



RESEARCH ARTICLE

# Investigation on underutilized plants used as daily medication, fruit source and traditional ceremonies in Bireuen regency, Aceh, Indonesia

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## Abstract

Bireuen is a regency that constitutes 3.13 % of the total area of the Aceh province, with elevations ranging from 0 to 2637 m above sea level (asl). Although the biodiversity of this regency is expected to be high, there is limited data available on its plant species. Many of the plants are believed to be considered underutilized. Therefore, this study aimed to investigate some ethnobotanical aspects of underutilized plant species in Bireuen Regency, Aceh. The study was carried out as a survey using an open questionnaire in 17 districts, with 70 respondents selected through purposive sampling. Quantitative indices such as Relative Frequency of Citation (RFC), Use Value (UV), Informant Consensus Factor (ICF) and Pearson Correlation were performed on RFC and UV to determine the relationship between the 2 indices. A total of 40 families and 74 plant species were recorded, identified and grouped based on their use as traditional medicine (32 families and 47 species), fruit consumption (12 families and 21 species) and traditional ceremonies (15 families and 17 species). The common methods used to prepare medicine based on these local plants were crushing or boiling to treat mild symptoms and diseases. The fruit of these plants was often consumed and some plant information is scarcely available, such as *buah brahim* (*Uvaria siamensis*) and *kayee kunyet* (*Polyalthia littoralis*). The ICF value showed that the category with the highest consensus factor was traditional ceremonies (0.85), followed by consumption as fruit (0.84), and traditional medicine (0.68). This study revealed that many local plants commonly used as part of local culture had potential medicinal properties. Therefore, further investigations are recommended to validate the use of indigenous plants and preserve the knowledge.

## Keywords

Aceh; Bireuen regency; ethnobotany; plant species; underutilized plants

## Introduction

Bireuen Regency is located in the eastern coastal area of Aceh Province, Indonesia, covering 1.79631 km<sup>2</sup> in width and constituting 3.13 % of the total area of the province. Geographically, Bireuen is directly adjacent to the Malaccan Strait in the north, Northern Aceh Regency in the east, Bener Meriah and Middle Aceh Regencies in the south and Pidie Jaya regency in the west. The regency comprised 17 districts and 609 villages with a landscape consisting of beaches, lowland and hilly mountainous areas,

resulting in widely varied vegetation from coastal ecosystems to 0-2637 m asl (above sea level). The richest biodiversity recorded at an elevation of 0-1800 m (1) with tropical climate makes the biodiversity in the regency high. Moreover, the high biodiversity of plants in Aceh is also reflected in several aspects, such as the culinary, comprising a vast array of spices (2, 3) and traditional medicine that is customary among the locals for treating mild maladies and injuries (4, 5).

Currently, the main challenge in the species biodiversity is genetic erosion, which refers to the reduction in the number of species in various aspects of life. Although it is estimated that 200000 plant species are edible, only approximately 200 of them are being consumed. This is indicated by the lower number of species that are cultivated or planted. Genetic erosion, especially of plants with agricultural value, also has implications for food security, as biodiversity ensures diet diversification (6). On a larger scale, plant biodiversity offers a wide variety of ecosystem functions and resilience to climate change (7). Previous investigation has shown that the lack of proper documentation contributed to and masked the losses of these various plants (8). An ethnobotanical study is an effective way to identify and document plants that have been used traditionally with indigenous wisdom (9, 10).

Aceh Province is regarded as the last wall of biodiversity in Sumatera, due to its presently vast forest area and biodiversity richness, including plant species. Rapidly developed areas such as Bireuen Regency are in danger of losing their biodiversity, as a human activity holds a big role in changes in ecosystems. Various plant species equipped with biological properties, such as dabai (*Canarium odontophyllum*), have been reported to have nutritional values and compounds with potent antioxidant capacity, cholesterol reduction, diabetes type-2 prevention and a reduction in the risk of heart disease (11). Some plant species, such as *Physalis angulata*, *Thyphonium flagelliforme*, *Curcuma zedoaria*, *Garcinia mangostana*, *Andrographis paniculata*, *Annona muricata* and *Boesenbergia rotunda*, have been identified with potent anticarcinogenic properties (12). As biodiversity has been accepted as the basis for maintaining ecosystem stability and human wellbeing (13), reports on biodiversity loss during urban development have been previously reported as its trigger habitat conversion, degradation and species extinction (14). However, careful planning and including the local species in urban planning is one of the ways to protect biodiversity. Thus, it is then necessary to study local plants that shape the environment in Bireuen Regency these days. Moreover, reports on climate change affecting plant availability have begun to appear (15), weighing more on the importance of the study on local plant species.

Underutilized plants are often identified as minor or neglected plants, but they are of high importance due to their sustainability, local availability and cultural importance (16). Despite the high biodiversity of Bireuen regency, there is still limited data available on its plant

species. Previous studies (17, 18) have reported the polyphenol, carotenoid profiles and biological activities of several citrus species sampled from Bireuen regency and the results highlighted that the citrus fruits in Aceh were comparable to those found in other parts of the world. Therefore, it is hypothesized that other plant species will exhibit similar results. This makes it necessary to study the potential of locally used plants and establish comprehensive documentation of these plants based on their use. Moreover, unfavorable climate change and human activities pose greater danger to natural vegetation around the planet than ever before. Although human knowledge has made the vegetation change to climate compensated by human agriculture activities (19), the effect of the loss of biodiversity is far greater. A previous study estimated that 15-37 % of the tropics will be "committed to extinction" by 2050 (20). Thus, preserving our current knowledge is highly important. Therefore, this study aimed to identify and document underutilized plants that were often used for medicinal, consumption and traditional ceremonial purposes by the local community in Bireuen regency.

## Materials and Methods

### Site Description

The study sites were selected based on the location of the villages from the center of public activities and encompass 17 districts of Bireuen Regency (5° 12' 5.0040" N and 96° 42' 9.5184" E). All sites were located at an elevation of 0-300 m asl, with annual rainfall generally >80 mm/year, as presented in Fig. 1.

### Data Collection

Field surveys were undertaken from July to December 2022. An informed consent was obtained from the respondents before the interview. The interview was carried out using an open-ended questionnaire, encompassing aspects of the use of local plants for common medicinal purposes in households, fruit consumption and traditional ceremonies. A purposive sampling technique was used to interview 70 respondents based on the following criteria: age > 60 years, local residents for more than 10 years, had a good knowledge of tradition and the use of plants in daily life as well as various traditional celebrations. Subsequently, the identity of the local plants mentioned was verified by the residents. Plant samples were documented, while for the unidentified species, herbarium samples were prepared and sent to the Herbarium facility, Laboratory of Science and Mathematics, Universitas Almuslim.

