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Review

Medicinal plants for women's healthcare in southeast Asia: A meta-analysis of their traditional use, chemical constituents, and pharmacology

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ABSTRACT

Ethnopharmacological relevance: This is an extensive review of plants used traditionally for women's healthcare in Southeast Asia and surrounding countries. Medicinal plants have a significant role in women's healthcare in many rural areas of the world. Plants with numerous efficacious observations have historically been used as a starting point in the development of new drugs, and a large percentage of modern pharmaceuticals have been derived from medicinal plants.

Materials and methods: A review was conducted for all plant use mentioned specifically for female healthcare, such as medicine to increase fertility, induce menstruation or abortion, ease pregnancy and parturition, reduce menstrual bleeding and postpartum hemorrhage, alleviate menstrual, parturition and postpartum pain, increase or inhibit lactation, and treat mastitis and uterine prolapse, in 200 studies focusing on medicinal plant use, either general studies or studies focusing specifically on women's healthcare.

Results: Nearly 2000 different plant species are reported to be used in over 5000 combinations. Most common are *Achyranthes aspera*, *Artemisia vulgaris*, *Blumea balsamifera*, *Carica papaya*, *Curcuma longa*, *Hibiscus rosa-sinensis*, *Leonurus japonicus*, *Psidium guajava* and *Ricinus communis*, and each of these species had been reported in more than 10 different scientific articles.

Conclusions: This review provides a basis for traditional plant use in women's healthcare, and these species can be used as the starting point in the discovery of new drugs.

Contents

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1. Introduction

In Southeast Asia, despite the increasing availability of modern medicine, the use of traditional medicine remains popular as access to modern medicine is widespread but not available to all (Shein, 2001). People with low socioeconomic status are generally believed to rely more on traditional medicine because of inaccessibility and unavailability of health care services (Gaitonde and Kurup, 2005). In fact, all member countries of the Southeast Asian region, with assistance from WHO, are developing, strengthening and introducing the use of traditional medicine into primary health care (Shein, 2001; World Health Organization, 2004), as these are inexpensive and readily available compared to their pharmaceutical alternatives (Belew, 1999).

Herbal medicines, which include herbs, herbal preparations and herbal products, are the most widespread of traditional medicines (World Health Organization, 2008), and women their most frequent users (Murphy et al., 1999; Hall et al., 2011). Herbal medicines are used by women to treat a number of reproductive health problems, such as menstrual problems, infertility, discomforts and dysfunctions of pregnancy, labor and menopause (Beal, 1998). Women's reproductive health problems are mostly functional disorders (e.g. dysregulation of cyclical events, adjustment of physiological events to pregnancy, adjustments to cyclical events at perimenopause), rather than infectious or surgical emergencies for which most Western modern medicines have been developed. This could explain why problems in women's reproductive health may be more amenable to treatment with herbal medicines (Beal, 1998). Many pregnant women also consider herbs to be generally milder and safer than pharmaceutical drugs (Westfall, 2003a; Low Dog, 2009).

Modern research focusing on the use of plants often focuses on the realm of knowledge of male traditional healers, and scholars have missed the wealth of knowledge that is held by women (Pfeiffer and Butz, 2005). Erosion and deterioration of traditional medical knowledge can be observed in many cultures and leads not only to a loss in biocultural diversity, but also diversity in alternatives for primary healthcare and leads for drug discovery (Farnsworth et al., 1985). Documenting the use of plants by ethnic minorities is not only an important part in understanding and analyzing elements of traditional birth practices, but a way to perpetuate knowledge at risk of being lost.

This study provides a review of 200 selected studies that include plants used in Southeast Asia to treat women's health issues, including plants used to increase fertility, induce menstruation or abortion, ease pregnancy and parturition, reduce menstrual bleeding and postpartum hemorrhage, alleviate menstrual, parturition and postpartum pain, increase or inhibit lactation, and treat mastitis and uterine prolapse. Species cited in over 20 species-use reports are reviewed for chemical constituents, pharmacological studies and efficacy in an attempt to evaluate their traditional use in women's healthcare.

2. Materials and methods

2.1. Literature review

Women's health use was defined as any plant reported to be used to increase fertility, induce menstruation, abortion, and fetal or placental expulsion, ease pregnancy and parturition, reduce menstrual bleeding, vaginal discharges, and postpartum hemorrhage, alleviate menstrual, parturition and postpartum pain, increase or inhibit lactation, and treat mastitis, uterine prolapse and sexually transmitted diseases. Some of the terms used to describe ailments were ambiguous, and, therefore, have been excluded unless it was clear from the context that such use was implied, e.g. gonorrhea, which could affect either gender, but may be employed specifically for one only; abdominal pain, which may have been an euphemism for menstrual pain; or headache, in which the informant omitted to specify that its use was particularly important in conjunction with the menses. All available original research publications on medicinal plants, in general, as well as those mentioned for their specific use in women's health, from Southeast Asia and its surroundings, were reviewed from 1886 to 2012. A number of theses, books and articles from the library of the Kunming Institute of Botany were translated from Chinese for this paper (see references). Reference lists, ISI Web of Science and Google Scholar, were used to identify eligible studies on medicinal plants. Some studies were omitted due to limited data on women's health plant use. In addition, catalogs and compilations were reviewed, such as the Medicinal Plants of Southeast Asia (Perry and Metzger, 1980), De Nuttige van Planten van Nederlandsch-Indië (Heyne, 1913), A Dictionary of the Economic Products of the Malay Peninsula (Burkill, 1935), Les Plantes Medicinales du Cambodge, du Laos et du Vietnam (Petelot, 1952), and Plant Resources of South-east Asia (De Padua et al., 1999). Reviewing of general studies was limited to the Southeast Asia region, but included Northeastern India, Bangladesh, and the southern Chinese provinces of Guangxi, Guangdong, Guizhou, Hainan, Hunan, Sichuan and Yunnan. Studies focusing specifically on medicinal plants used for women's health are more scarce and were selected more broadly as species-reports from these studies are highly relevant, and geographically include Polynesia, Japan, Korea, and the other provinces of China and India, but excluding Australia. Some publications (e.g. Boorsma, 1897; De Clercq, 1927; Crevost and Petelot, 1929; Burkill and Haniff, 1930; Blackwood, 1935; Okabe, 1940; Cheo, 1947, 1949; Browne, 1955; Chung yao chih, 1959; Kuo, 1959; Chung, 1961; Chu, 1968) were reviewed by proxy through Perry and Metzger (1980), as these were either unavailable or written in a language that the author was unfamiliar with. Inevitably this review will have overlooked some relevant studies, and ideally these would be included in future studies. Fig. 1 provides a topographical overview of the literature studied in this paper.

2.2. Plant nomenclature

Botanical nomenclature is less static than it might appear, and all plant names mentioned in the reviewed studies have been verified using a combination of the International Plant Names Index (IPNI) (2012), Missouri Botanical Garden's Tropicos database (Tropicos.org, 2012), the USDA Genetic Resources Information Network's Taxonomy database (Germplasm Resources Information Network (GRIN), 2012), and The Plant List (2012), to check spelling, eliminate the use of older synonyms, and to ensure a uniform nomenclature for the data analysis. Plant families follow APGIII family circumscriptions (APG, 2009).

2.3. Data analysis

Expected species accumulation curves of the number of species-use-reports were computed using the Sobs (Mao Tau) function (Colwell et al., 2004) in EstimateS 8.0 (Colwell, 2006), a randomized resampling-based method, to assess the coverage of the sampling. Reports were summarized per species, genus, family, and reported use to analyze which species, genera, families, and uses are most commonly reported. A geographic coordinate was assigned to each study based on the study area, region, or country, to map geographic distribution of women's health data (Fig. 1).

3. Results and discussion

3.1. Reported plant use

A total of 1875 different plant species were found in 200 different articles for their use in traditional women's healthcare in Southeast Asia (Table 1). The 1875 species belonged to 211 families and 980 genera of plants, and the total number species-use reports was 5423 (Supplemental data S1). Species-use reports are defined in this paper as each specific species mentioned for a specific use in a specific paper, e.g. Species S is mentioned to be used to cure affliction U in publication R, then that is counted as one species-use-report. The 20 most common families, genera and species are presented in Fig. 2. The nine species with over 20 species-use reports are *Achyranthes aspera* (Amaranthaceae), *Artemisia vulgaris* (Asteraceae), *Blumea balsamifera* (Asteraceae), *Carica papaya* (Caricaceae), *Curcuma longa* (Zingiberaceae), *Hibiscus rosa-sinensis* (Malvaceae), *Leonurus japonicus* (Lamiaceae), *Psidium guajava* (Myrtaceae) and *Ricinus communis* (Euphorbiaceae). Each of these plant species had been mentioned in more than 10 different scientific articles. These species are reviewed below for chemical constituents, pharmacological studies and efficacy in an attempt to evaluate their traditional use in women's healthcare.

