional spa in Lako Akediri Village, West Halmahera, Indonesia. The plant family, habitus, vernacular name, part used, number of informants citing the plant, plant source and conservation status based on IUCN

Plant family	Species name	Habitus	Vernacular name	Part used	No of informant	Source	IUCN status*)
Acanthaceae	<i>Ruellia simplex</i> Wright	Herb	<i>Puli</i>	Leaf, stem	2	Cultivated	NE
Annonaceae	<i>Cananga odorata</i> (Lam.) Hook.f. & Thomson	Tree	<i>Kenanga</i>	Stem bark	10	Semi-wild	NE
Apiaceae	<i>Coriandrum sativum</i> L.	Herb	<i>Surai</i>	Leaf, seed	2	Cultivated	NE
Araliaceae	<i>Polyscias scutellarium</i> (Burm.f.) Fosberg	Shurb	<i>Daun mangkok</i>	Leaf	3	Cultivated	NE
Arecaceae	<i>Areca catechu</i> L.	Tree	<i>Pinang</i>	Fruit	4	Semi-wild	NE
Lamiaceae	<i>Vitex pinnata</i> L.	Tree	<i>Gofasa</i>	Stem bark	2	Wild	LC
Malvaceae	<i>Kleinhovia hospita</i> L.	Tree	<i>Liwui</i>	Stem bark	2	Wild	LC
Myristicaceae	<i>Myristica fragrans</i> Houtt.	Tree	<i>Pala</i>	Fruit, seed	7	Semi-wild	DD
Myrtaceae	<i>Psidium guajava</i> L.	Tree	<i>Giawas</i>	Leaf	6	Cultivated	LC
	<i>Syzygium aromaticum</i> (L.) Merr. & Perry	Tree	<i>Cengkeh</i>	Leaf, fruit	7	Semi-wild	NE
Piperaceae	<i>Piper nigrum</i> L.	Climber	<i>Rica jawa</i>	Fruit	2	Cultivated	NE
Poaceae	<i>Cymbopogon citratus</i> (DC.) Stapf	Herb	<i>Gramakusu</i>	Stem	7	Cultivated	NE
	<i>Oryza sativa</i> var. <i>glutinosa</i>	Herb	<i>Puloputih/hitam</i>	Seeds	2	Cultivated	NE
Punicaceae	<i>Punica granatum</i> L.	Shurb	<i>Delima</i>	Fruit, seed	9	Cultivated	LC
Ranunculaceae	<i>Nigella sativa</i> L.	Herb	<i>Jinta hitam</i>	Fruit	5	Cultivated	NE
Rhamnaceae	<i>Alphitonia moluccana</i> Teijsm. & Binn.	Tree	<i>Raurika</i>	Stem bark	2	Wild	NE
Zingiberaceae	<i>Boesenbergia rotunda</i> (L.) Mansf.	Herb	<i>Tumbukunci</i>	Rhizome	1	Cultivated	LC
	<i>Curcuma longa</i> L.	Herb	<i>Kuning</i>	Rhizome	8	Cultivated	DD
	<i>Curcuma zanthorrhiza</i> Roxb.	Herb	<i>Tumbulawak</i>	Rhizome	1	Cultivated	DD
	<i>Kaempferia galanga</i> L.	Herb	<i>Bataka</i>	Rhizome	7	Cultivated	NE

Note: \*) NE: Not evaluated; LC: Least concern; DD: Data deficient



**Figure 2.** Number of species in each plant family used in *bafufu* traditional spa in Lako Akediri Village, West Halmahera, Indonesia

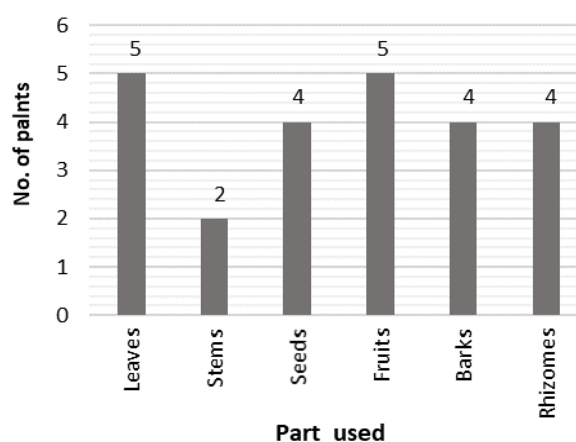
The process of making *bafufu* spa concoction is carried out by using parts of plants, including leaves, barks, roots, and fruits (Table 2). First, the parts of plants are mashed up until smooth, mixing with water and then kneading. Second, the water from the plant mixture is filtered then squeezed, after that, the mixture is boiled. Third, the concoction is poured into a jug and remains heated on the furnace only when used. The jug size is relatively small, like jug used in vagina spa at woman beauty treatment. Approximately 0.15 liter of the concoction is taken to be drunk by the girl before being vaporated as *bafufu*.