### Data Analysis

The data obtained from this study on the use of indigenous plants were analyzed with ethnobotanical quantitative indices, including Relative Frequency of Citation (RFC), Use Value (UV) and Informant Consensus Factor (ICF).

**Relative frequency of citation (RFC).** RFC is the number of citations of given plants on certain use reported by

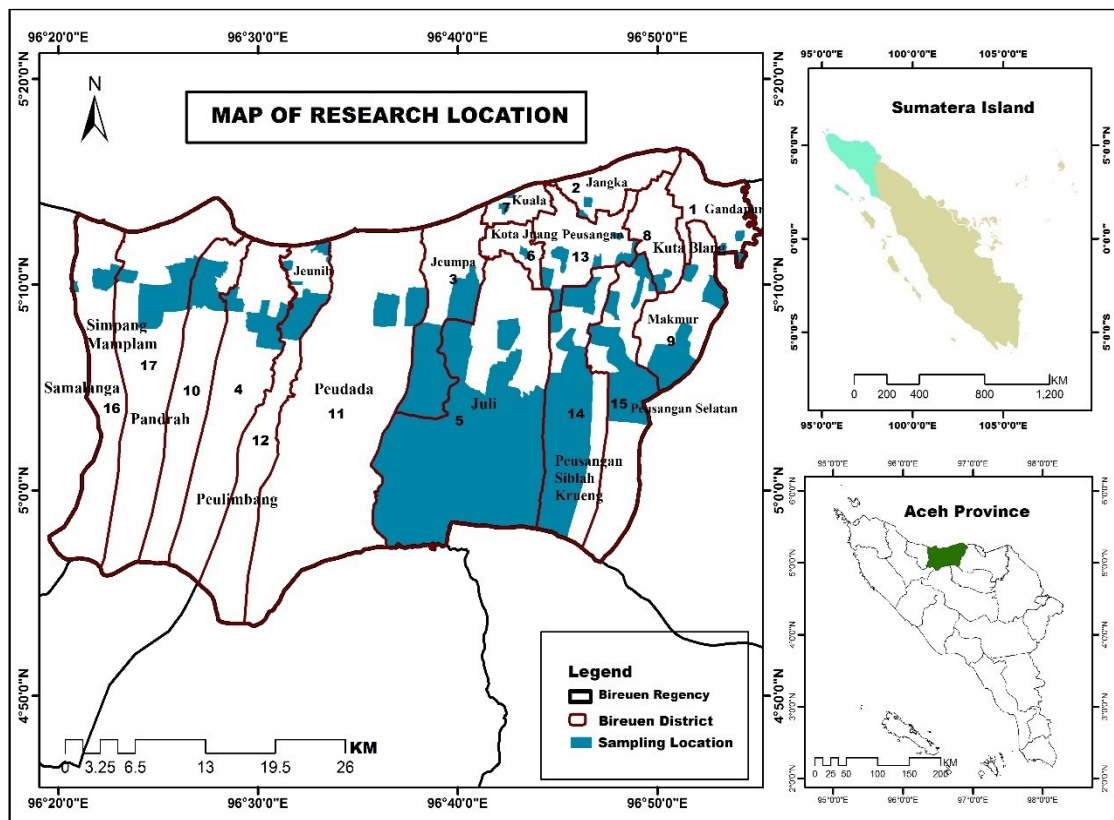


Fig. 1. Sampling location in 17 subdistricts of Bireuen Regency, Aceh, Indonesia.

informants. This value reflects the importance of certain species of plants over others with the same use report. The RFC value is calculated using the equation below (21):

$$RFC = FC/N \quad (0 < RFC < 1)$$

where FC is the number of times informants cited a species of plants for a certain use and N is the number of informants who participated in the study.

**Use value (UV).** UV shows the comparative importance of particular species of plants informed by informants. UV is calculated using the formula expressed below (22):

$$UV = \sum U/n$$

where U is the number of uses reported by informants for a given species of plants and n is the number of informants.

**Informant consensus factor (ICF).** ICF is a reflection of the homogeneity of local knowledge on the use of indigenous plants in their area. ICF is calculated with the formula:

$$ICF = (Nur - Nt) / (Nur - 1)$$

where Nur is the number of uses cited by informants for a particular use category and Nt is the number of taxa of plants reported in a particular use category by all informants. The ICF value ranges from 0 to 1, with a value closer to one indicating a high homogeneity of consensus amongst the informants (23).

### Statistical Analysis

Relative Frequency of Citation (RFC) and Use Value (UV) were subjected to statistical analysis using Pearson Correlation with SPSS (Statistical Package for the Social Sciences) software version 25 to determine the linearity relationship of the two indices, which are relative frequency of citation and use of value.

## Results

Results of use of plants used commonly in Bireuen Regency are presented in Table 1. Familia Anacardiaceae, Annonaceae, Rutaceae and Zingiberaceae represented families dominantly utilized as medicine, consumed as fruit and in traditional ceremonies compared to other plant species. Those families are native to tropical regions; thus, the dominant presence is expected. But the composition is different and forms the richness of an ecosystem.

### Use of Local Plants as Traditional Medicine

The use of local plants as traditional medicine had the highest number of citations, with 32 families and 47 species of plants, as shown in Table 2. Most of the plants were used as a daily remedy for various mild conditions. For external use, most plants were crushed using mortar and pestle (*Cananga odorata*, *Anredera cordifolia*, *Myristica fragrans*, *Magnolia champaca*, *Ceiba pentandra*, *Moringa oleifera*, *Jasminum sambac*) or rubbed to release the valuable juice inside (*Calotropis gigantea*, *Plumeria acuminata*, *Citrus hystrix*, *C. aurantiifolia*). Meanwhile, for internal use, plants were dried or freshly boiled and the filtered solution was drunk (*A. paniculata*, *Lannea coromandelica*, *Annona muricata*, *Centella asiatica*, *Orthosiphon stamineus*, *Caesalpinia pulcherrima*, *Lawsonia inermis*, *Syzygium polyanthum*, *S. cumini*, *Pandanus amaryllifolius*, *Manilkara kauki*, *Phaleria macrocarpa*, *Curcuma longa*, *C. xanthorrhiza*); directly juiced and drunk (*Morinda citrifolia*, *Apium graveolens*, *Abrus precatorius*, *Zingiber officinale*); or directly eaten (*Arecha catechu*, *Citrus grandis*, *Dioscorea hispida*, *Lepisanthes rubiginosa*,

**Table 1.** Family, scientific name, common name and local use of plant species used by community in Bireuen regency, Aceh Province, Indonesia (A=Aceh language, Ind.=Indonesian language).