3.2. Reported health conditions

The targeted literature study shows that plants have been, and still are, used in traditional medicine to treat women's health conditions, such as menstrual disorders (amenorrhea, anemia, oligomenorrhea, menorrhea, menorrhagia and dysmenorrhea), and pregnancy, as well as labor-related conditions (morning sickness, prolonged and difficult parturition, uterine hemorrhage and prolapse). Plants have also been reported to be used as abortifacients, contraceptives, lactagogues, lactifuges and postpartum tonics. Fig. 3 shows the number of species-use-reports for

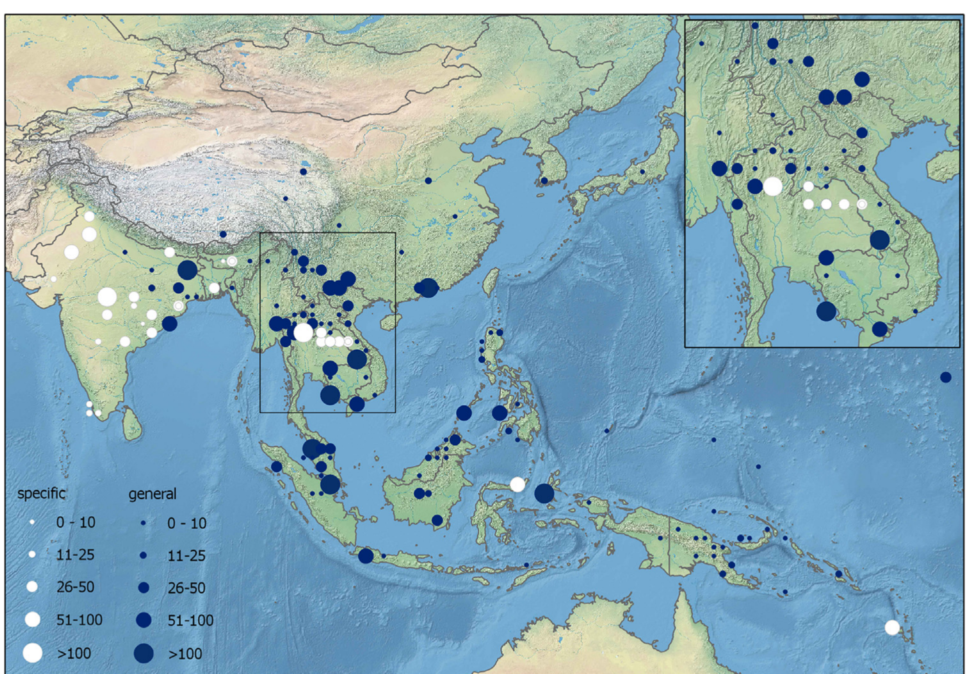

Fig. 1. Geographic origin of reviewed ethnobotanical literature. Color of points indicates General studies (blue) or those Specific on women's healthcare (white). Size of points indicates number of women's health-related species-use combinations reported per paper. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Table 1
Reviewed scientific literature.

Publication	Country	Type	Spec.	Comb.
Ahmad and Holdsworth (1994a), Ahmad and Holdsworth (1994b)	Malaysia	G	4	5
Ahmad and Holdsworth (1994a), Ahmad and Holdsworth (1994b)	Malaysia	G	5	5
Ahmad and Holdsworth (1995a)	Malaysia	G	7	7
Ahmad and Holdsworth (1995b)	Malaysia	G	3	4
Ahmad and Holdsworth (2003)	Malaysia	G	3	4
An and Ziegler (2001)	Vietnam	S	2	2
Anderson (1986a)	Thailand	G	13	13
Anderson (1986b)	Thailand	G	7	7
Anderson (1993), Akha	Thailand	G	53	67
Anderson (1993), Hmong	Thailand	G	54	69
Anderson (1993), Karen	Thailand	G	36	47
Anderson (1993), Lahu	Thailand	G	39	46
Anderson (1993), Lisu	Thailand	G	29	37
Anderson (1993), Yao	Thailand	G	38	48
Arens (1957)	Philippines	G	1	1
Au et al. (2008)	China	G	6	8
Augustine et al. (2010)	India	S	15	22
Bakhuizen van der Brink (1937)	Nederlandsch-Indië	G	1	1
Balangcod and Balangcod (2011)	Philippines	S	4	4
Balun and Holdsworth (1988)	Papua New Guinea	G	1	1
Behera (2006)	India	S	20	21
Bhattarai (1994)	Nepal	S	50	68
Bhogaonkar and Kadam (2006)	India	S	30	34
Blackwood (1935)	Papua New Guinea	G	10	10
Bodner and Gereau (1988)	Philippines	S	2	2
Boorsma (1897)	Nederlandsch-Indië	G	6	6
Bourdy and Walter (1992)	Vanuatu	S	71	83
Browne (1955)	Malaysia	G	1	1
Buragohain (2008)	India	S	24	26
Burkill (1935)	Malaysia	G	169	184
Burkill and Haniff (1930)	Malaysia	G	135	145
Caniago and Siebert (1998)	Indonesia	S	20	20
Cheo (1947)	China	G	4	4
Cheo (1949)	China	G	2	2
Chu (1968)	China	G	16	20
Chung (1961)	South Korea	G	14	14
Chung yao chih (1959)	China	G	74	112
Collins et al. (2007)	East Timor	G	6	6
Crevost and Petelot (1929)	Indochine	G	50	56
Das et al. (2005)	India	S	1	1
De Boer and Lamxay (2009), Brou	Laos	S	30	36
De Boer and Lamxay (2009), Kry	Laos	S	14	19
De Boer and Lamxay (2009), Saek	Laos	S	32	37
De Clercq (1927)	Nederlandsch-Indië	G	8	8
Delang (2007)	Laos	G	5	7
De Lanessan (1886)	Indochine	G	9	9
De Laszlo and Henshaw (1954)	Southeast Asia	S	1	1
Diguangco (1959)	Philippines	G	13	18
Dournes (1955)	Vietnam	G	2	2
Dragendorff (1898)	Southeast Asia	G	4	4
Eberhardt (1907)	Indochine	G	1	1
Ebert (1907)	China	G	7	7
Elliott and Brimacombe (1987)	Indonesia	G	25	29
Ford and Crow (1880)	China	G	1	1
Foucaud (1954)	Vietnam	G	47	51
Fox (1953)	Philippines	G	13	14
Foxworthy (1922)	Malaysia	G	9	9
Freudweiler (1933)	Indochine	G	1	1
Gage (1904)	Burma	G	6	6
Gimlette et al. (1930)	Malaysia	G	7	7
Girard and Barrau (1957)	Papua New Guinea	G	4	6
Goswami et al. (2011)	India	S	18	26
Groff et al. (1923)	China	G	1	1
Grosvenor et al. (1995)	Indonesia	G	7	7
Guerrero (1922)	Philippines	G	35	48
Guha et al. (2003)	India	S	6	6
Guo (2000)	China	G	2	2
Guo et al. (1990)	China	G	32	36
Heyne (1927)	Nederlandsch-Indië	G	116	138
Holdsworth (1975)	Papua New Guinea	G	12	12
Holdsworth (1980)	Papua New Guinea	G	17	18
Holdsworth (1984)	Papua New Guinea	G	6	6
Holdsworth (1987)	Papua New Guinea	G	2	2
Holdsworth (1989)	Papua New Guinea	G	3	3
Holdsworth (1990)	Cook Islands	G	10	11

Table 1 (*continued*)

Publication	Country	Type	Spec.	Comb.
Holdsworth (1991)	Brunei Darussalam	G	10	11
Holdsworth (1993)	Papua New Guinea	G	11	12
Holdsworth and Balun (1992)	Papua New Guinea	G	5	5
Holdsworth and Damas (1986)	Papua New Guinea	G	4	5
Holdsworth and Kerenga (1987)	Papua New Guinea	G	2	2
Holdsworth and Lacanienta (1981)	Papua New Guinea	G	14	14
Holdsworth and Mahana (1983)	Papua New Guinea	G	3	3
Holdsworth and Sakulas (1986)	Papua New Guinea	G	5	6
Holdsworth and Wamoi (1982)	Papua New Guinea	G	1	1
Holdsworth et al. (1980)	Papua New Guinea	G	10	10
Holdsworth et al. (1983)	Papua New Guinea	G	6	7
Holdsworth et al. (1989)	Papua New Guinea	G	7	7
Hooper (1929)	Malaysia	G	3	3
Hossan et al. (2010)	Bangladesh	S	30	48
How (1956)	China	G	24	34
Huai (2000)	China	G	1	1
Huang et al. (2004)	China	G	4	5
Ichimura (1932)	Japan	G	8	9
Inta et al. (2008), China	China	G	3	3
Inta et al. (2008), Thailand	Thailand	G	4	4
Ishidoya (1925)	Korea	G	2	2
Ishidoya (1933)	China	G	36	43
Jain and De (1966)	India	G	9	9
Jain et al. (2004)	India	S	43	56
Jumelle (1935)	Indochine	G	2	2
Kalita et al. (2011)	India	S	19	21
Kariyone and Kimura (1949)	China	G	16	21
Kishore et al. (1989)	India	G	52	60
Kloppenburg-Versteegh (1934)	Nederlandsch-Indië	G	25	29
Kulip (2003)	Malaysia	G	1	1
Kuo (1959)	China	G	3	3
Lamxay et al. (2011)	Laos	S	48	153
Lane-Poole (1925)	Papua New Guinea	G	1	1
Langenberger et al. (2009)	Philippines	S	9	9
Lecomte et al. (1907)	Indochine	G	6	6
Li et al. (2006)	China	G	45	68
Libman et al. (2006)	Laos	G	4	4
Lin (2005)	Malaysia	S	1	1
Liu (1952)	Taiwan	G	25	26
Liu et al. (2009)	China	G	8	12
Liulan et al. (2003)	Thailand	S	35	35
Long and Li (2004)	China	G	38	52
Long et al. (2009)	China	G	3	3
Loureiro (1790)	Indochine	G	4	4
Lundh (2007), Akha	Laos	G	5	9
Lundh (2007), Hmong	Laos	G	6	8
Lundh (2007), Lanten	Laos	G	6	8
Lundh (2007), Lao, Luang Namtha	Laos	G	4	5
Lundh (2007), Lao, Vientiane	Laos	S	17	36
Mahyar et al. (1991)	Indonesia	G	2	2
Matras and Martin (1972)	Cambodia	G	7	7
Menaut (1930)	Cambodia	G	64	73
Mohapatra and Sahoo (2008)	India	S	32	39
Mojiol et al. (2010)	Malaysia	S	2	2
Nguyen et al. (2004)	Vietnam	G	14	16
Okabe (1940)	Palau	G	6	9
Ong and Nordiana (1999)	Malaysia	S	23	26
Ong and Norzalina (1999)	Malaysia	S	9	9
Ong et al. (2011a)	Malaysia	S	4	4
Ong et al. (2011b)	Malaysia	G	16	18
Ong et al. (2011c)	Malaysia	S	23	29
Ostraff et al. (2000)	Tonga	S	59	59
Pal and Jain (1998), Lodha	India	G	100	111
Pal and Jain (1998), Munda	India	G	15	15
Pal and Jain (1998), Oraon	India	G	8	8
Pal and Jain (1998), Santal	India	G	40	40
Panduranga et al. (2011)	India	S	37	41
Panyaphu et al. (2011)	Thailand	S	45	77
Pardo de Tavera and Thomas (1901)	Philippines	G	54	116
Patel (2010)	India	S	9	13
Perrot and Hurrier (1907)	Indochine	G	12	13
Petard (1972)	Tahiti	G	34	73
Petelot (1952)	Indochine	G	316	411
Poonam and Singh (2009)	India	G	10	10
Priya et al. (2002)	India	S	18	18
Purkayastha et al. (2005)	India	G	12	15