The user position during practice *bafufu* is purposed to reduce pain during menstruation and after giving birth. Traditional spa such as *bafufu* has many other benefits, i.e., enhance blood circulation (Campbell et al. 2004), reducing body odor (Kardinan 2005), and maintaining vaginal hygiene (Gupta and Rajpurohit 2011; Asgarpanah and Kazemivash 2012). The warmth of the vapor will relieve pain, as shown on the water birth method. Warm water can trigger the body to secrete endorphin hormones and opioid endogenous peptide compounds that help relax body muscles and reduce the body's pain nerves (Sprouse-Blum et al. 2010). Besides, the chemical compound of *Syzygium aromaticum* (L.) Merr. & Perry may work like an anesthetic to relieve aches and pains (Verma et al. 2018).

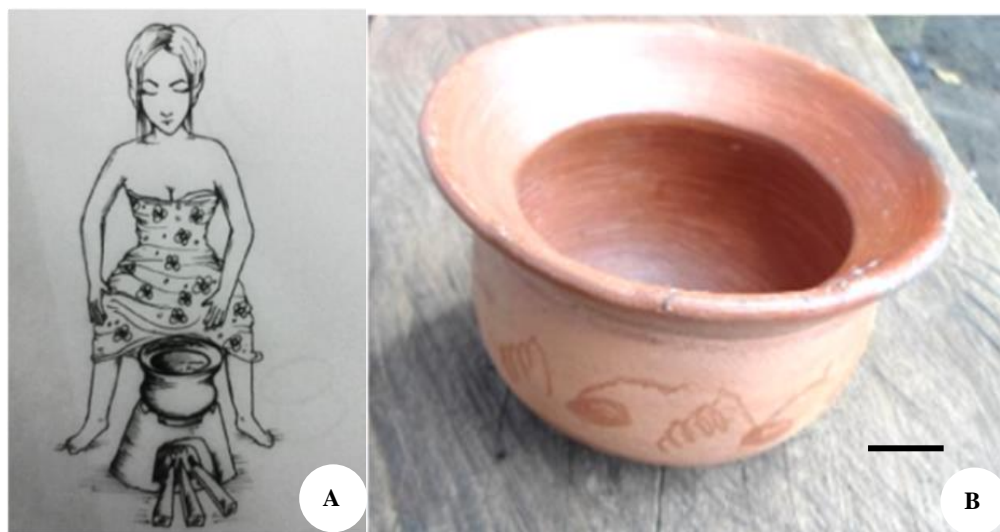
*Bafufu* steam bath can also enhance blood circulation and eliminate metabolically waste in the body. The warm conditions activate the body's heat receptors that cause blood vessels to dilate, improving O<sub>2</sub> circulation and nutrient distribution. The warm condition also causes the dilation of skin pores and activates the sweat glands (Campbell et al. 2004), increasing the effectiveness of waste removal through sweat.

Leaves and flowers of *S. aromaticum* and seeds of *Myristica fragrans* Houtt. are used as a fragrance and to keep the cleanliness of the vagina. In addition, those plants

contain essential oils and other compounds which good for reproductive health. For example, *S. aromaticum* contains essential oil eugenol, which helps warm the body and works as an antibacterial (Kardinan 2005). Moreover, eugenol can inhibit the growth of fungi which is often found in the external reproductive organs of women, such as *Candida albicans* (C.P.Robin) Berkhout (Japri et al. 2020) and *Candida tropicalis* (Castell.) Berkhout (de Paula et al. 2014). Other compounds contained in *S. aromaticum* are eugenyl acetate,  $\beta$ -caryophyllene, 2-heptanone, ethyl hexanoate, humulenol,  $\alpha$ -humulene, calacorene, calamine (Table 3). Those compounds are usually extracted as clove oil that has pharmacological activities such as antibacterial, antiviral, antioxidant, and anesthetic properties (Verma et al. 2007).



**Figure 3.** Number of plant species based on plant part used in *bafufu* traditional spa in Lako Akediri Village, West Halmahera, Indonesia



**Figure 4.** *Bafufu* traditional steam bath application. A. The woman position when *bafufu* procession (drawn by Saputro S.B. 2014). B. The jug (*belangga*) used in *bafufu* implementation. Bar = 3 cm.

