



Review Article

# Herbal Infusions and Women's Health: A Review of Findings with a Focus on Human Studies on Specific Infusions with Studies on Extracts to Evaluate Mechanisms

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## Abstract

**Aim:** The popularity of herbal infusions, particularly amongst women, is increasing. Whilst many herbal infusions are associated with health and wellness, some in particular are associated with women's health outcomes. This review gathers evidence on three specific herbal infusions-German chamomile, rose hip and spearmint.

**Methods:** This review focused on clinical trials investigating health outcomes of importance to women for German chamomile (*Matricaria chamomilla* L. Asteraceae), rose hip (*Rosa canina* L. Rosaceae) and spearmint (*Mentha spicata* L. Lamiaceae) infusions. Additional data collected was derived from human studies involving the extract of these herbs and from laboratory studies to gain an insight into potential mechanisms.

**Findings:** This review identified five human trials for German chamomile infusion, one for rose hip infusion and three for spearmint infusion. All nine clinical trials included women in the study group whilst some, which looked specifically at women's health issues, such as menstrual cycle related issues included only women. In a study involving postnatal women, German chamomile was found to improve aspects of sleep. In a further study, involving women German chamomile had a beneficial impact on Pre-Menstrual Syndrome (PMS), whilst in another study chamomile tea significantly reduced scores of menstrual pain, anxiety and stress compared with control. In two studies including both women and men in the study population, German chamomile was associated with improved metabolic control (glucose, insulin, blood lipids). In women, rose hip was associated with improved symptoms of menstrual pain and spearmint with improved hormone control. In a study involving both women and men, spearmint improved pain and stiffness in osteoarthritis. These infusions contain a range of phytochemicals, including flavonoids, which help to explain their health outcomes. Most of the human studies indicated that 1-3 cups daily with brewing times of 5-15 minutes provided the health benefit in question. **Conclusions:** From the evidence gathered for this review, these three herbal infusions could provide important specific health benefits for women. More clinical research in women is needed, specifically looking at individual ingredient infusions and amounts that could benefit women with specific brewing times.

**Keywords:** Herbal infusion; Women's health; Menstrual cycle; Sleep; Chamomile; Rose hip; Spearmint; Phytochemicals

## Introduction

Herbal infusions are historically important in Europe, increasingly popular in the UK and worldwide with a growing range of herbal ingredients used in infusions. Data from Mintel in 2019 indicated that herbal infusions accounted for 36% of the UK tea market [1]. This increase is related mainly to a growing health consciousness, particularly amongst women as they seek healthy, low calorie drinks that are low in caffeine and pleasant to drink with a range of potential wellness benefits. Herbal tea has a distinctly feminine appeal with herbal teas being consumed by 35% of women compared with 25% of men [2].

Scientific research increasingly backs the traditional uses for which herbal infusions have long been consumed. Improved health and wellness, as well as reduction in risk of specific conditions, is likely a reflection of the variety of antioxidant compounds present in all herbal teas [3]. Herbal infusions, depending on the type, are rich sources of alkaloids, carotenoids, coumarins, flavonoids, lignans and lignins, phenolic acids, polyacetylenes, saponins and terpenoids. Evidence shows that natural bioactive compounds such as these have antioxidant, anti-inflammatory, anti-ageing, anti-allergic and blood vessel dilating properties [4]. Whilst much remains to be understood regarding the mechanisms of herbal tea and its compounds in promoting health and wellness, new research suggests that their abundant antioxidant content facilitates cellular homeostasis, including the balance of repairing to damaging proteins and cell contents, so mediating the risk of diseases such as cardiovascular disease, diabetes, cancer and Alzheimer's disease [5].