Table 1 (*continued*)

Publication	Country	Type	Spec.	Comb.
Pushpangadan and Atal (1984)	India	G	16	21
Quisumbing (1951)	Philippines	G	62	77
Rai and Lalramnghinglova (2010)	India	S	4	4
Rajith et al. (2010)	India	S	17	23
Rao and Jamir (1982)	India	G	6	6
Rawat and Kharwal (2011)	India	S	22	26
Read (1936)	China	G	2	5
Reddi et al. (2011)	India	S	29	29
Ridley (1897)	Malaysia	G	28	29
Roi (1955)	China	G	12	12
Roosita et al. (2008)	Indonesia	G	67	67
Sahu (2011)	India	S	19	26
Samuel et al. (2010)	Malaysia	S	2	2
Shibata (1957)	Japan	G	1	1
Shukla et al. (2008)	India	S	16	21
Singh and Singh (2009)	India	G	10	10
Singh et al. (1984)	Tonga	S	60	100
Soriano (1940)	Philippines	G	2	3
Srithi et al. (2009)	Thailand	G	24	33
Srithi et al. (2011)	Thailand	S	75	131
Van Steenis-Kruseman (1957)	Indonesia	G	30	37
Stopp (1963)	Papua New Guinea	G	5	6
Stuart (1911)	China	G	47	58
Sulit (1934)	Philippines	G	7	7
Svengsuksa (2006)	Laos	S	36	40
Tamuli and Saikia (2004)	India	G	1	1
Tanaka and Odashima (1939)	China	G	3	7
Teo et al. (1990)	Malaysia	S	4	4
Thomson (1907)	Malaysia	G	7	7
Tripathi et al. (2010)	India	S	75	154
Uhe (1974)	Samoa	G	24	33
Valenzuela et al. (1949)	Philippines	G	11	13
Van Duong (1993)	Vietnam	G	37	170
Van Sam et al. (2008)	Vietnam	S	15	18
Vidal (1959)	Laos	G	11	11
Vidal and Lemoine (1970)	Laos	G	4	5
Vidyasagar and Prashantkumar (2007)	India	S	17	23
Vorderman (1894)	Nederlandsch-Indië	G	2	2
Wang (1999)	China	G	43	46
Warburg (1899)	Papua New Guinea	G	2	2
Webb (1955)	Papua New Guinea	G	3	3
Weckerle et al. (2009)	China	G	15	17
Weiner (1971)	Tonga	G	7	7
Whistler (1985)	Cook Islands	G	5	7
Whistler (1991)	Tonga	G	3	3
Yadav et al. (2006)	India	S	43	53
Zhang et al. (2009)	China	G	43	54
Zheng and Xing (2009)	China	G	20	20
Zumsteg and Weckerle (2007)	Indonesia	S	58	58

Type: General study (G), specific study on women's health (S); spec.: number of species mentioned for use in women's health; comb: species-use combinations for women's health.

each use. Postpartum recovery (745 times reported), leucorrhea (473), stimulate menstrual flow (422), induce abortion (328), reduce uterine hemorrhage (291), and stimulate lactation (286) were the most commonly reported uses, and this could reflect their importance as afflictions to women in this region.

3.2.1. Amenorrhea and oligomenorrhea

Amenorrhea and oligomenorrhea are menstrual disorders associated with changes in the length of the menstrual cycle. Primary amenorrhea is defined by the absence of menstruation by the age of 16. Secondary amenorrhea is when menstruation in an adult has not occurred for more than 3 months. Oligomenorrhea, on the other hand, is when menstruation occurs for intervals longer than 35 days (Oats and Abraham, 2010). Both these conditions are either caused by a physical defect in reproductive organs or an aberration in hormone levels. Hormonal imbalances can block ovulation.

Phytoestrogens, or estrogen derived from plants, can affect the hormonal balance and regulate ovulation in a number of ways, by (1) acting as estrogen antagonists, (2) modifying hormone receptors or (3) mimicking endogenous estrogen and altering the pattern of synthesis and metabolism of endogenous hormones (Burton and Wells, 2002). In modern medicine, increasing ovulation is done using clomifene, which acts by inhibiting the negative feedback of endogenous estrogen, causing a rise in FSH and LH, stimulating follicular maturation and ovulation (Meldrum, 2010; Oats and Abraham, 2010). Plants that are anti-estrogenic or have the capability to block the production of estrogen could theoretically initiate ovulation through a similar action. It is possible that plants that are considered emmenagogues, or herbs given to promote menstruation (Stapleton and Tiran, 2000), are plants with phytoestrogens that could initiate ovulation.

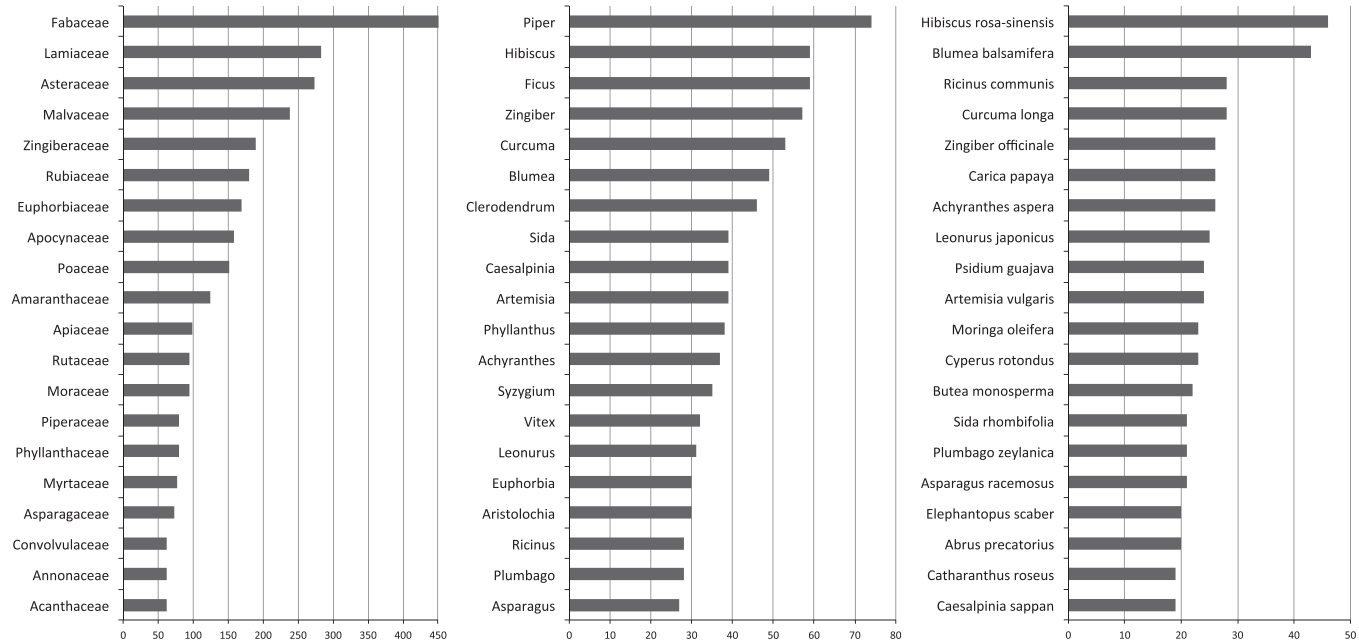

Fig. 2. Most common plant families (left), genera (center) and species (right) reported in the reviewed literature, with the number of reported species-use combinations per entity.

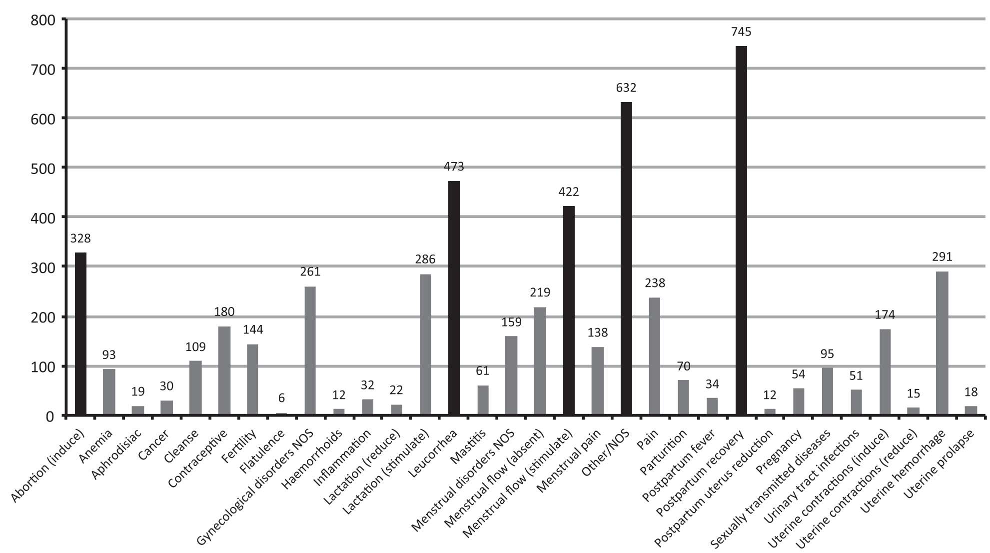

Fig. 3. Summary of species-use-reports per reported use.