Nutmeg (*M. fragrans*) has essential oil, namely myristicin (Kardinan 2005), which strengthens the aroma of *bafufu* and has antibacterial activity. Besides myristicin, other essential oils in *M. fragrans* are limonene, eugenol, and terpinen-4-ol. Those compounds not only work as aromatherapy and antioxidants but also have antiparasitic activity (Pillai et al. 2012) (Table 3). Other compounds in *M. fragrans* are trimyristin, erythro-austrobaillignan-6, mesodihydroguaiaretic acid, and nectaridrin-B. These compounds have antifungal and antibacterial activity (Gupta and Rajpurohit 2011). The existence of those compounds and essential oils play an important role in maintaining the cleanliness of the vagina. Thus, the customary beliefs about the efficacy of the *bafufu* spa concoction of the Lako Akediri community can be proven scientifically because the used plant species have medicinal properties that are appropriate with those beliefs.

#### Phytochemical properties

As many as 7 species were cited more than 6 times by the Lako Akediri people with kananga [*Cananga odorata* (Lam.) Hook.f. & Thomson] is the most cited species with 10 citations. The other species are delima (*Punica granatum* L.; 9 citations), kuning (*C. longa*; 8 citations), bataka (*K. galanga*; 7 citations), pala (*M. fragrans*; 7 citations), cloves (*S. aromaticum*; 7 citations), and gramakusu (*C. citratus*; 7 citations). Those species have been well studied regarding their various chemical compounds and their pharmacological activities that potentially have medical purposes (Table 3). Those studies are scientific evidence of *bafufu* spa concoction's efficacy, proving that the customary beliefs of the Lako Akediri people are true. For that reason, the utilization of *bafufu* spa concoction needs to be maintained.

Based on literature studies, it is known that each plant species has a specific compound with certain pharmacological activities. For example, *P. granatum* contains punicalagins that act as antifungal and anticancer. Punicalagins can fight *C. albicans* and *Candida parapsilosis* (Ashford) Langeron & Talice, which cause

vaginal discharge in women by thickening the fungi cell wall and reducing the cytoplasmic composition of cells (da Silva et al. 2020). In addition, Punicalagins can inhibit the growth of cancer cells in the body (anticancer activity) by interfering with the growth of the cell cycle and apoptosis (Berdowska et al. 2021). Therefore, the utilization of *P. granatum* in *bafufu* spa concoction is scientifically proven to maintain the cleanliness and health of the reproductive organs.

The most cited species, *C. odorata*, contains chemical compounds including o-methylmoschatoline, liriodenine, and 3,4-dihydroxybenzoic. Tan et al. (2015) proved that chemical compounds in *C. odorata* act against various Gram-positive and Gram-negative pathogens and pathogenic fungi. Furthermore, a high essential oil in *C. odorata* produces many different and fragrant aromas, such as linalool and ethmethylanisole, that function as aromatherapy (Tan et al. 2015). Therefore, the essential oil content in *C. odorata* plays a role in enhancing the fragrance of *bafufu* spa concoction, while the ability of antibacterial and antifungal activity strengthens the efficacy of this concoction.

The typical chemical compounds produced by Gramakusu (*C. citratus*) include citral a, citral b (Leite et al. 2014), b-myrcene, neral, geranial (Boukhatem et al. 2014), and geranial (Basera et al. 2019). The content of citral a and citral b act as antifungal since both compounds can inhibit the growth of *C. albicans* (Leite et al. 2014). Besides, *C. citratus* contains  $\alpha$ -limonene and geraniol that role as anticancer. Based on research by Boukhatem et al. (2014), the essential oil of *C. citratus* has activity as antifungal and antiinflammation. Meanwhile, the geraniol compound has a potent antimicrobial activity after mixing with the myrcene compound found in this species (Basera et al. 2019). *Cymbopogon citratus* also produces a fragrant aroma of essential oils and the smells like lemon because it contains citral compound up to 85% (Zaituni et al. 2016). Based on its chemical compound, *C. citratus* has roles in maintaining the cleanliness and health of the reproductive



organs. Moreover, its fragrant aroma can enrich the fragrance of the *bafufu* spa concoction.