No	Family	Scientific Name	Common name	Local Use
1	Acanthaceae	<i>Andrographis paniculata</i> Nees	Sambiloto (Ind.), green chiretta	
2	Anacardiaceae	<i>Lannea coromandelica</i> Merr.	kuda-kuda (A), Kedondong pagar (I), Indian ash tree	
3	Annonaceae	<i>Annona muricata</i> L.	boh nokna (A), sirsak (Ind.), soursop	
4	Apiaceae	<i>Apium graveolens</i> L. <i>Centella asiatica</i> Urban	oen sop (A), daun sop (Ind.), celery oen pegaga (A.), pegagan (Ind.), Asiatic pennywort	
5	Apocynaceae	<i>Calotropis gigantea</i> Dryand. <i>Plumeria rubra</i> L.	bak reubeek (A), widuri (Ind.), crown flower Jeumpa kebiru (A), kamboja (Ind.), frangipani	
6	Arecaceae	<i>Areca catechu</i> L.	pineung (A), pinang (Ind.), betel nut	
7	Asparagaceae	<i>Ornithogalum umbellatum</i> L.	bak katarak (A), bintang matahari (Ind.), star of Bethlehem	
8	Asphodelaceae	<i>Aloe vera</i> Burm.f.	lidah buaya (Ind.), aloe	
9	Asteraceae	<i>Chromolaena odorata</i> RM. King & H. Rob.	barakacida, seurapoh atos (A), babandotan (Ind.), Jack in the bush	
10	Basellaceae	<i>Anredera cordifolia</i> Steenis	binahong (Ind.), Madeira vine	
11	Cucurbitaceae	<i>Coccinia grandis</i> Voigt.	timun tikus (Ind.), kowai fruit	
12	Dioscoreaceae	<i>Dioscorea hispida</i> Dennst.	gadong (A), gadung (Ind.), Indian three-leaved yam	
13	Euphorbiaceae	<i>Jatropha curcas</i> L. <i>Jatropha multifida</i> L.	jarak (Ind.), castor oil plant betadin (A), jarak tintir (Ind.), coral plant	
14	Fabaceae	<i>Abrus precatorius</i> L. <i>Caesalpinia pulcherrima</i> Sw.	saga (A, Ind.), rosary pea kembang merak (A, Ind.), peacock flower	
15	Lamiaceae	<i>Orthosiphon stamineus</i> Benth.	kumis kucing (Ind.), cat whisker's, java tea	
16	Lythraceae	<i>Lawsonia inermis</i> L.	oen gaca (A), daun pacar (Ind.), henna	
17	Magnoliaceae	<i>Magnolia champaca</i> Baill. ex Pierre	jeumpa kuneng (A), cempaka kuning (Ind.), champak	Traditional medicine
18	Malvaceae	<i>Ceiba pentandra</i> Gaertn.	panjoe (A), kapuk (Ind.), kapok	
19	Moringaceae	<i>Moringa oleifera</i> Lam. <i>Myristica fragrans</i> Houtt.	murong (A), kelor(I), moringa pala (A, Ind.), nutmeg	
20	Myrtaceae	<i>Syzygium cumini</i> Skeels. <i>Syzygium polyanthum</i> Walp.	jamblang (A), duwet (I), java plum oen salam (A), daun salam (I), Indonesian bay leaf	
21	Oleaceae	<i>Jasminum sambac</i> Aiton	melati (A, Ind.), jasmine	
22	Pandanaceae	<i>Pandanus amaryllifolius</i> Roxb. <i>Piper betle</i> L. <i>Piper nigrum</i> L.	oen seukee (A), pandan (Ind.), pandan ranup (A.), sirih (Ind.), betel lada (A.), merica (Ind.), pepper	
23	Piperaceae	<i>Piper ornatum</i> N.E. Br. <i>Piper retrofractum</i> Vahl.	ranup mirah (A.), sirih merah (A, Ind.), Celebes pepper cabe jawa (Ind.), Balinese long pepper	
24	Poaceae	<i>Cymbopogon citratus</i> Stapf. <i>Saccharum officinarum</i> L.	rheu (A.), serai (Ind.), lemon grass teubee (A), tebu (Ind.), sugarcane	
25	Polypodiaceae	<i>Pyrossia piloselloides</i> MG. Price	sisik naga (A, Ind.), dragon scales	
26	Rubiaceae	<i>Morinda citrifolia</i> L.	keumudee (A), mengkudu (Ind.), vomit fruit	
27	Rutaceae	<i>Citrus aurantiifolia</i> Swingle <i>Citrus hystrix</i> DC.	boh kuyuen (A), jeruk nipis (Ind.), lime kruet (A), jeruk purut (Ind.), kaffir lime	
28	Sapindaceae	<i>Lepisanthes rubiginosa</i> Leenh.	keulayu (A), kelayu, boni (Ind.)	
29	Sapotaceae	<i>Manilkara zapota</i> P. Royen	sa'oh (A), sawo (Ind.), sapota	
30	Solanaceae	<i>Solanum torvum</i> Sw.	Trung cawieng (A), rimbang, takokak (Ind.), pea eggplant	
31	Thymellaceae	<i>Phaleria macrocarpa</i> Boerl. <i>Alpinia galanga</i> Willd. <i>Curcuma longa</i> L.	Mahkota dewa (A, Ind.), God's crown lengkuas (Ind.), galangal kunyet (A.), kunyit (Ind.), turmeric	
32	Zingiberaceae	<i>Curcuma xanthorrhiza</i> Roxb. <i>Kaempferia galanga</i> L. <i>Zingiber officinale</i> Roscoe.	temulawak (Ind.), javanese turmeric ceko (A.), kencur, cekur (Ind.) jahe (A, Ind.), ginger	