Given the popularity of herbal infusions amongst women, there has been a relative gap in research focusing on the impact of herbal teas in this population group, particularly for health outcomes around menstruation and hormonal health as well as health and

wellness aspects that women care about, such as sleep and anxiety, ageing and so on. Under representation of women in clinical trials in general is an issue and in the case of drugs can often result in women being prescribed inappropriate doses of medication. Whilst the current review concerns infusions, gender differences may impact health outcomes and more studies employing infusions and teas in women are needed. A recent scoping review of 21 research publications included specific aspects of women's health, as well as cardiovascular disease, weight loss and diabetes [6]. However, reviews to date have not focused specifically on herbal infusions and women's health.

In the present review we focus on three specific herbal infusions: German chamomile *Matricaria chamomilla* L. Asteraceae), spearmint (*Mentha spicata* L. Lamiaceae) and rose hip teas (*Rosa canina* L. Rosaceae) with respect to women's health and wellness issues. NB: With regards to herbals, the terms infusion and tea are used interchangeably throughout this paper.

## Materials and Methods

A literature search was conducted to identify human trials examining inter-relationships between these three herbal infusions and markers of health with a focus on women. A National Centre for Biotechnology Information (PubMed) search was undertaken to identify these studies using the selection filter. Filters were applied to extract English language publications. Search terms applied were: "herbal tea/infusion/tisane", "chamomile tea/infusion/tisane", "peppermint/spearmint tea/infusion/tisane" and "rose hip/rose tea/infusion/tisane". Initially the filter was set to only identify human clinical trials and these studies are tabulated in Table 1. Table 1 summarises the human studies according to author, date of publication and country of research; number of participants, age and gender at baseline; study design; the number of cups of herbal infusion provided with the length of time the herb was infused; health outcomes measured; study findings. Publications were not included in Table 1, if they were not one of the named three infusions or were multiple/combined infusions, or were extracts rather than tea infusions in the form of a drink.

<b>Herbal tea/ infusion (author, year, location)</b>	<b>Population (number, age, gender, health)</b>	<b>Study design</b>	<b>Herbal tea intervention</b>	<b>Health outcome measurements</b>	<b>Key findings</b>
<b><i>Chamomile tea</i></b>					
Chang & Chen Taiwan [14]	80 postnatal women with poor sleep quality	2-week RCT	One 300 ml cup daily (each teabag contains 2g dried flowers of German chamomile; infused for 0-15 minutes in 300ml hot water)	Sleep, depression	Chamomile tea significantly reduced scores of symptoms of poor sleep and symptoms of depression
Jenabi et al (2010) Iran [13]	80 students	3 month semi- experimental study	2 cups of chamomile tea daily one week before menstruation and first five days of menstruation	Pain, anxiety, stress related to menstruation. Scales and questionnaires applied before the study and at 1 and 3 months	Chamomile tea significantly reduced scores of menstrual pain, anxiety and stress compared with control
Rafraf et al (2015) Iran [15]	64 patients (women and men) (30-60 years) with type 2 diabetes mellitus	8-week single blind RCT	Three 3 g/150 ml cups daily without milk or water; infused for 10 minutes in 150 ml water; consumed immediately after meals or water as a control	Glycaemic control, antioxidant status	Chamomile significantly reduced concentrations of glycosylated haemoglobin (HbA1C), serum insulin, total cholesterol, triglyceride and LDL cholesterol
Zemestani <i>et al</i> (2016) Iran [16]	64 patients (women and men) (30-60 years) with type 2 diabetes mellitus	8-week single blind RCT	Three 3 g/150 ml cups daily without milk or water; infused for 10 minutes in 150ml water; consumed immediately after meals or water as a control	Glycaemic control, antioxidant status	Chamomile tea significantly reduced HbA1C, serum insulin, HOMA and serum malondialdehyde. Total antioxidant status, superoxide dismutase, glutathione peroxidase and catalase activities significantly increased with chamomile tea
<b><i>Rose hip tea</i></b>					
Tseng et al (2015) Taiwan [42]	130 adolescent women	RCTs for 6 menstrual cycles	Two 300 ml cups (6 dry rosebuds infused in 300 ml hot water for 10 minutes) daily 1 week before menstrual period until the 5 <sup>th</sup> menstrual day for 6 cycles	Measures/scores of pain, menstrual symptoms, life quality, stress	Rose tea reduced perceived menstrual pain, distress, anxiety and improved wellbeing at 1, 3 and 6 months
<b><i>Spearmint tea</i></b>					