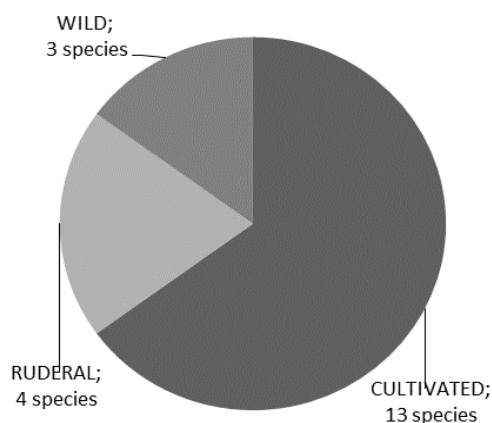
### Plant management and conservation

The results research showed that there are 3 collection sources of plant used in *bafufu* spa concoctions, namely from cultivation, semi-wild, and obtained wildly (Figure 5). The highest plants source is from cultivation with 13 species in total, 4 species are obtained from semi-wild while the least plant sourced from wild with only 3 species. The plant which is harvested from cultivation includes surai (*C. sativum*), daun mangkok (*P. scutellarium*), giawas (*P. guajava*), and rica jawa (*Piper nigrum* L.). The Lako Akediri people cultivate those plants in the yard with an extent of about 20-60 m<sup>2</sup>. The highest plant source from cultivation indicates that the cultivated species used in *bafufu* spa concoction have many other benefits. For example, *P. scutellarium*, besides its leaves are used in the *bafufu* spa concoction, the plant has beautiful leaves and suitable as an ornamental plant. The other example, *P. nigrum* is needed in *bafufu* and utilized as a food flavoring spice. Thus, it can be concluded that the use of species in *bafufu* spa concoction with more than a single-use generally would be cultivated in the yard.

Furthermore, 3 plant species harvested from the wild are gofasa (*Vitex pinnata* L.), liwui (*Kleinhovia hospita* L.), and raurika (*Alphitoniama luccana* Teijsm. & Binn.). The bark of those species is used in preparing *bafufu* spa concoctions. The Lako Akediri people would go to their agroforest near the forest whenever those species were needed. Since those wild species are only used at a certain time and not many benefits can be obtained, the Lako Akediri people let them grow wild. Additionally, tree habitus species take a long time and need a wide space to grow. This causes the Lako Akediri people to be somewhat difficult to cultivate in the yard. From a scientific view, some plant species can only be harvested after reaching a certain age because the content of chemical compounds varies by each age (Tan et al. 2015). So, the harvest time is likely quite long. Moreover, abiotic environmental factors, which are difficult to control, also affect plants' chemical compounds' content (Gupta et al. 2013). Therefore, it would be better to let those species grow wild for some reason. Despite all of that, the local people might have local wisdom, believing that allowing those plants to grow wild would bring goodness for them and their environment.

**Table 3.** The most frequently mentioned plants used in *bafufu* traditional spa in Lako Akediri Village, West Halmahera, Indonesia, along with phytochemical profiles and pharmacological activities

Plants species	Phytochemical profile	Pharmacological activity
<i>Cananga odorata</i>	<i>n</i> -hexane, ethyl acetate, ethanolic (Tan et al. 2015); $\beta$ -sitosterol, stigmaterol, liriodenine, and lycosamine (Husain et al. 2012); $\alpha$ -humulene, germacrene D, (E, E) - $\alpha$ -farnesene (E, E) -farnesol, benzyl benzoate, linalool dan c-caryophyllene (Giang and Son 2016); Linalool, <i>p</i> -methylanisole) (Tan et al. 2015)	Antimicrobial, Antifungal, Anti-inflammatory, Antidiabetic, Antifertility, Aromatherapy (Tan et al. 2015)
<i>Punica granatum</i>	Methanolic, polyphenol (Miguel et al. 2010); Punicalagins (Gosset-Erard et al. 2021); Flavonols, phenolics, anthocyanins (Jaiswal et al. 2010); Ellagic acid (Berdowska et al. 2021); Punicalagins (Kasimetty et al. 2009)	Antimicrobial (Miguel et al. 2010; Gosset-Erard et al. 2021); Antifungal (da Silva et al. 2020); Antibacterial, Antioxidant (Jaiswal et al. 2010); Anticancer (Kasimetty et al. 2009; Berdowska et al. 2021)
<i>Curcuma longa</i>	Curcumin (Zhang et al. 2019); ar-turmerone, $\alpha$ -turmerone, $\beta$ -turmerone (Ferreira et al. 2013); Linalool, menthol, limonene (Silalahi 2017); Demethoxy curcumin, Bisdemethoxy curcumin (Zhang et al. 2019)	Antibacteria, Antioxidant, Antitumor (Zhang et al. 2019); Antifungal (Ferreira et al. 2013; Silalahi 2017; Zhang et al. 2019)
<i>Kaempferia galanga</i>	$\alpha$ -pinene, camphene, $\delta$ -3-carene, $\beta$ -cymene, 1,8-cineole, chrysanthenone, transpinocarveol, camphor, borneol (Liu et al. 2014); <i>p</i> -thyl- <i>trans</i> -cinnamate; (Hong et al. 2011); Ethyl-cinnamate (Umar et al. 2011)	activities antibacterial and anti-tuberculosis (Lakshmanan et al. 2011); Antimicrobial (Umar et al. 2011); Nematicidal activity (Hong et al. 2011); Vasorelaxant (Umar et al. 2011)
<i>Myristica fragrans</i>	Isoeugenol, lignans, eugenol, $\beta$ -caryophyllene (Gupta et al. 2013); Trimyristin, myristic acid (Asgarpanah and Kazemivash 2012); Erythro-austrobailignan-6, mesodihydroguaiaretic acid, nectaridrin-B (Gupta and Rajpurohit 2011)	Antioxidant (Gupta et al. 2013); Antibacterial and Antifungal (Gupta and Rajpurohit 2011)
<i>Syzygium aromaticum</i>	Clove oil and eugenol (Radünz et al. 2019; Rana et al. 2011); Eugenol, eugenyl acetate, $\beta$ -caryophyllene, 2-heptanone, ethyl hexanoate, humulene, $\alpha$ -humulene, calacorene, calamene (Verma et al. 2018)	Antiphatogen (Radünz et al. 2019); Antifungal (Rana et al. 2011); Antibacterial, Antiviral, Antioxidant, Anaesthetic activity (Verma et al. 2018)
<i>Cymbopogon citratus</i>	Citral a, citral b (Leite et al. 2014); b-Myrcene, Neral, Geranial (Boukhatem et al. 2014); geranial, myrcene (Basera et al. 2019)	Fungicidal (Leite et al. 2014); Antifungal, inflammation (Boukhatem et al. 2014); Antimicrobial (Basera et al. 2019)