However, pregnancy is also the frequent cause for the absence of menstruation. In rural settings, without the proper facilities to determine pregnancies, pregnancy can be misdiagnosed as amenorrhea. As such an emmenagogue could also act as an abortifacient, as the termination of pregnancy would initiate menstruation.

3.2.2. *Menorrhagia and metorrhagia*

Menorrhagia (heavy or prolonged menstrual discharge) or metorrhagia (irregular episodes of menstrual bleeding) can be associated with a number of organic causes such as uterine myomata, diffuse adenomyosis, endometrial polyps and blood dyscrasias. But, in the absence of these organic causes dysfunctional uterine bleeding (DUB) is often considered (Gambone, 2010; Oats and Abraham, 2010). Like the previous two conditions, the underlying cause of DUB is almost always an aberration in the hypothalamic–pituitary–ovarian hormonal axis resulting in anovulation. The absence of ovulation is usually either due to a decline in the functional capacity of the ovary in women nearing menopause or a failure of the hypothalamic–pituitary system to respond to positive feedback of estrogen in adolescents. In either case, the absence of ovulation results in less prostaglandin being secreted. Prostaglandin is a powerful vasoconstrictor and without it, the endometrial ischemia that will normally result and cause a cessation in the bleeding will not occur (Gambone, 2010). Plants that can initiate ovulation and allow for the normal secretion of prostaglandins during the menstrual cycle can be beneficial in DUB. In addition, since menorrhagia and metorrhagia could be caused by blood dyscrasias and the immediate cause of DUB is less effective hemostasis due to reduced vasoconstriction and a lack of platelet aggregation (Oats and Abraham, 2010), plants with blood coagulative, vasoconstricitve or relaxant effects could be beneficial in treating DUB.

3.2.3. Dysmenorrhea

Another menstrual condition is dysmenorrhea or pain during menstruation. Primary dysmenorrhea, in contrast to secondary dysmenorrhea, caused by organic pelvic disease, has no identifiable cause. The main etiology of dysmenorrhea is the production of prostaglandins, particularly $PGF_{2\alpha}$ and PGE_2, by the luteinized endometrium. When there is an imbalance in prostaglandin levels with $PGF_{2\alpha}$ predominating, myometrial ischemia occurs and uterine contraction increases (Oats and Abraham, 2010). The combined effect of increased uterine activity, increased nerve terminal sensitization to prostaglandin and endoperoxides and uterine ischemia produces the experienced pain (Rapkin and Gambone, 2010). Primary dysmenorrhea is usually treated with nonsteroidal anti-inflammatory agents (NSAIDs) (Rapkin and Gambone, 2010). NSAIDs lower prostaglandin levels by inhibiting cyclooxygenase, the enzyme that catalyzes the formation of prostaglandin from arachidonic acid (Oats and Abraham, 2010). Plants have been shown to have anti-inflammatory properties, some by mediating prostaglandin synthesis and could be beneficial in treating dysmenorrhea. Plants that are tocolytic or have relaxing effects on the uterus, as well as plants that could block ovulation and cause decreased production of prostaglandins can also be helpful in treating primary dysmenorrhea.

Moreover, plants with analgesic effects could also provide some temporary relief in dysmenorrhea, as well as other forms of pain like abdominal, pelvic, severe labor pains and backache. Pain during labor is due to uterine contractions, as well as stretching of vaginal, pelvic and perineal tissues. Ischemia of the myometrial fibers in part causes pain accompanying uterine contractions (Oats and Abraham, 2010). The relaxation of the ligaments and muscles supporting the joints, because of progesterone and relaxin stimulation is the cause of backache during the late stages of pregnancy (Oats and Abraham, 2010). Pelvic pain, on the other hand, may or may not have a gynecological cause. When the cause is gynecologic, it is usually organic like endometriosis or pelvic inflammatory disease (Rapkin and Gambone, 2010).

Aside from providing relief from amenorrhea, tocolytic plants could also prevent miscarriage and delay preterm labor by suppressing or coordinating uterine contractility. Uterine overefficiency is known to precipitate early labor (Oats and Abraham, 2010).

3.2.4. Uterine contractants

In contrast, plants that have the ability to increase the strength or frequency of the contraction of the uterus can help the progress of abnormal labor, such as when the mother has a hypoactive uterus (uterine inertia). The resting tone and the intensity of contractions of a hypoactive uterus is low and therefore, the force needed to expel the fetus out of the uterus is insufficient (Oats and Abraham, 2010). In these cases, oxytocin can be given to induce labor. Labor induction is sometimes necessary to rescue the fetus from a potentially hazardous intra-uterine environment (Oats and Abraham, 2010). Spasmodic plants that increase uterine contractility could also be abortive by causing the expulsion of the implanted embryo.

3.2.5. Abortifacients and contraceptives

Another way to avoid pregnancy is to prevent the fertilized egg from even being implanted. Several plants have been found to prevent implantation or cause the implanted embryo to detach from the uterus and as such act as abortifacients or contraceptives. Plants that disrupt the estrous cycle and prevent ovulation also have a contraceptive effect. It is likely that many species that are reported to treat amenorrhea or those that function as emmenogogues are in fact used as early-stage abortifacient, and the mechanisms of action for these uses should be taken into account when studying these species.

3.2.6. Microbial infections

Finally, there are a number of women's health conditions that are caused by infections. *Staphylococcus* or *Streptococcus* acquired from the infant during breastfeeding is the usual cause of mastitis (Oats and Abraham, 2010). Fungal yeasts, *Candida albicans* and *Candida glabrata*, as well as the protozoan *Trichomonas vaginalis* can cause vulvovaginitis. *Chlamydia trachomatis*, *Neisseria gonorrhea* and the genital mycoplasmas, *Mycoplasma hominis*, *Mycoplasma genitalium* and *Ureaplasma urealyticum*, are usually responsible for pelvic inflammatory disease (PID), a sexually transmitted upper reproductive tract infection. Herpes simplex virus and human papilloma virus also commonly cause infections in the reproductive tract (McGregor and Lench, 2010). A non-bloody discharge, sometimes referred to as leucorrhea, may accompany these infections (McGregor and Lench, 2010). The numerous studies that have demonstrated antibacterial, antifungal and antiviral properties in plants provide a basis to its use in treating sexually transmitted infections and mastitis.

Moreover, since one of the symptoms of PID is abdominal pain and tenderness (McGregor and Lench, 2010), treatment of the underlying PID with antibacterial plants could resolve the overlying abdominal pain. Similarly, preterm delivery is associated with bacterial vaginosis (Hobel, 2010), and treatment of bacterial vaginosis can address the problem with preterm delivery.

The pH of the vagina becomes more basic after parturition because of the neutralizing effect of the alkaline amniotic fluid, blood and lochia (discharge of the genital tract after childbirth), as well as a decrease in lactic acid-producing lactobacilli. A more favorable environment for aerobic bacteria is created with a more alkaline vagina. Moreover, 48 h postpartum, the intrauterine environment becomes favorable for growth of anaerobic bacteria because of progressive necrosis of endometrial and placental remnants. Anaerobic organisms account for 70% of puerperal infections, with *Peptostreptococcus*, *Peptococcus*, *Streptococcus* and *Bacteroides fragilis* most common. *Escherichia coli*, on the other hand, is the most common aerobic pathogen. Vaginal microorganisms may be given an opportunity to invade the uterine cavity because the mother's immune system may be weakened after a tiresome labor. Invasion of the lymphatic system, causing a more widespread infection and sepsis is also possible. Puerperal infection presents with a rising fever and increasing uterine tenderness on postpartum days 2 or 3 (Kim et al., 2010). Bathing in antibacterial and antifungal plants could also be useful in the prevention of postpartum fever and sepsis.

3.2.7. Hemorrhage

Another possible complication after giving birth is hemorrhage. Postpartum hemorrhage is defined as blood loss in excess of 500 ml at the time of vaginal delivery to 24 h after giving birth. Most of the blood comes from myometrial spiral arterioles and decidual veins that previously supplied the placenta, after uterine contractions cause the placenta to separate. Normally, uterine musculature contracts around the blood vessels and acts as physiologic-anatomic ligature. However, if the uterus fails to contract (atonic uterus) or if placental tissue is retained, excessive placental bleeding can occur. If placental tissue is retained in the uterus, the uterus is unable to maintain contraction and involutes around the retained tissues (Kim et al., 2010). Atonic uterus and placental remnants account for 80% of primary postpartum hemorrhage cases (Oats and Abraham, 2010). Control of the bleeding can be achieved by increasing the uterine tone with uterotonic or spasmodic plants.

Moreover, plants that can enhance wound healing can also be beneficial with postpartum hemorrhage as trauma resulting from childbirth to the genital tract can also cause postpartum hemorrhage. Plants with coagulative properties could be useful in hemorrhage due to coagulation disorders.

As for hemorrhage during the antepartum and intrapartum period, conditions like placenta previa, abruptio placentae, preterm labor and uterine rupture all carry the risk for hemorrhage. In placenta previa, the placenta partially or totally covers the cervix. In abruptio placentae, there is a premature separation of the placenta. Uterine rupture occurs when all the layers of the uterine musculature completely separate, leading to the fetus being expelled from the uterine cavity (Kim et al., 2010).

3.2.8. Lactation stimulants

During the postpartum period, some plants are used to affect milk production, as galactagogues or lactifuges. Galactagogues are substances that increase the production or flow of milk, and a common problem with breastfeeding is the perceived insufficiency of milk supply (Westfall, 2003b). Without outside stimulation, early and frequent suckling should encourage lactation, as this stimulates the pituitary gland to secrete prolactin. Oxytocin causes milk to be ejected by causing myoepithelial cells surrounding the milk glands to contract. Oxytocin also inhibits the release of prolactin-inhibitor dopamine from the hypothalamus (Oats and Abraham, 2010). However, neither hormone determines the amount of milk produced. The amount of milk produced is dependent on the amount and frequency of milk removed from the breast (Westfall, 2003b).