Akdogan et al (2017) Turkey [56]	21 people (18-40 years) with polycystic ovary syndrome (PCOS) or idiopathic hirsutism	5-day trial during the follicular phase of menstrual cycle	Two 250 ml spearmint tea ( <i>Mentha spicata</i> ) cups daily; 5 g dried leaves steeped for 5-10 minutes	Fasting blood samples	Spearmint tea significantly reduced free testosterone with significant increase in Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH); triglyceride levels reduced significantly
Connelly et al (2015) Canada [62]	62 women and men (mean age 60-70 years) with medically diagnosed osteoarthritis (OA) of the knee	16-week randomised parallel arm, double blind study	One 300 ml cup daily of high rosmarinic acid spearmint tea; 1 tea bag steeped for 5 minutes (280 mg rosmarinic acid); no milk, cream, sugar, sweetener vs control of commercial spearmint teabag (26 mg rosmarinic acid)	Walk and stair climbs	Spearmint tea significantly improved stiffness and physical disability scores in adults with knee OA, but only the high rosmarinic teas significantly reduced pain
Grant (2010) UK [61]	42 women (aged 19-42 years) with PCOS and hirsutism	30-day dual centre RCT	Two cups daily. Spearmint tea twice daily for 1 month or a placebo chamomile tea (no hormone disrupting properties)	Degree of hirsutism, skin appearance	Spearmint tea significantly reduced free and total testosterone. LH and FSH increased. Patient’s subjective assessment of hirsutism significantly reduced (i.e. improved)

**Table 1:** Human Studies Investigating herbal (chamomile, rose hip, spearmint) tea on aspects of women’s health.

Studies evaluating the health outcomes of extracts (e.g. powders, capsules, tablets) of the herbs in question (i.e. chamomile, rose hip and spearmint) were identified to provide further background. Relevant studies including ingredients in the three herbal teas were also identified for discussion on each of the three herbal teas to supplement evidence. When full texts were not available, these were purchased. Latin binomials were checked using the Kew Medicinal Plant Names Services database ([www.mpns.science.kew.org](http://www.mpns.science.kew.org)).

### German Chamomile infusion

German chamomile (*Matricaria chamomilla* L. Asteraceae; syn. *Matricaria recutita* L.) is frequently used for infusions. Data from Nielsen indicated that in 2019, over 450,000 cups of German chamomile tea were drunk daily in the UK-the equivalent of over 165,000,000 cups a year [7].

German chamomile should not be confused with the similar-looking Roman chamomile *Chamaemelum nobile* L. Asteraceae]. Both types of chamomile are native to southern and eastern Europe [8] and are used in tea, though German chamomile is the more commonly used. Nowadays, they are sourced throughout Europe, including the UK and in North African countries (e.g. Egypt and Morocco). Both types of chamomile were used medicinally by

the ancient Egyptians, Romans, and Greeks, and remain popular worldwide.

### Phytochemistry

German chamomile contains a diverse range of compounds [9,10]. These include:

- Coumarins: umbelliferone and its methyl ether, heniarin
- Flavonoids: apigenin, apigenin, apigenin, luteolin patuletin, quercetin, and glucosides.
- Sesquiterpenes, including matricin
- Terpenoids, including chamazulene, alpha bisabolol, and bisabolol oxides,
- Volatile essential oils (contains chamazulene, spiroethers, sesquiterpenes, cadinene, farnesene, furfural, spanthulenol.

Other constituents include: amino acids, anthemic acid, choline, fatty acids, polysaccharides (e.g. inulin, fructooligosaccharides and pectin, which may act as prebiotics) tannin and triterpene hydrocarbons (e.g. triacontane) and minerals.