		<i>Anacardium occidentale</i> L.	jambe hana malee (A), Jambu monyet (I), Cashew	
1	Anacardiaceae	<i>Mangifera foetida</i> Lour.	mancang (A, Ind.), bachang	
		<i>Mangifera odorata</i> Griff.	Kuweni (Ind.), Saipan mango	
		<i>Mangifera quadrifida</i> Jack ex Wall.	Kumbang	
		<i>Annona squamosa</i> L.	asoekaya (A), srikaya (Ind.), sweetsops	
2	Annonaceae	<i>Polyalthia littoralis</i> Boerl	kayee kunyet (A.), kunyit hutan	
		<i>Uvaria siamensis</i> L.L. Zhou,Y.C.F. Su & RMK Saunders	brahim; kucimi, sambua (A),	
3	Apocynaceae	<i>Carissa carandas</i> L.	buah renda (Ind.), carandas plum	
4	Areceae	<i>Borassus flabellifer</i> L.	lontar (Ind.), lontar palm	
5	Malvaceae	<i>Grewia tiliifolia</i> Vahl	teumereu (A), Phalsa	
6	Meliaceae	<i>Sandoricum koetjape</i> Merr.	sentui (A), sentul (Ind.), cotton fruit	Consumption (as food/table fruit)
7	Myrtaceae	<i>Syzygium cumini</i> Skeels.	jamblang (A), duwet (I), java plum	
8	Oxalidaceae	<i>Averrhoa bilimbi</i> L.	boh limeng (A), belimbing sayur (Ind.), bilimbi, cucumber tree	
9	Phyllantaceae	<i>Phyllanthus acidus</i> Skeels.	boh limeng meulati (A), cermai (Ind.), gooseberry	
		<i>Citrus aurantium</i> L.	mentui (A)	
		<i>Citrus aurantium</i> L.	calung (A)	
10	Rutaceae	<i>Citrus aurantium</i> L.	makin (A)	
		<i>Citrus aurantium</i> L.	kruet mameh (A), jeruk purut manis	
		<i>Citrus hystrix</i> DC.	kruet (A), jeruk purut (Ind.), kaffir lime	
11	Sapindaceae	<i>Lepisanthes rubiginosa</i> Leenh.	keulayu (A), kelayu, boni (Ind.)	
12	Sapotaceae	<i>Manilkara zapota</i> P. Royen	sa'oh (A), sawo (Ind.), sapota	
1	Amaranthaceae	<i>Aerva lanata</i> Juss. ex Schult.	Manek manoe (A), pokok batu karang, pokok muntah kucing (Ind.), mountain knotgrass	
2	Annonaceae	<i>Cananga odorata</i> Hook.f. & Thomson	seulanga (A), kenanga (Ind.), ylang-ylang	
3	Araceae	<i>Alocasia plumbea</i> Van Houtte	on leubue (A), keladi(Ind), elephant ear	
4	Arecaceae	<i>Areca catechu</i> L.	pineung (A), pinang (Ind.), betel nut	
5	Crassulaceae	<i>Kalanchoe pinnata</i> L.	bak seunijuek (A), cocor bebek (Ind.), Goethe plant	
6	Cyperaceae	<i>Cyperus</i> sp.	naleung fambo (A.), teki (Ind.), sedge	
7	Euphorbiaceae	<i>Jatropha curcas</i> L.	jarak (Ind.), castor oil plant	
8	Lamiaceae	<i>Pogostemon cablin</i> Benth.	nilam (A, Ind.) ; patchouli	Traditional ceremonies
9	Lythreaceae	<i>Lawsonia inermis</i> L.	oen gaca (A), daun pacar (Ind.), henna	
10	Marantaceae	<i>Calathea</i> sp.	daun ekor ayam (Ind.), prayer plant	
11	Oleaceae	<i>Jasminum sambac</i> Aiton	melati (A, Ind.), jasmine	
12	Pandanaceae	<i>Pandanus amaryllifolius</i> Roxb.	oen seukee (A), pandan (Ind.), pandan	
13	Poaceae	<i>Cymbopogon citratus</i> Stapf.	rheu (A.), serai (Ind.), lemon grass	
		<i>Cynodon dactylon</i> Pers.	naleung samboe (A), rumput Bermuda (Ind.), Bermuda grass	
		<i>Oryza sativa</i> L.	padee (A), padi(I), rice	
14	Rubiaceae	<i>Gardenia jasminoides</i> J. Ellis	kaca piring (Ind.),gardenia	
15	Rutaceae	<i>Citrus hystrix</i> DC.	kruet (A), jeruk purut (Ind.), kaffir lime	



**Table 2.** Scientific name, RFC (relative frequency of citation) and UV (use value) of local plants use as traditional medicine, consumption and in traditional ceremonies in Bireuen Regency, Aceh Province, Indonesia.

