Ethnobotanical study of traditional steam bath \textit{bafufu} in Lako Akediri Village, West Halmahera, Indonesia


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Abstract. Wakhidah AZ, Silalahi M, Yudiyanto. 2022. Ethnobotanical study of traditional steam bath \textit{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. \textit{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 \textit{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 \textit{bafufu}. We recorded 20 plant species used in \textit{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 \textit{Cananga odorata} (Lam.) Hook. f. & Thomson. as 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 liriodenine, punicalagins, curcumin, myristic acid, eugenol and citral a-citral b. The \textit{bafufu} spa concoction has various benefits, such as maintaining the health of the reproductive organs reducing menstrual pain and body odor.

Keywords: \textit{Bafufu}, Lako Akediri, postpartum, stem 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; Kandowangko 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 (\textit{Puskesmas}), 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 \textit{Imperata cylindrica} (L.) P.Beauv. as medicine for influenza and tinea versicolor (Mabel et al. 2016); while the leaves of \textit{Celita pentandra} (L.) Gaertn. is used as heartburn medicine by the local people of Maros, South Sulawesi (Hasmawati et al. 2020); or \textit{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, \textit{Curcuma longa} L. is the most important medicinal plants which is traditionally used as antiasthma (Paramita et al. 2018) and the use rhizomes of \textit{C. longa} to cure postpartum (Rahayu et al. 2019), the people of Papua drink whole \textit{Biopphytum umbraculum} Welw. decoction to improve fertility in women (Riyadi et al. 2019), and the Simalungun people of North Sumatra drink leaf decoction of \textit{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, \textit{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 (Susirti 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 Madara (Astuti 2017), \textit{ookup or marisidudu} from North Sumatra (Batubara et al. 2017; Silalahi and Nisyawati 2019), \textit{betangas} from West Kalimantan (Putri et al. 2017), \textit{molangu} from Gorontalo (Halid and Novianti 2017), and \textit{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. 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.
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 communities from conflict with local customs and maintain the existence of customs in the village for generations. 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.), *kaleng* (C. *longa*), *tumbulawak* (*Curcuma zanthorrhiza* Roxb.), and *batak* (*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)

| Social structure | Duty | Social structure | Duty |
|-----------------|------|-----------------|------|
| Walasae         | Village leader | Fomanyira       | Village leader; regulate people's lives and welfare |
| Kapita/homomole| Warlord        | Gam Makale      | Traditional custom chief (walasae dan walangatom); enforce and regulate customary law; take part in a traditional party in a traditional house |
| Walangatom      | Soldier executing commands from the kapita; in charge of defense and security | Baba ma soi     | The elders; participate in deliberation with gam ma kale to enforce the implementation of customary law |
| Jou ma bala     | Collect tribute to the sultan every year to | Tua Tua kampung | They assist and give legitimacy to Gam Makale in regulating and enforcing customary law. |
| Gomater         | Serving the religious field; maintain the sacredness of religious ceremonies | Ngoa repe       | General society |
| Khalifa         | Guru assistant; assisting in taking medicines for sacred ceremonies |                 |                 |
| Ngoa repe       | 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, α-pinene, camphene, δ-3-carene, β-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 inhibiting the entry of calcium ions (Lakshmanan et al. 2011). Furthermore, other active compounds in K. galanga are ethyl-cinnamate which has a vasorelaxant activity.

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 scutellariam (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 Tsembila 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 can be 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.