### Traditional use

Traditionally, German chamomile is used for gastrointestinal

disorders, haemorrhoids, hay fever, inflammation, insomnia, menstrual disorders, muscle spasms, nasal catarrh, rheumatic pain, travel sickness, ulcers and wounds [10]. The German Commission E has approved use of German chamomile for gastrointestinal spasms and inflammatory diseases of the gastrointestinal tract. The European Union herbal monograph for *Matricaria recutita* L., flos identifies a range of traditional uses including minor gastrointestinal complaints, the common cold, inflammation of the mouth and throat, inflammation and irritation of the skin [11].

### Pharmacological activity

According to the findings of modern research, German chamomile is stated to possess anti-inflammatory, anti-spasmodic, anti-septic, anti-catarrhal, carminative and mild sedative properties [12]. Laboratory studies also suggest that German chamomile has antioxidant and antimicrobial activities, and significant antiplatelet activity. Animal model studies indicate it has anti-inflammatory action, cholesterol-lowering activities and anti-anxiety effects [12].

### Clinical trials

Four Randomised Controlled Trials (RCTs) in humans of relevance to women's health have studied the effects of German chamomile tea on several aspects of health (Table 1).

German chamomile tea has been evaluated for an impact on menstrual symptoms. A three-month semi-experimental study evaluated scores for menstrual pain, anxiety and stress in 80 female students who received two cups of German chamomile tea daily one week before menstruation and during the first five days of menstruation. Data were gathered using four separate questionnaires (McGill Pain Questionnaire, Visual Analogues Scales for Anxiety, Perceived Stress Scale and the Psycho physiologic Life Adaptation Scale). These measurement scales were applied to the participants before the start of the study and on the first and third months respectively. The German chamomile tea study group had significantly reduced menstrual pain, distress and anxiety compared to the control group. There were statistically significant differences between the tea and control groups when the mean scores on the four questionnaires were added together on the first and third months of drinking German chamomile tea [13].

German chamomile is most commonly associated with a sedative and anti-anxiety effect and used to promote sleep. One two-week RCT conducted on 80 mothers with poor sleep quality 6 weeks after giving birth found that drinking one cup (300 ml) daily of German chamomile tea, infused for 15 minutes can improve sleep quality and symptoms of depression [14].

Two other RCTs focussed on the markers of glycaemic control in patients with type 2 diabetes mellitus. Firstly, a single blind 8-week RCT in 64 individuals (women and men; 30-60 years) with type 2 diabetes mellitus found that German chamomile

tea (3 g/150 ml hot water) infused for 10 minutes three times a day immediately after meals significantly decreased concentrations of glycosylated haemoglobin, (HbA1c), serum insulin levels, Homeostatic Model Assessment (HOMA) for insulin resistance, total cholesterol, triglycerides ( $p < 0.001$ ), and Low-Density Lipoprotein (LDL) cholesterol compared with the control group. No significant changes were shown in serum High-Density Lipoprotein (HDL) cholesterol levels in both groups [15].

In another piece of research using the same data set, German chamomile tea again significantly decreased concentration of glycosylated haemoglobin, serum insulin levels, HOMA and serum malondialdehyde (a marker of oxidation), compared with control group. Total antioxidant capacity, and enzymes with antioxidant capacity- i.e. superoxide dismutase, glutathione peroxidase, and catalase activities were significantly increased by 6.81%, 26.16 %, 36.71 % and 45.06% respectively in the German chamomile group compared with these variables in the control group at the end of the intervention [16].

### Studies with German chamomile extract

Evidence of benefit for chamomile in sleep also comes from studies with German chamomile extract. A single-blind RCT in 60 elderly women and men found that 200 mg daily of chamomile extract improved sleep quality [17]. A double-blind RCT in 34 patients (18-65 years) with primary insomnia found that 270 mg of German chamomile extract twice daily for 28-days found no significant differences between the German chamomile and control groups in changes in sleep diary measures, including total sleep time, sleep efficiency, sleep latency, wake after sleep onset, sleep quality, and number of awakenings. But there were modest benefits in daytime functioning [18].