**Figure 5.** Number of plant species based on source of collection in *bafufu* traditional spa in Lako Akediri Village, West Halmahera, Indonesia

Semi-wild plants live in abandoned gardens, places of manure, road embankments, or ground dumps (Steenis et al. 2005). A total of 4 species used in *bafufu* spa concoction are ruderal plants, namely kananga (*C. odorata*), aren (*Areca catechu* L.), pala (*M. fragrans*), and cloves (*S. aromaticum*). The indigenous people of West Halmahera, especially the Lako Akediri people, have a gardening habit by planting annual plants, such as *A. catechu*, *M. fragrans*, and *S. aromaticum*. These plants are found semi-wild in gardens which naturally grow from seeds.

The result based on the IUCN Red List category (<https://www.iucnredlist.org/>) showed that the conservation status of plant species used in the composition of *bafufu* spa concoction are not a conservation concern (Tabel 2). A total of 12 species are not listed yet on the IUCN red list (NE), while 3 species are declared data deficient (DD), and the rest of 5 species are stated in the least concern status (LC), meaning that the extinction risk is shallow. Thus, none plant species used in the *bafufu* spa concoction are at extinction risk. Besides, the Lako Akediri community already knows to preserve the valuable plant species for their daily lives by cultivating or letting them go wild.

In conclusion, the composition of *bafufu* spa concoction consists of various species of therapeutically scented plants. Those plant species have bioactivity that is closely related to antimicrobial and antioxidants. Compared to several types of steam bath concoction throughout Indonesia, the number of used plant species for *bafufu* is quite diverse (20 species, 15 families). Zingiberaceae, as the most used plant family in *bafufu*, tend to be the most used family in other steam bath concoctions. This fact proves that Zingiberaceae contains phytochemistry compounds useful in steam bath efficacy. That is why the plant family is used extensively across various parts of Indonesia region. The composition of the most widely used plant parts is also similar, i.e., leaves, fruit, and rhizomes. Thus, these plant parts contain important compounds, which are used more than other parts. The collection of plants for *bafufu* spa concoction is from 3 sources:

cultivation, wild, and ruderal. The used plant sources mainly come from yard, likewise plant acquisition in other steam bath concoctions. This indicates that the used plants in steam bath concoction are commonly well managed by local people and have more than one use. Since cultivation is the highest source of plant collection, it indicates that the local people have conservation awareness. The most cited plant species that cited more than 5 times, generally have been widely studied for their phytochemical content and bioactivity. Those plants are also used in other steam bath concoctions in various regions of Indonesia, for example, clove (*S. aromaticum*). The active chemical compounds recorded from the most cited species (7 species) include liriiodenine, punicalagin, curcumin, ethyl-methoxycinnamate, myristic acid, eugenol, citral a, and citral b. These compounds play an important role in composing the efficacy of *bafufu* spa concoction such as maintaining the health of the reproductive organs, reducing menstrual pain, and producing fragrances to reduce body odor.

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