| Plant family | Species name | Habitus | Vernacular name | Part used | No of informant | Source | IUCN status |
|--------------|--------------|---------|----------------|----------|----------------|--------|-------------|
| Acanthaceae  | Ruellia simplex | Herb    | Puli           | Leaf, stem | 2              | Cultivated | NE          |
| Annonaceae   | Cananga odorata (Lam.) Hook. f. & Thomson | Tree    | Kenanga        | Stem bark | 10             | Semi-wild | NE          |
| Apiaceae     | Coriandrum sativum L. | Herb    | Surai          | Leaf, seed | 2              | Cultivated | NE          |
| Araliaceae   | Polyscias scutellariam (Burm.f.) Fosberg | Shurb   | Daun mangkok   | Leaf      | 3              | Cultivated | NE          |
| Areceaceae   | Areca catechu L. | Tree    | Pinang         | Fruit     | 4              | Semi-wild | NE          |
| Lamiaceae    | Vitex pinnata L. | Tree    | Gofasa         | Stem bark | 2              | Wild     | LC          |
| Malvaceae    | Kleinohvia hospita L. | Tree    | Livai          | Stem bark | 2              | Wild     | LC          |
| Myristicaceae| Myristica fragrans Houtt. | Tree    | Pala           | Fruit, seed | 7           | Semi-wild | DD          |
| Myrtaceae    | Psidium guajava L. | Tree    | Giawas         | Leaf      | 6              | Cultivated | LC          |
| Piperaceae   | Piper nigrum L. | Climer  | Rica jawa      | Fruit     | 2              | Cultivated | NE          |
| Poaceae      | Cymbopogon citratus (DC.) Stapf | Herb    | Gramakusu      | Stem      | 7              | Cultivated | NE          |
|              | Oryza sativa var. glinosa | Herb    | Pulopathi hitam | Seeds    | 2              | Cultivated | NE          |
| Punicaceae   | Punica granatum L. | Shurb   | Delima         | Fruit, seed | 9           | Cultivated | LC          |
| Ranunculaceae| Nigella sativa L. | Herb    | Jista hitam    | Fruit      | 5              | Cultivated | NE          |
| Rhamnaceae   | Alphitonia moluccana Teijms. & Binn. | Tree    | Raurika        | Stem bark | 2              | Wild     | NE          |
| Zingiberaceae| Boesenbergia rotunda (L.) Mansf. | Herb    | Tumbukunci     | Rhizome   | 1              | Cultivated | LC          |
|              | Curcuma longa L. | Herb    | Tumbulawak     | Rhizome   | 1              | Cultivated | DD          |
|              | Curcuma zanthorrhiza Roxb. | Herb    | Tumbulawak     | Rhizome   | 1              | Cultivated | DD          |
|              | Kaempferia galanga L. | Herb    | Bataka         | Rhizome   | 7              | Cultivated | NE          |

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

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
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 $O_2$ 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, β-caryophyllene, 2-heptanone, ethyl hexanoate, humulenol, a-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).
Nutmeg (*M. fragrans*) has essential oil, namely myristicin (Kardina 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-austroballigian-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, liriodene, 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 ¿-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.
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*), giwas (*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 m². 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 (*Alphitonia lucuca* Teijjsm. & 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 widely. Additionally, tree
habitats 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.

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### 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                                          |
|-------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------|
| Cananga odorata         | *n*-hexane, ethyl acetate, ethanolic (Tan et al. 2015); β-sitosterol, stigmasterol, liriodenine, and lycscamine (Husain et al. 2012); α-humulene, germacrene D, (E, E)-α-farnesene (E, E)-farnesol, benzyl benzoate, linalool and c-caryophyllene (Giang and Son 2016); Linalool, p-methylisopule (Tan et al. 2015) | Antimicrobial, Antifungal, Anti-inflammatory, Antidiabetic, Antifertility, Aromatherapy (Tan et al. 2015) |
| Punica granatum         | 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 (Kasimietty 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 (Kasimietty et al. 2009; Berdowska et al. 2021) |
| Curcuma longa           | Curcumin (Zhang et al. 2019); ar-turmerone, α-turmerone, β-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) |
| Kaempferia galanga      | α-pinene, camphene, δ-3-carene, β-cymene, 1,8-cineole, chrysanthene, transpinocarveol, camphor, borneol (Liu et al. 2014); p-thyl-trans-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) |
| Myristica fragrans      | Isoegenolin, lignans, eugenol, β-caryophyllene (Gupta et al. 2013); Trimyristin, myristic acid (Asgarpanah and Kazemivash 2012); Erythro-austrobaileignan-6, mesodihydrogaiaeric acid, nectaridrin-B (Gupta and Raijporhit 2011) | Antioxidant (Gupta et al. 2013); Antibacterial and Antifungal (Gupta and Rajpurohit 2011) |
| Syzygium aromaticum     | Clove oil and eugenol (Radinz et al. 2019; Rana et al. 2011); Eugenol, eugenyl acetate, β-caryophyllene, 2-heptanone, ethyl hexanoate, humuleno, α-humulene, calacorene, calame (Verma et al. 2018) | Antiphagogen (Radinz et al. 2019); Antifungal (Rana et al. 2011); Antibacterial, Antiviral, Antioxidant, Anaesthetic activity (Verma et al. 2018) |
| Cymbopogon citratus     | Citral a, citral b (Leite et al. 2014); b-Mycrere, 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) |
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 kanaanga (C. odorata), areca (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 (Table 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 liroidiene, punicalagin, curcumin, ethyl-met-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.

ACKNOWLEDGEMENTS

The authors thank the local people of Lako Akediri Village, West Halmahera, Indonesia for sharing their knowledge and hospitality, also other assistance when this research was conducted. We acknowledge Shafia Zahra for the feedback on English writing.

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