An 8-week RCT in 61 outpatients with Generalised Anxiety Disorder (GAD) suggested that German chamomile extract reduces anxiety in these patients [19]. In an open RCT on 179 patients with GAD, 1500 mg daily of German chamomile extract for 8 weeks produced a positive response on the GAD score in 58% of the patients [20]. In a longer-term study (12 weeks of German chamomile extract with no control plus 26 weeks of either German chamomile or control), German chamomile reduced moderate to severe anxiety but did not reduce rate of relapse [21].

An exploratory analysis as part of the same RCT analysed findings from patients with or without depression. After 8 weeks, German chamomile extract produced a similar reduction in anxiety in those with and without depression, but the reductions in anxiety were significantly greater in the patients with depression [22].

Of particular relevance to women's health are studies on menstrual health where in an RCT in 90 students, German chamomile in comparison with mefenamic acid reduced the intensity of emotional symptoms, but not physical pain [23].

A double-blind RCT in 60 young women found that German chamomile extract reduced the pain of mild to moderate cyclical mastalgia (breast pain linked to menstrual periods) [24]. An RCT in 118 female students found that German chamomile extract 250 mg three times a day reduced menstrual bleeding compared with placebo. There was no difference in duration or frequency of menstruation [25]. More recently, a clinical trial in 118 female students given a German chamomile extract capsule every 8 hours for 7 days before menstrual bleeding found that the chamomile capsules were more effective than control in reducing menstruation-related mood disorders [26]. A systematic review of seven clinical trials involving 1033 participants evaluated the impact of German chamomile extract on pain and bleeding in primary dysmenorrhoea. Two out of seven studies examined the effect of German chamomile on the pain of primary dysmenorrhoea, two studies on the effect of chamomile on menstrual bleeding volume, and three on the effect of German chamomile on pain and menstrual bleeding in primary dysmenorrhoea. This systematic review suggested that German chamomile was an effective treatment for the pain of primary dysmenorrhoea and reduction of menstrual bleeding [27].

A systematic review of 8 RCTs found that German chamomile is effective for relief of PMS because of anti-inflammatory effects (suggested to be due to the chamazulene and  $\alpha$ -bisabolol content); anti-spasmodic effects (suggested to be due to the apigenin, quercetin, and luteolin, heniarin/7-methoxycoumarin, matrisin, and phytoestrogen content); anti-anxiety effects (glycine, flavonoids) [28]. German chamomile extract has also been tested in Polycystic Ovary Syndrome (PCOS). In an RCT in 80 women with PCOS German chamomile 370 mg three times daily reduced testosterone but had no impact on the hormone dehydroepiandrosterone and no impact on the ratio of Luteinising Hormone (LH) to Follicle-Stimulating Hormone (FSH) [29].

### **Mechanistic studies**

With regards to possible mechanisms and of relevance to the clinical trials demonstrating a sedative impact of German chamomile, amongst the polysaccharides found in the tea, a highly substituted 4-O-methyl-D-glucuronoxylan (fraction SN-50R) demonstrates sedative and anxiolytic-like effects and may be contributing to the calming effects obtained by ingestion [30].

Of relevance to the clinical findings that German chamomile infusion can have a positive impact on glycaemic control, laboratory studies have indicated that German chamomile extract and some of its components (e.g. esculetin, luteolin and quercetin) can suppress hyperglycaemia in a model of type 2 diabetes [31]. A further modelling study suggested that German chamomile tea has a glucose lowering effect [32]. *In vivo* research work [33] shows that German chamomile tea inhibits digestive enzymes

related to sugar release along with sugar transport pathways (GLUT2 and GLUT5), potentially managing sugar absorption and metabolism. Amongst the compounds in German chamomile, apigenin-7-O-glucoside, apigenin, and (Z) and (E)-2-hydroxy-4-methoxycinnamic acid glucosides appear to be the active polyphenols, capable of impacting carbohydrate digestion and absorption [34]. Together, these laboratory findings could explain some of the findings from the human studies showing a positive impact on glucose and insulin.