The mechanism of galactagogue herbs is largely unknown, but a review by Westfall (2003b) noted that commonly used herbs were able to stimulate blood flow to the breasts, were oxytocic, provided a rich source of fatty acids or directly increased breast tissue. These properties could indirectly increase milk production.

4. Discussion of pharmacological evidence of most common plant species

4.1. *Achyranthes aspera* L.

Achyranthes aspera (Amaranthaceae) was mentioned in 19 publications in 26 species-use-reports. It is reported to have anti-fertility effects, and is traditionally used as an abortifacient and contraceptive, but also for treat menstrual disorders, gonorrhea, leucorrhea, breast and abdominal pain, as well as hemorrhage. It is also used to facilitate parturition, including the expulsion of the lochia and placenta, and helps the mother to recover after giving birth.

Extracts of the whole plant were shown to be abortive in animal models. In mice, these extracts were abortive, and in rabbits, no implantation sites were seen (Pakrashi and Bhattacharya, 1977). In rats, extracts of the aerial parts (Wadhwa et al., 1986), leaves (Shibeshi et al., 2006) and roots (Vasudeva and Sharma, 2006, 2007) were shown to be abortive, either by preventing implantation or causing reduced survival of rat fetus. However, the abortive effects of aerial part extracts were not seen in hamsters (Wadhwa et al., 1986).

The anti-implantation activity has been ascribed to the estrogenicity of the plant. However, as extracts of the leaves were unable to increase serum concentrations of estradiol and progesterone in rats (Shibeshi et al., 2006), the demonstrated estrogenic effects could be due to phytoestrogens binding to estrogen receptors in the pituitary and hypothalamus and disrupting negative estrogen feedback. Pakrashi and Bhattacharya (1977) however reported no estrogenic effects in mice. Aside from anti-implantation and abortive effects, the capability of the plant to disrupt hormonal balance could also extend to its use to treat menstrual disorders, which is hormonally regulated.

As for its reported contraceptive properties, extracts of the plant were found to be spermicidal in rats (Sandhyakumary et al., 2002) and in human semen (Paul et al., 2006). The spermicidal action was isolated to a 58 kDa protein that was comparable to known spermicides, gossypol and nonoxynol-9, and retained its properties even after proteolytic digestion (Anuja et al., 2010, 2011). Furthermore, a combined hexane fraction of *Stephania japonica* var. *discolor* (Blume) Forman. (Menispermaceae) and *A. aspera* roots has been shown to have 100% efficacy as a vaginal contraceptive in rats (Paul et al., 2010).

Alcohol extracts of whole plant (Gokhale et al., 2002; Vetrichelvan and Jegadeesan, 2003) and roots (Vijaya Kumar et al., 2009) showed both acute and chronic anti-inflammatory actions in animal models. The presence of previously documented anti-inflammatory compounds, like alkaloids, saponins and oleanolic acid, could explain the observed anti-inflammatory activity of *A. aspera* (Gokhale et al., 2002). Dysmenorrhea is mediated by inflammatory processes, and the plant's reported anti-inflammatory effects could explain its traditional use in treating dysmenorrhea. In conjunction with its use in treating dysmenorrhea, extracts of the leaves (Barua et al., 2010b) and aerial parts (Alam et al., 2009; Bhosale et al., 2010) have shown both peripheral (inflammation-mediated) and central (mediated through inhibition of central pain receptors) analgesic effects in animal pain models. The analgesic and anti-inflammatory effects could explain its use in treating dysmenorrhea, as well as breast and abdominal pain.

Properties that enhance wound healing were shown in studies of the leaves (Barua et al., 2010a; Ghosh et al., 2011) and whole plant (Edwin et al., 2008), and this could justify its traditional use in postpartum recovery. Antimicrobial activity was observed from extracts of the whole plant (Navneet and Krishna, 2005; Geetha et al., 2010; Beaulah et al., 2011), aerial parts (Kumar et al., 2003), roots (Kumar et al., 2003) and seeds (Reddy et al., 2011). Some extracts had equal action to known antibiotics, cotrimoxazole (Kumar et al., 2003) and gentamicin (Beaulah et al., 2011). This could explain its reputed use in treating leucorrhea and gonorrhea, which are often caused by yeasts and bacteria, and routinely treated with antibiotics and antimycotics.

4.2. *Artemisia vulgaris* L.

Artemisia vulgaris (Asteraceae) was mentioned in 11 publications in 22 species-use-reports. Traditionally in Southeast Asia it is used to treat menstrual conditions, such as amenorrhea, dysmenorrhea and oligomenorrhea, pregnancy disorders, and severe pain during labor and leucorrhea. It is also used as an emmenagogue, uterine sedative and postpartum tonic.

Pharmacological studies on the reported traditional use of the plant *Artemisia vulgaris* are few, and only five were found, each of which focuses on the aerial parts (Lee et al., 1998; Temraz and El-Tantawy, 2008; Khan and Gilani, 2009; Pires et al., 2009; Natividad et al., 2011). Temraz and El-Tantawy (2008) characterized its antioxidant activity. Pires et al. (2009) showed that the plant had mild peripheral antinociceptive activities, probably caused by substances such as flavonoids, rutin, hydroxybenzoic acid and caffeic acid derivates, which were all found in high concentrations in extracts. The acetic acid writhing test used by Pires et al. (2009) to demonstrate the antinociceptive effects, mimics the local inflammation process. Since inflammation is implicated in dysmenorrhea, this could support its use in treating dysmenorrhea.

Lee et al. (1998) found the flavonoids, eriodictyol and apigenin, isolated from the plant, to be estrogenic. The presence of these weak estrogens may account for its folkloric use to treat menstrual disorders, as an emmenagogue and uterine relaxant. Furthermore, Natividad et al. (2011) reported relaxing activities in other smooth muscles, the ileum and the trachea. Although not directly tested on the uterus, the smooth muscle relaxing effect could explain why it has been reported to be uterine antispasmodic.

Traditional use in the bulk of the reviewed articles focused on its use in moxibustion, and moxibustion in conjunction with acupuncture. Moxibustion is an oriental therapy involving the stimulation of acupuncture points with heat from the burning of medicinal plants, and often involves *Artemisia vulgaris* (Cardini et al., 2005). Many clinical studies were done on the efficacy of moxibustion in correcting fetal breech position, but so far, results on its efficacy are inconclusive (Ewies and Olah, 2002; Coyle et al., 2005). Promising results were noted by Kanakura et al. (2001), Neri et al. (2004), Cardini et al. (2005), Manyande and Grabowska (2009) and Do et al. (2011). However, studies by Arai et al. (2001) and Guittier et al. (2009) showed contradictory results, with no or only slight beneficial effect to correcting breech position. The variability in the results may be due to differences in the course of treatment, dosage, frequency, timing and acceptability of moxibustion therapy. It is postulated that moxibustion stimulates the adenocortical system, which results in an increase in placental estrogen and alteration of prostaglandin levels. Estrogens could stimulate fetal movements to cause inversion (Ewies and Olah, 2002). Correcting breech position could pertain to the reported use of *Artemisia vulgaris* to treat pregnancy disorders.

4.3. *Blumea balsamifera (L.) DC*

Blumea balsamifera (Asteraceae) was mentioned in 30 publications in 43 species-use-reports, and is most commonly used to aid postpartum recovery. After giving birth, the mother may feel weak because of significant blood loss, tissue tearing, and hormonal changes associated with labor. Medicinal plants used for postpartum recovery have antioxidant, anti-inflammatory and antimicrobial action on target organs of the mother (De Boer et al., 2011). The plant is reported to be used to treat menstrual conditions, such as amenorrhea and dysmenorrhea, pain, hemorrhage and infections. It is also used as an abortifacient, emmenagogue, lactagogue and in steam baths.

Various flavonoids have been isolated from the aerial parts of *Blumea balsamifera* (Ruangrungsi et al., 1981; Barua and Sharma, 1992; Ali et al., 2005; Saewan et al., 2011). These flavonoids may be responsible for antioxidant and anti-inflammatory activities reported from studies on extracts of the aerial parts or leaves (Lin and Long, 1998; Zhao and Xu, 1997; Fazilatun et al., 2004; Shyur et al., 2005; Nessa et al., 2004, 2010). The anti-inflammatory activity in *Blumea balsamifera* aerial part extracts was further demonstrated as it shows an inhibitory effect on nitric oxide (Chen et al., 2010) and xanthine oxidase production (Nessa et al., 2010; Nguyen and Nguyen, 2012). Nitric oxide is implicated in inflammatory-mediated diseases like arthritis, and xanthine oxidase plays a role in gout as it helps catalyzing the conversion of purines to uric acid. This could explain some of its reported use in alleviating bone and joint pain in postpartum women.

Besides being used as an herbal tonic, plant parts of *Blumea balsamifera* are also used in baths for postpartum women. Adding *Blumea balsamifera* to the bath could have conferred some antibacterial and antifungal properties, since essential oils and extracts of *Blumea balsamifera* were found to be antibacterial (Wat et al., 1980; Sakee et al., 2011) and antifungal (Ragasa et al., 2005). Antibacterial baths could help deter puerperal sepsis. However, it should also be noted that other research found no antibacterial activity in leaf extracts of *Blumea balsamifera* (Ongsakul et al., 2009).

Blumea balsamifera is also used as an abortifacient and emmenagogue. Osaki et al. (2005) extracted a sesquiterpenoid compound from *Blumea balsamifera* leaves that was mildly cytotoxic and hence may be abortive. In addition, Osaki et al. (2005) also demonstrated the plasmin inhibitory activity of two flavonoids, giving credence to its use as an emmenagogue.

4.4. *Carica papaya L.*

Carica papaya (Caricaceae) was mentioned in 21 publications in 26 species-use-reports, and is traditionally used as an abortifacient, contraceptive, emmenagogue, and lactagogue. It is also used to treat menstrual disorders (amenorrhea, metorrhagia and dysmenorrhea) and uterine cancer, as well as help the mother recover after pregnancy.