No	Scientific Name	RFC	UV	Use in consumption (as food/table fruit)	
<b>Use as traditional medicine</b>					
1	<i>Andrographis paniculata</i>	0.06	0.03	1	<i>Anacardium occidentale</i>
2	<i>Lannea coromandelica</i>	0.1	0.03	2	<i>Mangifera foetida</i>
3	<i>Annona muricata</i>	0.32	0.06	3	<i>Mangifera odorata</i>
4	<i>Apium graveolens</i>	0.06	0.06	4	<i>Mangifera quadrifida</i>
5	<i>Centella asiatica</i>	0.16	0.06	5	<i>Annona squamosa</i>
6	<i>Calotropis gigantea</i>	0.06	0.03	6	<i>Polyalthia littoralis</i>
7	<i>Plumeria rubra</i>	0.03	0.03	7	<i>Uvaria siamensis</i>
8	<i>Arecha catechu</i>	0.1	0.1	8	<i>Carissa carandas</i>
9	<i>Ornithogalum umbellatum</i>	0.06	0.03	9	<i>Borassus flabellifer</i>
10	<i>Aloe vera</i>	0.16	0.06	10	<i>Grewia tiliifolia</i>
11	<i>Chromolaena odorata</i>	0.1	0.06	11	<i>Sandoricum koetjape</i>
12	<i>Anredera cordifolia</i>	0.06	0.03	12	<i>Syzygium cumini</i>
13	<i>Coccinia grandis</i>	0.06	0.06	13	<i>Averrhoa bilimbi</i>
14	<i>Dioscorea hispida</i>	0.1	0.06	14	<i>Phyllanthus acidus</i>
15	<i>Jatropha curcas</i>	0.16	0.06	15	<i>Citrus aurantium</i>
16	<i>Jatropha multifida</i>	0.23	0.03	16	<i>Citrus aurantium</i>
17	<i>Abrus precatorius</i>	0.03	0.03	17	<i>Citrus aurantium</i>
18	<i>Caesalpinia pulcherrima</i>	0.1	0.06	18	<i>Citrus aurantium</i>
19	<i>Orthosiphon stamineus</i>	0.1	0.03	19	<i>Citrus hystrix</i>
20	<i>Lawsonia inermis</i>	0.06	0.06	20	<i>Lepisanthes rubiginosa</i>
21	<i>Magnolia champaca</i>	0.03	0.03	21	<i>Manilkara kauki</i>
22	<i>Ceiba pentandra</i>	0.19	0.06	<b>Use in traditional ceremonies</b>	
23	<i>Moringa oleifera</i>	0.29	0.06	1	<i>Cananga odorata</i>
24	<i>Myristica fragrans</i>	0.1	0.03	2	<i>Areca catechu</i>
25	<i>Syzygium cumini</i>	0.03	0.06	3	<i>Alocasia plumbea</i>
26	<i>Syzygium polyanthum</i>			4	<i>Aerva lanata</i>
27	<i>Jasminum sambac</i>	0.03	0.1	5	<i>Kalanchoe pinnata</i>
28	<i>Pandanus amaryllifolius</i>	0.13	0.13	6	<i>Cyperus sp.</i>
29	<i>Piper betle</i>	0.26	0.1	7	<i>Jatropha curcas</i>
30	<i>Piper nigrum</i>	0.03	0.06	8	<i>Lawsonia inermis</i>
31	<i>Piper ornatum</i>	0.06	0.1	9	<i>Pogostemon cablin</i>
32	<i>Piper retrofractum</i>	0.03	0.03	10	<i>Calathea sp.</i>
33	<i>Cymbopogon citratus</i>	0.1	0.1	11	<i>Jasminum sambac</i>
34	<i>Sachharum officinarum</i>	0.03	0.06	12	<i>Pandanus amaryllifolius</i>
35	<i>Pyrossia piloselloides</i>	0.06	0.03	13	<i>Cymbopogon citratus</i>
36	<i>Morinda citrifolia</i>	0.16	0.06	14	<i>Cynodon dactylon</i>
37	<i>Citrus aurantiifolia</i>	0.06	0.06	15	<i>Oryza sativa</i>
38	<i>Citrus hystrix</i>	0.1	0.1	16	<i>Gardenia jasminoides</i>
39	<i>Lepisanthes rubiginosa</i>	0.03	0.06	17	<i>Citrus hystrix</i>
40	<i>Manilkara zapota</i>	0.06	0.06		
41	<i>Solanum torvum</i>	0.1	0.03		
42	<i>Phaleria macrocarpa</i>	0.03	0.03		
43	<i>Alpinia galanga</i>	0.1	0.06		
44	<i>Curcuma longa</i>	0.13	0.1		
45	<i>Curcuma xanthorrhiza</i>	0.06	0.03		
46	<i>Kaempferia galanga</i>	0.03	0.03		
47	<i>Zingiber officinale</i>	0.1	0.1		

*Solanum torvum*).

The number of reports for the use of each plant varied significantly based on their importance. To determine this level of importance, RFC was used and the range showed a value of 0.03 - 0.32. Plants with the highest RFC were *A. muricata*, followed by *M. oleifera* and *Piper betle*, with values of 0.32, 0.29 and 0.26 respectively (Table 3). Measurement of UV showed a range of 0.03 - 0.13, where *P. amaryllifolius* had the highest UV of 0.13. Pearson's correlation analysis showed a positive linear relationship ( $r^2 = 0.24$ ) between RFC and UV, with no significant

variation observed ( $p = 0.10$ ).

### Underutilized Fruits for Consumption

The local use of plants for consumption nowadays was found to be quite similar in Indonesia. Therefore, this study focused more on fruit plants that were commonly consumed and were widely available but nowadays not commonly found in the community. Some plant samples are presented in Fig. 2. The results showed that there were 21 plants species, as presented in Table 2. These plants showed significantly varied importance, as identified from RFC, that ranged from 0.03 to 0.35. *Lepisanthes rubiginosa* had the highest RFC value of 0.35, followed by 2 of the *Citrus* species, *Kruet mameh* (Rutaceae) and *Rheng* (Rutaceae) with values of 0.26 and 0.23 respectively (Table 3). UV for plants in this category ranged from 0.03 to 0.10 and there was a positive linear relationship between UV and RFC with a Pearson correlation value of ( $r^2 = 0.14$ ), while no significant variation was observed between them ( $p = 0.56$ ).

### Use of Plants in Traditional Ceremonies (15 Familia 17 Species)

Traditional ceremonies such as pregnancy, childbirth, marriage and *khatan* (male circumcision) held by Aceh people were unique and revolved around special occasions in life or marks upon reaching certain milestones. In all these ceremonies, the use of plants was important and often represented symbolic means, as presented in Table 3.

Plants that were often used by Aceh people in various local ceremonies comprised a lesser amount of taxa compared to the other 2 categories. However, these plants held the highest importance, as shown by the RFC value, which ranged from 0.03 to 0.55. The highest RFC of

0.55 was obtained from *Cynodon dactylon*, locally known as *naleung sambo*, followed by *A. catechu* with a value of 0.35 and *Kalanchoe pinnata* and *Pogostemon cablin* with RFCs of 0.32. The UV value for plants recorded in this category ranged from 0.03 to 0.13, where *P. amaryllifolius* had the highest value. Correlation analysis between RFC and UV exhibited a negative linear relationship ( $r^2 = -0.06$ ) with no significant difference ( $p = 0.83$ ), as indicated by the result of Pearson product-moment of correlation.

### Diversity of Indigenous Plants in Bireuen Regency

A total of 70 respondents, encompassing residents from 17 districts in Bireuen Regency, were interviewed to document and identify the use of 75 plant species in the daily lives of Aceh people. These plants were classified into 3 main categories based on the reported use, namely traditional medicine, food and traditional ceremonies. The number of plant species reported in each category along with their ICF values is shown in Table 4.