### **Rose hip infusion**

Rose hip (*Rosa canina* L. Rosaceae) is commonly used to make infusions. There are approximately 100 *Rosa* species found across Europe, Asia, and North America [35]. Rose hip, which can be obtained from various *Rosa* species, is the ripe, dried receptacle (hip) of the rose that contains the pseudocarp and seed.

### **Phytochemistry**

Rose hip contains an abundance of vitamin C and polyphenolic compounds, including flavonoids (chiefly flavanols: quercetin, rutin, hesperidin, kaempferol; and flavones: tiliroside), pectin, sugars (glucose, fructose, sucrose), tannins, proanthocyanidins, leucoanthocyanins and catechins [36,37]. Rose hip also contains carotenoids (carotene and lutein). The wild rose hip fruit is also naturally high (12.9-35.2 mg/100 g) in lycopene, the pigment found in tomatoes [38]. Organic acids, including malic and citric acids, are also present. The amount of these compounds in rose hips varies considerably, depending on the plant species, time of harvest and altitude at which the plant is grown [39].

The calyx provides vitamins A, B, C, E, potassium and phosphorus but is particularly high in vitamin C. Processing of rose hip, including cutting of the rose hip and air-drying have an impact on the vitamin C content. For example, cutting before drying accelerates the drying process and results in greater retention of vitamin C [40]. With regards to rose hip tea, brewing conditions have been shown to have an impact on the content of vitamin C and polyphenolics. In one study, optimal "brewing conditions" for rose hip tea was an infusion time of 6-8 minutes and temperature 84-86°C which resulted in the tea providing 3.15 mg/100 ml of ascorbic acid, 61.44 mg/100 ml of total phenolic content and 2,591 mmol of ferric reducing antioxidant power [41].

### **Traditional use**

Rose hip tea has long been used in traditional medicine to alleviate menstrual pain [42]. Rose hip tea has mucilaginous properties that coat and soothe mucous membranes in the throat and throughout the gastrointestinal tract. The tea has traditionally been used as a demulcent for treating a sore throat and digestive upsets.

## Pharmacological activity

Scientific research has suggested a wide range of pharmacological activities for rose hip including antioxidant, anti-inflammatory, immune function support, anti-obesity, anti-cancer, cardio protective, protective effects on the liver and kidneys, anti-aging and neuroprotection [36,37]. These suggested activities are linked mainly to the antioxidant content of rose hips. Polyphenolics have antioxidant activity and could prevent oxidation-related disease [43].

The range of vitamins in rose hip, particularly vitamin C, as well as polyphenols, play a role in immune function. Vitamin C stimulates the production of lymphocytes [44] and supports the epithelial barrier function (e.g. the skin and respiratory tract) [45]. Flavonoids also support immune function [46]. Laboratory studies have indicated that concentrated rose hip extract may support immune function [47], but human studies are lacking.

## Clinical studies

Rose hip tea has long been used in traditional medicine to alleviate menstrual pain [42]. In one six-month RCT (Table 1), 130 adolescent young women with primary dysmenorrhoea (menstrual cramps) consumed two cups of rose hip tea daily (each 300 ml) infused for 10 minutes one week before menstruation and continuing until the fifth day of menstruation. Perception of menstrual pain, distress and anxiety were reduced and these women reported greater psychophysiological well-being compared to placebo [42]. These findings suggest that rose hip tea could be an effective non-pharmacological strategy for women with primary dysmenorrhoea.

## Studies with rose hip extract

Rose hip extract has been shown to have anti-inflammatory activity in people with joint pain. In a review of three studies, supplementing with rose hip significantly reduced joint pain in people with osteoarthritis. Furthermore, those receiving rose hip were twice as likely to report improved pain levels, compared with the placebo group [48].