In the literature a number of reports on the use of *Carica papaya* as an abortifacient are found. The abortive qualities of the plant have been studied extensively. Extracts of the seeds possess abortive qualities in various animal models (Oderinde et al., 2002; Raji et al., 2006; Anuar et al., 2008; Abdulazeez et al., 2009). The fruit itself was able to induce abortion (Gopalakrishnan and Rajasekharasetty, 1978; Anuar et al., 2008). Furthermore, leaf extracts had adverse effects on fetal development (Ekong et al., 2011). However, other authors have reported the opposite findings, being unable to induce abortions (Schmidt, 1995; Adebiyi et al., 2002; Shrivastava et al., 2011). It should be noted that in the first two studies (Schmidt, 1995; Adebiyi et al., 2002) ripe papaya fruit and papain were tested, instead of seed extracts (Shrivastava et al., 2011).

The abortive property of the plant may be due to its ability to contract the uterus, and expel its contents. Seed extracts (Chinoy et al., 1995) and latex (Cherian, 2000; Adaikan and Adebiyi, 2005) were found to increase uterine contractility in animal models. According to Cherian (2000), the contractile effect was produced mainly by acting on α-adrenergic receptors in the uterus. While, Adaikan and Adebiyi (2005) suggest that the mechanism is prostaglandin release brought about by the proteolysis-dependent ability of the latex to mobilize Ca^{2+}.

In contrast, the opposite effect, or the ability to inhibit spontaneous contractions was observed when *Carica papaya* seeds were used (Adebiyi et al., 2003). The spasmolytic effect is probably due to the damaging effect of benzyl isothiocyanate (BITC), the main phytochemical in *Carica papaya* seeds, on the myometrium of the uterus. BITC was found in another study to inhibit spontaneous, prostaglandin $PGF_{2\alpha}$ and oxytocin-induced contractions in isolated uterine strips of rats (Adebiyi et al., 2004).

Raji et al. (2005) demonstrate pre-coital anti-implantation activity of seed extracts, suggesting a contraceptive function. Seed extracts did not affect the production of hormones of the ovaries, but instead caused a change in the uterine environment, making it hostile for implantation (Joshi and Chinoy, 1996).

Carica papaya extracts of the seeds (Amazu et al., 2010; Anaga and Onehi, 2010) and leaves (Owoyele et al., 2008) were also demonstrated to have antinociceptive and anti-inflammatory effects, properties which are useful in treating dysmenorrhea. Extracts of the fruit (Mikhalchik et al., 2004; Nayak et al., 2007; Anuar et al., 2008), leaves (Mahmood et al., 2005), seeds (Nayak et al., 2012) and latex (Gurung and Skalko-Basnet, 2009) found to enhance wound healing. Extracts of the ripe fruit (Osato et al., 1993), fermented fruit (Mikhalchik et al., 2004), unripe fruit

(Oloyede et al., 2011) and leaves (Srikant et al., 2010) exhibit antioxidant activity. Extracts of the leaves (Anibijuwon and Udeze, 2009; Bhattacharjee et al., 2011; Rahman et al., 2011), stem (Rahman et al., 2011), fruit (Emeruwa, 1982; Nayak et al., 2007; Dawkins et al., 2003), fermented fruit (Mikhalchik et al., 2004), seeds (Okoye, 2011; Nayak et al., 2012) and unripe fruits (Osato et al., 1993) have antibacterial properties, and extracts of the roots (Adejuwon et al., 2011), seeds (Okoye, 2011) and the latex (Giordani et al., 1991) have antifungal activity. These effects could be beneficial to reduce postpartum opportunistic infections.

4.5. *Curcuma longa* L.

Curcuma longa (Zingiberaceae) was mentioned in 20 publications in 28 species-use-reports, and is most commonly used in postpartum recovery. Aside from that, *Curcuma longa* is reported to treat excessive vaginal discharges, menstrual disorders and as an infant medicine.

Since the discovery of curcumin was published in Lancet in 1937 by Oppenheimer an excess of 2600 research articles have been published on its properties (Strimpakos and Sharma, 2008). However, the majority of this research has focused on the constituent curcumin, not on the extracts or other preparations of *Curcuma longa* (Ulbricht et al., 2011). One of the most well-studied properties of curcumin is its antioxidant effect (Jayaprakasha et al., 2006; Ak and Gulcin, 2008). Curcumin can suppress superoxide production (Ruby et al., 1995), inhibit lipid peroxidation (Sharma, 1976; Shalini and Srinivas, 1987; Ruby et al., 1995; Ramsewak et al., 2000; Ak and Gulcin, 2008) and scavenge free radicals (Kunchandy and Rao, 1990; Sreejayan and Rao, 1997; Song et al., 2001; Fujisawa et al., 2004; Kim et al., 2003; Ak and Gulcin, 2008). Antioxidant properties were not reduced when the plant was prepared using two traditional culinary and medicinal recipes (Tilak et al., 2004). Furthermore, the antioxidant principle had been isolated to the proteins, turmerin (14 kDa) (Srinivas et al., 1992), turmeric antioxidant protein (24 kDa) (Selvam et al., 1995), BGS-Haridrin (28 kDa) (Dinesha and Srinivas, 2010) and beta-turmerin (34 kDa) (Smitha et al., 2009).

Curcumin has also demonstrated significant anti-inflammatory effects in acute and chronic animal inflammation models, exhibiting stronger efficacy than phenylbutazone in treating acute inflammation (Srimal and Dhawan, 1973; Anto et al., 1998). Laboratory studies have shown that the anti-inflammatory effects of curcumin may be due to its potent antioxidant activities, inhibition of cell signaling pathways, diverse effects on cellular enzymes and inhibition of various inflammatory molecules (Sharma et al., 2005; Ulbricht et al., 2011). In fact, curcumin has been shown to have beneficial effects in clinical studies in treating inflammatory-mediated diseases, such as cancer, asthma, ulcerative colitis, anterior uveitis, irritable bowel syndrome and inflammatory bowel disease (Chainani-Wu, 2003; Aggarwal and Harikumar, 2009; Jurenka, 2009; Bisht et al., 2010).

Aside from the anti-inflammatory and antioxidant properties of *Curcuma longa* and curcumin, curcumin also has immunomodulatory effects. In a review of its immunomodulatory effects, curcumin was described to be primarily immunosuppressive. But, reports of immunostimulative effects also exist (Jagetia and Aggarwal, 2007; Srivastava et al., 2011).

In addition, curcumin enhanced wound healing in animals (Sidhu et al., 1998; Mani et al., 2002; Panchatcharam et al., 2006; López-Jornet et al., 2011). Furthermore, in a human clinical study, the rhizome extract improved wound healing after episiotomy (Golmakani et al., 2009). The anti-inflammatory, antioxidant, immunomodulatory and wound healing properties of *Curcuma longa* and the constituent curcumin could explain why it is traditionally used in postpartum recovery.

Apart from being used to aid maternal recovery after delivery, *Curcuma longa* rhizome is also used postpartum in baths and steam baths. Antibacterial activity is reported from extracts of the rhizome (Singh et al., 2002; Kim et al., 2005; Niamsa and Sittiwet, 2009; Naz et al., 2010; Aly and Gumgumjee, 2011) and rhizome essential oils (Negi et al., 1999; Singh and Jain, 2011), and antifungal activity from the rhizome (Martins et al., 2009; Aly and Gumgumjee, 2011) and essential oils (Singh and Jain, 2011). These activities could be beneficial when bathing in *Curcuma longa*-infused waters to reduce microbial infections and sepsis after delivery. Curcumin was also found to be protective against sepsis in rats. Rats given curcumin before and after onset of sepsis showed less tissue injury, lower mortality and decreased expression and levels of pro-inflammatory cytokine TNF-α, possibly through up-regulation of PPAR-γ (Siddiqui et al., 2006).

The use of *Curcuma longa* to expel the lochia during postpartum recovery is not supported, as studies on the effects of curcumin on the rat uterus showed it to inhibit uterine contractions (Itthipanichpong et al., 2003; El-Sayed, 2008).

Moreover, rhizome extracts of *Curcuma longa* were found to be estrogenic in rats. In rats treated with the extract, there was a longer estrus phase, increase in the uterine weight and a decrease in the levels of FSH and LH (Maligalig et al., 1994; Thakur et al., 2011). The estrogenicity of extracts of the rhizome have been used to explain its demonstrated abortive and contraceptive properties (Yadav and Jain, 2011, 2010), and it could also give some justification to its traditional use to treat menstrual cycle disorders, which are hormonally regulated.

4.6. *Hibiscus rosa-sinensis* L.

Hibiscus rosa-sinensis (Malvaceae) was mentioned in 22 publications in 46 species-use-reports, and traditionally been used in Southeast Asia as an abortifacient, aphrodisiac, contraceptive, emmenagogue and uterine tonic. It has also been reported to be used to treat menstrual disorders and venereal diseases.

Crude extracts of the flowers (Kholkute et al., 1976; Singh et al., 1982) and roots (Vasudeva and Sharma, 2008) show in-vivo postcoital anti-implantation activity in female rats, but this is not due to affection of the tubal transport of blastocyst or zygote (Kholkute and Udupa, 1976). This anti-implantation activity is probably due to the anti-estrogen activity of *Hibiscus rosa-sinensis*, as reported for extracts of the leaves (Nivsarkar et al., 2005) and flowers (A. Prakash, 1979; A.O. Prakash, 1979; Prakash et al., 1985, 1990). Anti-estrogenic plants intercept the normal development of the ovum and the endometrium (Shibeshi et al., 2006). When the uterine bed fails to prepare due to the inhibition of the estrogen-induced increase in progesterone from the corpus luteum, implantation does not occur (Kabir et al., 1984). The inhibition of the hyperpermeability of the endometrial capillaries to deciduogenic compounds may also interfere with proper uterus conditioning (Pal et al., 1985).

Furthermore, the abortive property of the flowers of *Hibiscus rosa-sinensis* could also be attributed to the growth inhibition of trophoblast cells (Zhao et al., 1998; Jiang, 2001), regression of the corpus luteum (Yan et al., 2000), or decreased secretion of human chorionic gonadotrophin (hCG) and progesterone (Zhao et al., 1998).