ICF was calculated to determine the level of agreement among informants on the use of indigenous plants. All plants recorded in this study were grouped into 3 categories, which included those used as traditional medicine, food and part of customary traditional ceremonies. ICF values recorded ranged from 0.68 to 0.85, with the highest consensus value of 0.85 observed on plants used as part of traditional ceremonies, followed by plants consumed as food and medicine with values of 0.84 and 0.68 respectively. The high consensus values obtained for consumption and traditional ceremonies, namely 0.84 and 0.85, showed that these indigenous plants played a very important role as a source of food and part of an effort to preserve tradition.



**Fig. 2.** Some plant species used as fruit consumption A. *Grewia tiliifolia*, B. *Lepisanthes rubiginosa*, C. *Polyalthia littoralis*, D. *Uvaria siamensis*.

**Table 3.** Scientific name and local use of plant species used by community in Bireuen regency, Aceh Province, Indonesia.

No	Scientific Name	Local Use
1	<i>Abrus precatorius</i>	Cough remedy (leaves are pounded, the juice is drunk directly)
2	<i>Aerva lanata</i>	In traditional ceremonies
3	<i>Alocasia plumbea</i>	Use in traditional ceremonies
4	<i>Aloe vera</i>	Treatment of various skin conditions (the gel from the leaves apply directly to the wound)
5	<i>Alpinia galanga</i>	Ringworm treatment (Sliced rhizome applied directly to the affected skin)
6	<i>Anacardium occidentale</i>	Mature cashew apple was eaten directly for its fresh taste
7	<i>Andrographis paniculata</i>	Antipyretic activity (leaves are dried, boiled with water, and drank)
8	<i>Annona muricata</i>	Asthma, rheumatics, asam urat, high blood pressure; fever remedies (leaves are dried, boiled with water, and drank; mature fruits are consumed fresh; leaves poultice applied to reduce fever)
9	<i>Annona squamosa</i>	Ripe fruit eaten directly
10	<i>Anredera cordifolia</i>	Burn skin treatment, acne treatment (Leaves pounded or crushed, applied directly to the affected area)
11	<i>Apium graveolens</i>	High blood pressure treatment (stem and leaves are juice and drink)
12	<i>Areca catechu</i>	Vitality (young fruits consumed or drunk as juice)
13	<i>Averrhoa bilimbi</i>	Ripe fruit were used as components in cooking, or processed as asam sunti (sun dried bilimbi)
14	<i>Borassus flabellifer</i>	Ripe fruit eaten directly
15	<i>Caesalpinia pulcherrima</i>	Cough remedy (leaves and flowers are pounded, filtered, and drunk)
16	<i>Calathea</i> sp.	Used in traditional ceremonies
17	<i>Calotropis gigantea</i>	Wart treatment (the sap of plants applied to the wart, until it eventually falls off)
18	<i>Cananga odorata</i>	Used in traditional ceremonies
19	<i>Carissa carandas</i>	Ripe fruit eaten directly
20	<i>Ceiba pentandra</i>	Antipyretic activity (leaves are pounded and applied to the whole skin body surface to reduce the fever)
21	<i>Centella asiatica</i>	Scar removal, lowering blood cholesterol (boiled water from stem and leaves is drunk)
22	<i>Chromolaena odorata</i>	Skin wound remedy, bone fracture treatment (leaves pounded or crushed, applied directly to the affected area)
23	<i>Citrus aurantiifolia</i>	Dandruff, cough (Fruits and sliced and apply to head skin to treat dandruff, fruit juice is drunk to treat cough)
24	<i>Citrus aurantium</i>	Ripe fruit used in preparation of seafood
25	<i>Citrus aurantium</i>	Ripe fruit used in preparation of seafood
26	<i>Citrus aurantium</i>	Ripe fruit used in preparation of seafood
27	<i>Citrus aurantium</i>	Ripe fruit eaten directly
28	<i>Citrus hystrix</i>	Dandruff, cough (Fruits are sliced and applied to head skin to treat dandruff, fruit juice is drunk to treat cough)
29	<i>Coccinia grandis</i>	Lowering blood sugar (Fresh fruit is eaten to lower blood glucose)
30	<i>Curcuma longa</i>	Gastric problems, wound (Turmeric rhizomes are mashed, boiled with water and palm sugar to reduce the bitterness, and drank, pounded turmeric is applied to the wound to treat and reduce inflammation and infection)
31	<i>Curcuma xanthorrhiza</i>	Gastric problems (Rhizomes boiled with water, and drank)
32	<i>Cymbopogon citratus</i>	Lowering blood cholesterol (Stem is boiled and drank)
33	<i>Cynodon dactylon</i>	Used in traditional ceremonies
34	<i>Cyperus</i> sp.	Used in traditional ceremonies
35	<i>Dioscorea hispida</i>	Heart disease (Tuber is eaten raw or boiled)
36	<i>Gardenia jasminoides</i>	Used in traditional ceremonies
37	<i>Grewia tiliifolia</i>	Ripe fruit eaten directly
38	<i>Jasminum sambac</i>	Antipyretic activity (leaves are pounded and applied to the whole skin body surface to reduce the fever)
39	<i>Jatropha curcas</i>	Diarrhea, toothache remedies (the sap of plants is applied directly to the ached tooth, sap is diluted to water to treat diarrhea)
40	<i>Jatropha multifida</i>	Skin wound treatment (the sap of plants applied directly to the wounded area)
41	<i>Kaempferia galanga</i>	Cough remedy (fresh leaves juiced and drink fresh )
42	<i>Kalanchoe pinnata</i>	Used in traditional ceremonies
43	<i>Lannea coromandelica</i>	Lowering cholesterol (leaves are dried, boiled with water, and drank)
44	<i>Lawsonia inermis</i>	Alleviate gastric problems, wound healer (leaves are boiled and drank to reduce gastric pain, leaves are pounded and applied to the skin area to treat wounds)
45	<i>Lepisanthes rubiginosa</i>	Diarrhea remedy (young fruits consumed or drunk as juice); ripe fruit eaten directly
46	<i>Magnolia champaca</i>	Antipyretic activity (leaves are pounded and applied to the whole skin body surface to reduce the fever)
47	<i>Mangifera foetida</i>	Ripe fruit eaten directly
48	<i>Mangifera odorata</i>	Ripe fruit eaten directly
49	<i>Mangifera quadrifida</i>	Ripe fruit is used as one of the components for making <i>rujak</i> sauce (local fruit salad)
50	<i>Manilkara zapota</i>	Diarrhea remedy (leaves boiled and drank)