Another 4-month study in 100 people with osteoarthritis found that those who supplemented with 5 g of rose hip extract daily experienced significantly less pain and increased hip joint mobility compared with the control group [49] with 65% of the participants in the rose hip group reporting some reduction in pain. Rose hip extract has also been suggested to aid rheumatoid arthritis, though research is limited, and high-quality human studies are lacking [35].

The suggested cardio protective benefits of rose hip (see pharmacological activities above) may also lie in the content of vitamin C and flavonoids. A 6-week study in 31 adults with obesity and impaired glucose tolerance found that those who consumed a

drink containing 40 g of rose hip powder per day (an amount which would not be available in a cup of rose hip tea) had significantly improved blood pressure and LDL cholesterol levels, compared with the control group [50]. However, the researchers suggested that these effects may have been partially due to the high fibre content of the rose hip powder, which is not present in rose hip tea.

Rose hip may help weight loss. Rose hips from the *Rosa canina* plant are high in the antioxidant tiliroside which is suggested to aid weight loss. In an 8-week laboratory study, a high-fat diet containing 1% rose hip extract led to significantly less body weight and stomach fat gain than than controls [51]. Human research shows similar results. In a 12-week study in 32 adults with excess weight, taking 100 mg of rose hip extract daily significantly decreased body weight and abdominal fat compared with the placebo group [52]. However, current research is limited to the effects of concentrated rose hip extract-not tea. More human studies are needed to evaluate the relationship between rose hip tea and weight loss.

Preliminary research indicates that rose hip extract may reduce skin ageing. In a double-blind RCT involving 34 healthy subjects, aged 35-65 years, with wrinkles on the face (crow's-foot) rose hip powder improved wrinkles, skin elasticity and skin moisture after 8 weeks of treatment [53].

Some research suggests that rose hip powder may protect against type 2 diabetes. In a laboratory study supplementing a high fat diet with rose hip powder over 10-20 weeks significantly reduced risk factors for diabetes including blood sugar levels, fasting insulin levels, and fat cell growth in the liver [54]. In another laboratory study, rose hip extract significantly lowered fasting blood sugar levels in animals with diabetes [55]. However, in a study in adults with obesity, supplementing with rose hip powder daily had no significant effects on fasting glucose levels or insulin sensitivity. These results applied to people with healthy and impaired blood sugar levels alike [52]. As with weight loss, current research is limited to rose hip extract, and more studies on the relationship between rose hip tea and type 2 diabetes risk are needed.

## Mechanistic studies

How the effects on menstrual pain (Table 1) and well-being occur with rose hip tea consumption is unclear. Rose hip is known to have anti-inflammatory effects including the reduction of pro-inflammatory cytokines and inhibition of pro-inflammatory enzymes, including prostaglandin-endoperoxide synthase (PTGS-1 and -2). Rose hip also has the capacity to reduce inflammatory C-reactive protein levels, pro-inflammatory metalloproteases and pro-inflammatory NF- $\kappa$ B signalling [37]. These impacts on inflammation could contribute to the reduction in menstrual pain. Biochemical markers of relevance in the menstrual cycle such as hormones have not been studied and may also be of relevance.

## **Spearmint infusion**

Mint, of which there are two main types: spearmint (*Mentha spicata* L. Lamiaceae) and peppermint (*Mentha x piperita* L. Lamiaceae), is a popular infusion [56]. Spearmint, which is discussed in this paper, is the less well known of the two but research shows consumption may be linked to outcomes of importance to women's health. Spearmint is a perennial plant with origins in Europe and Asia but is now commonly grown in all five continents around the world. Spearmint gets its name from its characteristic spear-shaped leaves. The infusion is made from fresh or dried leaves.

## **Phytochemistry**

Mint leaves contain a range of polyphenolic compounds, in particular the phenolic rosmarinic acid and the flavonoids including eriocitrin, hesperidin and luteolin [56]. It contains some menthol, but less than peppermint, limonene, dihydrocarvone and cineole.