As for its contraceptive properties, *Hibiscus rosa-sinensis* flower extracts have been shown to disrupt the estrous cycle, causing follicular atresia and ovarian atrophy in rats (Kholkute et al., 1976). Increased secretion of estrogen by atretic follicles combined with the estrogen activity of *Hibiscus rosa-sinensis* flower extracts could cause a hormonal imbalance with an anti-ovulatory effect (Murthy et al., 1997). In addition, extracts of the roots of *Hibiscus rosa-sinensis* increased the uterine weight and stimulated uterine growth in ovariectomized mice, which further demonstrates the estrogen activity of the plant (Vasudeva and Sharma, 2008).

The use of *Hibiscus rosa-sinensis* in parturition could be explained by its smooth muscle spasmogenic and spasmolytic activities found in extracts of the flowers (Agarwal and Shinde, 1967; Ganatra et al., 2011) and aerial parts (Gilani et al., 2005). The in-vivo analgesic effect demonstrated in extracts of the flowers (Sawarkar et al., 2009), roots (Soni and Gupta, 2011) and leaves (Tomar et al., 2010) of *Hibiscus rosa-sinensis* could explain its traditional use in treating dysmenorrhea and migraine. Some in-vitro antibacterial activity has also been reported in *Hibiscus rosa-sinensis* flower extracts (Ragasa and Rufino, 2011; Seyyednejad et al., 2010), which in turn could support its traditional use in treating venereal diseases, like gonorrhea.

4.7. *Leonurus japonicus* Houtt

Leonurus japonicus (Lamiaceae) was mentioned in 16 publications in 25 species-use-reports, and has traditionally been used to treat uterine hemorrhage disorders. In-vivo experiments show that treatment with leonurine hydrochloride, a compound extracted from *Leonurus japonicus*, reduced volume and duration of bleeding in rats with incomplete abortion (Li et al., 2011). Furthermore, Liu (2009), Wang et al. (2009) and Zhou et al. (2010) demonstrated that the use of oxytocin combined with *Leonurus japonicus* herb extracts was better than using oxytocin or *Leonurus japonicus* alone in decreasing hemorrhage blood volume in women giving birth either vaginally or by Caesarian section. The upregulation of estrogen levels could have increased uterine contractions and subsequently led to more forceful evacuation of the intrauterine residium (Li et al., 2011).

Besides being used to hinder blood flow, *Leonurus japonicus* herb extracts are also used as an emmenagogue, increasing blood flow to certain organs. This effect could be due to its property of increasing blood flow by decreasing blood viscosity, fibrinogen volume and platelet aggregation (Zou et al., 1989), as well as relaxation of blood vessels (Chen and Kwan, 2001; Morita et al., 2006). However, Yu Lin et al. (2003) demonstrated the opposite effect, with the extracts strongly inducing platelet aggregation. However, multiple actions of *Leonurus japonicus* extracts could be attributed to different substances found in *Leonurus japonicus.* Leonurine and prehispanolone extracted from the plant act as a platelet-aggregating factor inhibitors (Lee et al., 1991; Lin et al., 2007).

Leonurus japonicus herb extracts also displayed uterotonic properties, increasing uterine contractions in rats (Ma et al., 2000; Zhao et al., 2008) and rabbits (Ying and Pan, 2003). The effect has also been demonstrated in-vitro in human myometrium (Kong and Ng, 1974) and in clinical studies (Chan et al., 1983; Zhou et al., 2010). The uterotonic principle has been attributed to the compound leonurine (Kong et al., 1976; Yeung et al., 1977). The uterotonic property of *Leonurus japonicus* could explain its traditional use to expel the lochia and placenta after child birth, as well as a contraceptive, since uterotonic substances cause anti-fertility by making the ovum pass down the fallopian tube faster (Kong and Ng, 1974).

Aside from being uterotonic, *Leonurus japonicus* herb extracts were also found to be analgesic and anti-inflammatory (Wang et al., 2009), reduce PGF_2-α and PGE_2 concentrations, and increase progesterone levels (Jin et al., 2004). These properties, especially when combined, could explain its traditional use to treat dysmenorrhea. However, Zhang et al. (2010) found no significant anti-inflammatory or analgesic activity in herb extracts of *Leonurus japonicus*.

Furthermore, an antimicrobial protein extracted from the seeds of *Leonurus japonicus*, was found to inhibit a wide range of fungi and bacteria (Yang et al., 2006). The antimicrobial properties of the plant could explain its traditional use in postpartum baths and recovery.

4.8. *Psidium guajava* L.

Psidium guajava (Myrtaceae) was mentioned in 16 publications in 24 species-use-reports, and has traditionally been used to treat pain, profuse uterine bleeding, blenorrhagia, menstrual disorders, amenorrhea, and as emmenagogue. Postpartum it is used to expel the lochia and placenta, as a steam bath, as well as to aid the maternal recovery. There is also one report of it being used to prevent abortion (Petard, 1972).

Most of the studies on *Psidium guajava* have focused on the treatment of diarrhea and other gastrointestinal diseases. Numerous studies detailed its spasmolytic activities in the small intestine of animals (cf. Begum et al., 2002). The relaxing effects seem to extend to other smooth muscles as well. Leaf extracts inhibited the contractions of rat uterus (Chiwororo and Ojewole, 2009). Quercetin, kaempferol and other flavonoids have been isolated from *Psidium guajava* (Seshadri and Vasishta, 1964; Zhang et al., 2006), and Revuelta et al. (1997) has found kaempferol and quercetin to reduce contractions in rat uterus. The ability of *Psidium guajava* to affect the uterus could provide some explanation to its traditional use to prevent abortion and during the postpartum period.

In addition, the essential oils (Santos et al., 1998), extracts of the fruit (Sen et al., 1995) and leaf (Olajide et al., 1999; Shaheen et al., 2000; Ojewole, 2006) have demonstrated analgesic activities, which could justify its folkloric use in treating pain. The antinociceptive principle in the essential oil has been isolated to the constituent, α-pinene (Santos et al., 1998). Furthermore, the mechanism of the analgesic effect appears to involve adenosine receptors, and is independent of the activation of opiod receptors (Santos et al., 1998). Extracts of the leaves were even found to be effective in treating dysmenorrhea in a human clinical trial (Doubova et al., 2007).

Furthermore, extracts of the leaves (Sen et al., 1995; Olajide et al., 1999; Ojewole, 2006; Dutta and Das, 2010) and the volatile oils (Kavimani et al., 1997) have been shown to be anti-inflammatory and inhibiting edema formation. Anti-inflammatory effects augment its analgesic activity, and lend support to its traditional use in helping the mother recover after pregnancy. Leaf extracts inhibit cycloxygenase and hyperoxide activity of prostaglandin endoperoxidase H synthase (PGHS), a key enzyme in prostaglandin synthesis and inflammation-mediation (Kawakami et al., 2009). Quercetin was also noted in a review by Bischoff (2008) to suppress the production of leukotriene B4, TNF-α and nitric oxide by macrophages, microglial cells and mast cells, which all play a role in inflammation.

Extracts of the leaves (Qian and Nihorimbere, 2004; Chen and Yen, 2007; You et al., 2011) and fruit (Huang et al., 2011; You et al., 2011) have antioxidant and free radical scavenging activity, and leaf extracts enhance wound healing activity (Chah et al., 2006). The antioxidant and wound healing activity, and the anti-stress activity of leaf extracts (Lakshmi and Sudhakar, 2009) could provide additional benefits to the recovering mother. In addition, the traditional use of the bark (Abdelrahim et al., 2002; Sanches et al., 2005), leaves (Sanches et al., 2005; Nair and Chanda, 2007; Chandekar and Madhugiri, 2011), and roots (Sanches et al., 2005) of *Psidium guajava* in postpartum steam baths could be beneficial in preventing infection and sepsis as it has been reported to have antibacterial and antifungal effects.

The species has also been shown to have hormonal effects. Aqueous extracts of *Psidium guajava* leaves increased estradiol and progesterone levels, but had no effect on FSH and LH levels (Uboh et al., 2010). Being able to alter hormonal levels could provide grounds for its use in treating menstrual disorders and other fertility problems.

4.9. *Ricinus communis* L.

Ricinus communis (Euphorbiaceae) was mentioned in 18 publications in 28 species-use-reports, and was found to be used as an abortifacient, but it is also reported during parturition to ease delivery, reduce delivery pain and induce labor, and postpartum to expel the placenta, help the mother recover, and in steam baths. The plant was also reported to be used to treat breast tumors, menstrual disorders and abnormal vaginal discharges.

Castor oil, derived from *Ricinus communis*, is used as a vehicle for synthetic progesterone, 17-hydroxyprotesterone caproate, used in treating preterm labor. Castor oil in itself was found to enhance the oxytocin-induced contractility of the isolated human myometrium, suggesting a role in labor induction (O'Sullivan et al., 2010). Furthermore, Gao et al. (1998) demonstrated the induction of labor in pregnant rats fed with a castor oil diet. The same authors also showed that castor oil induced cervical ripening in pregnant rats and increased synthesis of PGE_2 in intrauterine tissues (Gao et al., 1999). Ricinoleic acid is the component likely to be causing the induction of labor (Gao et al., 1999).

In humans, Mathie and Dawson (1959) showed that castor oil increased the contractility of the uterus. While, Azhari et al. (2006) showed that castor oil was able to induce labor, but not increase contraction of the uterus. Labor induction has also been observed (Davis, 1984; Garry et al., 2000; Azarkish et al., 2008), but the effect is not as effective as the synthetic prostaglandin E_1 (PGE_1) analog, Misoprostol, in inducing labor (Wang et al., 1997). However, Boel et al. (2009), who did a review on labor induction, concluded that castor oil was not helpful in induction of labor. Time to birth between those given castor oil and those that did not, were not significantly different (Boel et al., 2009).

Aside from inducing labor, *Ricinus communis* has also been reported to ease delivery. An analgesic effect of the leaves was demonstrated in rats (Taur et al., 2011).