51	<i>Morinda citrifolia</i>	Diabetes mellitus treatment (fruits are juiced and drank)
52	<i>Moringa oleifera</i>	Stomach ache treatment (leaves pounded and applied directly to the stomach area)
53	<i>Myristica fragrans</i>	Treatment of bruises (seeds poultice applied directly to bruises)
54	<i>Ornithogalum umbellatum</i>	Eye disease remedy (the sap of plants applied directly to the eye)
55	<i>Orthosiphon stamineus</i>	Treatment of diabetes mellitus, kidney stones (stem, leaves, and flower boiled and drank)
56	<i>Oryza sativa</i>	Used in traditional ceremonies
57	<i>Pandanus amaryllifolius</i>	Lowering cholesterol level and high blood pressure (leaves are boiled and drank)
58	<i>Phaleria macrocarpa</i>	Treatment of rheumatics, diabetes mellitus (fruits dried, boiled with water, and drank)
59	<i>Phyllanthus acidus</i>	Ripe fruit eaten directly or processed as candied fruits
60	<i>Piper betle</i>	Antiemetic activity (leaves are boiled and drank)
61	<i>Piper nigrum</i>	Cough remedy (seeds crushed, mixed with pounded ginger, and drink)
62	<i>Piper ornatum</i>	Antiemetic activity (leaves are boiled and drank)
63	<i>Piper retrofractum</i>	Toothache treatment (leaves are boiled, concoction water then used to gargle)
64	<i>Plumeria rubra</i>	Wound treatment (the sap of plants applied directly to the wound)
65	<i>Pogostemon cablin</i>	Used in traditional ceremonies
66	<i>Polyalthia littoralis</i>	Ripe fruit eaten directly
67	<i>Pyrossia piloselloides</i>	Treatment of cough, jaundice, constipation (leaves boiled and drank)
68	<i>Saccharum officinarum</i>	Kidney stones treatment (stem water is squeezed and drink)
69	<i>Sandoricum koetjape</i>	Ripe fruit eaten directly or processed as candied fruits
70	<i>Solanum torvum</i>	Eye treatment for better vision (fresh fruit eaten directly )
71	<i>Syzygium cumini</i>	Diarrhea remedy (leaves are boiled and drank)
72	<i>Syzygium polyanthum</i>	Cholesterol, cancer treatments (leaves are boiled and drank)
73	<i>Uvaria siamensis</i>	Ripe fruit eaten directly
74	<i>Zingiber officinale</i>	Cough treatment; antiemetic activity (pounded, drink; used as herbal tea)

**Table 4.** ICF value of plant species used locally in community in Bireuen regency, Aceh Province.

No	Category of use	Nur	Nt	ICF
1	Traditional medicine	145	47	0.68
2	Consumption	127	21	0.84
3	Traditional ceremonies	109	17	0.85

## Discussion

Straightforward methods were employed in traditional preparations of traditional medicine, such as crushing and boiling. By crushing, the integrities of plant cells were compromised, leading to the destruction of the cytoplasm and vacuoles, thereby releasing the content of the cells to the surrounding. Many beneficial compounds stored inside the cells were released and came into contact with skin or any surface under various conditions. After examining plant lists carefully, it was assumed that many of the plants used superficially had antibacterial, antiviral and anti-inflammatory activities. For example, *A. paniculata* (24) was reported to exhibit anti-inflammatory, antiviral and antioxidant properties, while *L. coromandelica* exhibited potent antinociception activity, which was used in Ayurvedic herbals (25). Boiling of leaves in water, also called hot water extraction methods, has been reported to primarily extract polar compounds from the water. Heating of the cell plants was also found to disrupt the cell wall integrity and release beneficial compounds to the water surrounding the leaves. Subsequently, the compounds immersed in the extraction water were ingested and affected the gastrointestinal systems. Generally, boiling as an extraction method had little or no effect on the active components of plants. According to one report, boiling tended to exhibit better bioactivities than those of freshly consumed plants (26). This made boiling second-best to the steaming method since it helped to release more active compounds from cell storage. Moreover, compounds such as phenolic might

pass through a change of oxidation state when exposed to heat, which can contribute to their enhanced antioxidant activity (27). Most of the internal medicine reported in this study were on ailments, which were common in Indonesia. Based on previous reports, Indonesia was found to be the only Southeast Asian country among the top 10 list of the highest diabetic countries in the world. Several plants that were used as home remedies for diabetic treatment by locals included *A. muricata* and *O. stamineus*. A previous study also revealed that *A. muricata* exhibited  $\alpha$ -amylase inhibition and anti-glycation activity, which indicated an antidiabetic property (28). Similarly, *O. stamineus* also showed antidiabetic properties, but with different mechanisms for lowering blood glucose levels (29). Apart from internally used medicine, several local plants were also applied topically to treat certain ailments caused by the infestation of fungus or bacteria. In this case, it was customary to use *Citrus* sp. fruit slices directly on the scalp to get rid of dandruff. Furthermore, Rutaceae such as *C. hystrix* inhibited the growth of *Malassezia*, which was the main cause of dandruff (30). Even though plant species are often considered safe by general public opinion many studies have been undertaken to assess the efficacy of various plant species. *P. betle* topical use and ingestion are considered to be relatively safe (31), which generally pointed out its safety to use on various daily applications. On the contrary, even though *A. muricata*'s wide application and extensive reports of benefits have been previously reported (32), the toxicology effect on its acetogenins and alkaloids contents showed potentiate on inducing neural damage (33) resulting in Parkinson like symptoms. Reports on the safety concerns of ingestion of *A. catechu* resulted in the occurrence of oral cancer and oesophageal cancer, along with cytotoxic effects that were reported towards normal human cells (34). *C. odorata* flowers showed higher toxicity compared to the leaves, which are more commonly used as medicine (35).

Moreover, ingestion of *Cananga odorata* extract has been linked with kidney function in rats (36).

Anacardiaceae, a rich family of 600-850 species, is a plant family in which the fruit parts were edible and widely favorable and was found to be widely distributed in tropical and subtropical regions (37, 38). Kumpang, which was used in the preparation of rujak was well-known in Aceh province and the Malay peninsula (39) and had been reported as endemic (40). There were also 2 species of Annonaceae found in Bireuen, namely *buah brahim* (*Uvaria siamensis*) and *kayee kunyet* (*Polyalthia littoralis*). In the past, these shrubs which were 1-2 m tall, were commonly found in yards and gardens. When they grew wildly, plants were left to bear fruits, which were loved by many. The study on the biological properties of *Buah brahim*, bearing yellow and sweet-sour fruits, had not been investigated in Aceh. Although the presence of the Asia Pacific Region was reported (41) and its biological properties (42, 43). Several studies have highlighted the various benefits of *Uvaria*, which only included its potential as a good source of diet. The presence of *P. littoralis* (*kayee kunyet*) was also not reported in Bireuen but in Ketambe, Gunung Leuser (44). The vibrant red color of the fruit made it an excellent source of beneficial compounds to explore, such as carotenoids, anthocyanins or polyphenols. There was no previous report on the presence of *Grewia tiliifolia* (*temeureu*) in Bireuen, but the species had been identified in other parts of Aceh (4). In Bireuen, mature fruits of *temeureu* were consumed fresh by children and as snacks in the old times. It was discovered that the species had medicinal properties for the treatment of diabetes, typhoid, hepatitis, diarrhea, dyspepsia, smallpox, ulcers and eczema. The fruits were also reported to be an excellent source of ascorbic acid, fibers and proteins as well as micro and macronutrients (45). Another fruit that was often consumed fresh was *L. rubiginosa* (*Buah klayu*), with a sweet taste after ripe. Various parts of plants had been found to exhibit different bioactivities and the fruits were rich in components that can act as antioxidants and antimicrobes (46). Most of the fruits listed had a sour taste and required processing to make them more palatable. Fruits such as *Phyllanthus acidus* and *Eugenia cumini* were often consumed in candied or pickled form due to their sourness. *Sandoricum koetjape* was also commonly pickled, despite being able to be eaten fresh. This wide variety of fruit-based snacks was important in diversifying food and had certain economic value.

*Peusijuek* is a tradition in Aceh society where the elderly and respected people give their blessings in a ceremony. For the preparation of *peusijuek*, a small bouquet of plants is prepared to allow the blessing giver to dip the bouquet to scent the water prepared and spatter it to the receiver. Typically, there are 7 species of plants used in *peudijuek*, as previously reported (47), namely *naleung sambo*, *manek mano*, *gaca*, *puring*, *on seukee*, *on leubue* and *bak seunijuek*. The selection of plants usually symbolized certain aspects and wishes upon the celebrated events. In the Bireuen regency, various parts of plants had been used, with the seeds of *A. catechu* being incorporated as part of the offering with *P. betle* leaves, which symbolize love in certain types of ceremonies (47). The use of plants as an inseparable aspect in

traditional ceremonies was documented throughout the nation. For example, Arecaceae, Poaceae and Rutaceae among others, were often found used extensively in new home and wedding ceremonies by people of Tanjung Botung, North Sumatera (48), Peureulak, Aceh (49) and also as offerings in prayer by the Balinese (19). Traditional ceremonies played their roles in preserving the genetic source of these plants. Local communities believed that plants used in ceremonies were irreplaceable and could not be simply substituted with similar-looking plants for convenience. This implied that as long as the tradition and the cultural customs were maintained, the existence of plants used in the ritual must be preserved for immediate application (47). Plants also offered other purposes apart from rituals, such as *Cymbopogon citratus* and *P. amaryllifolius* which can be incorporated into cooking or the consumption of *L. inermis* as medicine.

The differences in ICF values were due to several factors, such as the uneven distribution of plants in the study area or the physical distance of the informants to the forest areas (49). The limited accessibility of each informant to these plants also played an important part that caused the low consensus value among the informants. This was due to the decreasing number of indigenous plants, especially fruit-bearing plants that were becoming less known to youth and the lack of documentation on the botanical aspects can lead to their loss over time. The preservation of these plants as part of the ecosystem can help ensure the continued existence of their edible fruit-bearing parts, which play a role in maintaining food security and preserving genetic diversity (4). However, the main threats faced by the indigenous fruit plants were mainly caused by human activities such as agricultural land expansion and selective harvesting.

Species erosion by simplification of plant cultivation threatened biodiversity in many developing countries, including Indonesia. Several indigenous fruit-bearing species faced a decrease in population, such as *E. cumini*, which were increasingly cut down and replaced with plantation crops. *Lepisanthes rubiginosa* was also sought after for its special sap, thereby resulting in overexploitation (49). Therefore, several species were only known by the older generation, leading to a loss of information on certain plant species.

Anacardiaceae comprised of 69-70 genera with 600-850 species, were widely distributed in tropical and temperate regions (38), including Sumatera. *Mangifera* genus is represented by 3 species, namely *M. foetida*, *M. quadrifida* and *M. odorata* (Table 1). *M. foetida* and *M. odorata* belong to the same sub-genus (*Limus*), while *M. quadrifida* belongs to the *Mangifera Ding-Hou* sub-genus (38). *Mangifera foetida* and *M. odorata* fruits morphologically share the same traits, such as green skin that turned yellow when ripe and long fibers found on the flesh of the fruits. While *M. quadrifida* distinctively has purple fruit skin and bright yellow flesh, with shorter fibers on its flesh. The classification Annonaceae comprises 200 genera and 2500 species and is considered the most diverse family of primitive Angiosperms. Its various genera indicate continental endemisms and the similarities between genera found in Africa and Asia are reported, such as genus *Uvaria*, *Polyalthia*; while *Annona*'s presence is more widely recorded

in Asia, America and Africa (50). Thus, further study of its biological properties will be very beneficial.

## Conclusion

The use of plants had been integrated into many aspects of life in Bireuen Regency, but there was limited documentation on their application, particularly the scientific information. Meanwhile, gathering information on these plants can serve as a valuable source of data for medicinal validation, conservation or plant breeding attempts. Studying indigenous plants is crucial for proper documentation of their usage by the local community. This knowledge is essential to preserving the biodiversity of nature and its implications on human lives. For example, many plants with potential as traditional medicine have not been studied thoroughly to reveal their full potential as new sources of medicine. Moreover, plants that are often consumed by the local community can be the potential source for diversifying food to overcome food insecurities in the future. Therefore, proper documentation of these valuable indigenous plants can be the first step in preventing their loss and providing several benefits for local people.

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## Authors' contributions

E and N planned the experiments, analyzed and interpreted the data and wrote the manuscript; IF analyzed and interpreted the data; HS wrote the manuscript. All authors read and approved the final manuscript.

## Compliance with ethical standards

**Conflict of interest:** Authors do not have any conflict of interest to declare.

**Ethical issues:** None

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