In addition to its uses in labor, *Ricinus communis* is also used as an abortifacient. The abortive effects of the seed extracts, particularly ricin-A, a compound derived from the plant, was demonstrated in rats (Salhab, 1996) and rabbits (Salhab et al., 1998). Moreover, high doses of the extract were found to be embryotoxic (Ekwere et al., 2011).

The prevention of post-coital implantation is an extension of the plant's abortive qualities. Oral administration of seed extracts exhibited anti-implantation in rats (Okwuasaba et al., 1991, 1997), guinea pigs (Makonnen et al., 1999) and rabbits (Salhab et al., 1998). In addition to preventing post-coital implantation, seed extracts protected from pregnancy in rats and rabbits (Okwuasaba et al., 1997; Salhab et al., 1997, 1999). Furthermore, in a clinical study, single dose oral administration of seed extracts was able to prevent pregnancy without any major side effects in female volunteers for 7–12 months (Okwuasaba et al., 1997; Das et al., 2000; Isichei et al., 2000). Castor bean extract (McNeil et al., 2004) and ricin-A (Salhab et al., 1999) inhibited ovulation. Moreover, oocytes pretreated with *Ricinus communis* agglutinin-I stopped the penetration by spermatozoa (Mori et al., 1989).

The estrogenicity of the seed extract, either directly affecting the fallopian tube, uterus or altering the delicate estrogen/progesterone balance, could have contributed to the anti-implantation and contraceptive properties (Han et al., 2008; Okwuasaba et al., 1991, 1997). However, Okwuasaba et al. (1997) also notes that since there were no side effects at least in humans, the antifertility activity may be due to non-hormonal mechanisms.

Relating to its use in breast cancer, ricin extracted from the plant was found in a review by Olsnes (2004) to have some anticancer and antitumor properties in animal models. However, unexpected side effects were observed when ricin was used therapeutically in humans. In more recent research, extracts of the leaves (Darmanin et al., 2009) and ricin toxin (Rao et al., 2005; Liao et al., 2011) were found to be cytotoxic in human cancer cell lines; and synthetic immunotoxins have been created with a lectin from ricin to selectively target cancer cells (Roy et al., 1991; Engert et al., 1997; Schnell et al., 2003; Wang et al., 2007).

Since the extracts of leaves (Islam et al., 2010), roots (Mathur et al., 2011) and seeds (Jombo and Enenebeaku, 2007, 2008; Khan et al., 2011) have been found to possess antibacterial and antifungal activity, and this could provide some basis to its traditional use in treating gonorrhea and leucorrhea, which are usually caused by bacteria and fungi.

Studies of a derived polymer (Valderramas et al., 2008) and the roots (Ilavarasan et al., 2006) show that *Ricinus communis* has anti-inflammatory activity. Anti-inflammation is probably brought about by the inhibition of phospholipase A_2 (Valderramas et al., 2008). Extracts of the roots (Ilavarasan et al., 2006) and the essential oils (Kadri et al., 2011) also have antioxidant and free radical scavenging properties. Ascorbate peroxidase (Klapheck et al., 1990), gallic acid, quercetin, gentisic acid, rutin, epicatechin and ellagic acid (Singh and Chauhan, 2009) are some of the antioxidant compounds found in this plant. The anti-inflammatory and antioxidant activities could account for the plant's reported use in postpartum recovery.

5. Conclusions

There is a clear need for ethnobotanical research to document plant use, and in particular to focus on traditionally ignored subjects such as women's health care. These traditions are common and widespread in Southeast Asia, and form the core of primary women's healthcare in many rural areas. Increasing the existing documentation of ethnobotany of the ethnic groups inhabiting Southeast Asia is essential as rapid assimilation with mainstream culture increases. Data collection aimed specifically at plant species used in women's healthcare remains scarce, and general ethnobotanical studies often overlook the variety and relative importance of plants used in women's healthcare.

Ethnobotanical studies from Asia highlight the diversity of plants used in women's healthcare, with nearly 2000 different species reported to treat different affections. At the same time many of these species are reported to treat many different affections, and nearly 900 species are mentioned twice or more, indicating a level of consensus among different peoples on the use of these species. However, traditional uses are often defined in terms of the symptoms they affect, and not the underlying causes. The limited means of diagnosis and the resulting cryptic descriptions of use can make it complicated to understand how certain traditional remedies could function.

Among the references identified in this review, the species with over 20 species-use reports are *Achyranthes aspera*, *Artemisia vulgaris*, *Blumea balsamifera*, *Carica papaya*, *Curcuma longa*, *Hibiscus rosa-sinensis*, *Leonurus japonicus*, *Psidium guajava* and *Ricinus communis*. These plant species with traditional uses in Southeast Asia for women's health have demonstrated analgesic, anti-implantation, anti-inflammatory, antimicrobial, blood coagulative, estrogenic, anti-estrogenic, spasmolytic, uterotonic, vasoconstrictive, vasorelaxant and wound healing properties that could have contributed to the alleviation of different conditions afflicting women. Many also have constituents with either clinically-proven efficacy or well-researched in-vivo effects related to their traditional use.

The most commonly reported uses were postpartum recovery, treat leucorrhea, stimulate menstrual flow, induce abortion, reduce uterine hemorrhage, and stimulate lactation, and the saliency of these uses reflects their importance as afflictions to women in this region. The postpartum period is important in many Southeast Asian cultures, and is seen as a period of recovery during which care should be taken to restore the mother to equilibrium (Manderson, 2003). In many cultures, the mother stays inside and near heat, washes only with hot water, drinks hot drinks, eats hot foods, and stays away from draughts (De Boer and Lamxay, 2009). Many of the nearly 800 recorded species-use-reports are for uses in steam baths and bathing and medicinal plant decoctions. Leucorrhea is a common manifestation and affects many women at some point in their lives. It can have many different causes, but the most common ones are estrogen imbalance, vaginal infections and sexually transmitted diseases, and the recorded plants are nearly always applied as topical medications. *Curcuma longa* and *Ricinus communis* have multiple species-use-reports for leucorrhea and in-vitro studies of extracts of both species have shown antibacterial activity, *Curcuma longa* (oil, Negi et al., 1999; rhizome, Singh et al., 2002; rhizome, Kim et al., 2005; rhizome, Niamsa and Sittiwet, 2009; rhizome, Naz et al., 2010; rhizome, Aly and Gumgumjee, 2011; volatile oils, Singh and Jain, 2011) and *Ricinus communis* (seeds, Jombo and Enenebeaku, 2007, fermented seeds, 2008; leaves, Islam et al., 2010; seeds, Khan et al., 2011; roots, Mathur et al., 2011). The 969 species-use-reports to stimulate menstrual flow, treat amenorrhea and induce abortion constitute nearly 20% of all species-use-reports. It is likely that many species reported to treat amenorrhea or those that stimulate the menstrual flow are in fact used for early-stage abortion, and grouping these together can facilitate studying the mechanisms of action of constituents of these species. *Hibiscus rosa-sinensis* and *Carica papaya* were most commonly reported for this group, with 14 and 11 species-use-reports respectively. *Hibiscus rosa-sinensis* has extensively studied in-vitro and in-vivo estrogenic effects (Kholkute and Udupa, 1976; Kholkute et al., 1977; Singh et al., 1982; Prakash et al., 1985, 1990; Nivsarkar et al., 2005; Vasudeva and Sharma, 2008), but no clinical trial data exists. *Carica papaya* has been studied extensively for its abortive properties, and constituents in the seeds and latex have been found to increase uterine contractility in animal models, that could lead to expulsion of its contents (Chinoy et al., 1995; Cherian, 2000; Adebiyi et al., 2002). Uterine hemorrhage, including primary postpartum hemorrhage and secondary postpartum hemorrhage, are a major cause of maternal morbidity (King et al., 1989), and it is no surprise that a diversity of traditional plant remedies exists. Most common among the species studied in depth for uterine hemorrhage is *Hibiscus rosa-sinensis*, but its efficacy has not been studied in-vivo. Another important use of plants in traditional women's healthcare is to stimulate lactation. A perception of a lack of breast milk is common (Pottier, 1978; Westfall, 2003b), and many people will complement their diets with specific plants to increase milk volume (De Boer and Lamxay, 2009; De Boer et al., 2012). Most commonly used are species that have white latex, such as *Euphorbia* spp., *Ficus* spp. and *Musa* spp., but the mechanism of lactagogue herbs remains largely unknown (Westfall, 2003b).

The review presented here of plants used in traditional medicine to treat women's health complaints in Southeast Asia could be included in a much needed comprehensive list of medicinal plants used globally in women's health research focusing on the pharmacological mechanisms and the efficacy of these species and their specific uses, that are both ancient and widespread, could provide insights that could help to augment and improve both local and Western women's healthcare. Many of these plant species could potentially harbor new drugs, and the compilation of data presented here is a first step towards a global review of common women's healthcare plants.

All plant species reviewed in this study require further study as most of the reviewed studies are still in the animal testing stages and target only single constituents. Traditional mixtures of plant parts and different species in herbal preparations on the other hand combine constituents with possible synergistic effects. Of the nine species reviewed here, *Achyranthes aspera*, *Carica papaya*, *Curcuma longa*, *Hibiscus rosa-sinensis*, *Leonurus japonicus*, *Psidium guajava* and *Ricinus communis* are show promising results in in-vivo experiments. Furthermore, clinical studies have demonstrated that herbal preparations of *Curcuma longa* aid wound healing after episiotomy (rhizome, Golmakani et al., 2009), *Leonurus japonicus* induces uterine contractions (aerial parts, Chan et al., 1983; aerial parts, Zhao et al., 2008), *Psidium guajava* relieves dysmenorrhea pain (leaves, Doubova et al., 2007) and *Ricinus communis* is a strong female contraceptive (Isichei et al., 2000). Research in to novel plant-based medications could benefit from focusing on those species with promising results in clinical trials. However, before introducing these herbal preparations to mainstream health care systems, better regulation and safety inspection of these herbal preparations is needed.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.jep.2013.11.030.

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