## **Traditional use**

Spearmint has traditionally been used in herbal medicine for digestive disorders including wind, indigestion, nausea, diarrhoea, upper gastrointestinal tract spasms, Irritable Bowel Syndrome (IBS), bile duct and gallbladder swelling (inflammation), gallstones, colds, muscle and joint pain, headaches, toothache and sore throat. Having a pleasantly sweet taste, it is also used to flavour mouthwash and toothpaste and in the food industry to flavour chewing gum, sweets and chocolate [56].

## **Pharmacological activities**

Spearmint extract has antioxidant, antimicrobial and anticancer properties as demonstrated in laboratory studies [57] with spearmint essential oil showing antimicrobial, antioxidant, anticancer and both extract and essential oil demonstrating hepatoprotective activities [58]. It also has anti-inflammatory activities [59,60] with a potential to have a beneficial impact on arthritic conditions. Spearmint has also been shown to alter hormone levels and improve hirsutism, a condition where women have thick, hair on their face, neck, chest, abdomen, lower back, buttocks or thighs [56].

## **Clinical trials**

Three human trials have evaluated effects of spearmint teas on aspects of women's health (Table 1). Two trials examined the effects of spearmint tea on female androgen levels and the impact on hirsutism. An intervention study involving 21 women (aged 18-40 years) with hirsutism and/or Polycystic Ovarian Syndrome (PCOS) provided them with 2 cups of spearmint tea daily (5 g dried leaves) steeped for 5-10 minutes during the first 5 days of the follicular phase of the menstrual cycle. Compared with baseline, after 5 days, there was a significant reduction in free testosterone

and increase in LH, FSH and oestradiol [56]. There was no decrease in total testosterone and the authors suggest that a decrease in free testosterone without a decrease in total testosterone is likely due to more testosterone bound to the Sex-Hormone Binding Globulin (SHBG). Since free testosterone is the active form of testosterone, the authors conclude that spearmint tea may be helpful as an anti-androgenic treatment for hirsutism.

A 30-day RCT enrolled 42 women (aged 19-42 years) with hirsutism and PCOS and found that spearmint tea consumption (2 cups daily) led to significant reductions in total and free testosterone levels, improved LH and FSH levels and the women's subjective assessment of hirsutism was also improved [61]. These findings from these studies imply that that spearmint tea has anti-androgenic properties but they were short-term studies and longer studies are needed.

Spearmint also has anti-inflammatory effects and spearmint tea has been evaluated in osteoarthritis. In a controlled trial 62 women and men (aged 60-70 years) with medically diagnosed osteoarthritis were randomised to drink high-rosmarinic acid spearmint tea or commercial spearmint tea twice daily over 16 weeks. Daily ingestion of both high-rosmarinic and commercial spearmint teas significantly improved stiffness and physical disability scores in subjects with knee osteoarthritis, but only the high-rosmarinic tea significantly decreased pain [62].

## **Studies with spearmint extract**

There is some limited evidence that spearmint may improve memory. A study in 90 women and men with age associated memory decline found that 900 mg daily spearmint extract improved quality of working memory by 15% and spatial working memory by 9% with improvements in ability to fall asleep compared to placebo. Trends for improved mood, alertness and behaviour were also evident [63]. A further human study using spearmint extract 900 mg daily in 142 women and men (aged 50-70 years) found that spearmint improved cognitive function [64].

Although there are no studies in humans, findings from laboratory studies suggest that spearmint may reduce blood glucose [65,66]. There is some evidence from laboratory studies that spearmint extract improves sleep and reduces anxiety [67]. This could partly be due to the menthol content of spearmint in that menthol may promote relaxation by interacting with the Gamma-Aminobutyric Acid (GABA) receptors in the brain [68].

## **Mechanistic studies**

With regards to mechanisms that might help to explain the findings from the clinical trials of spearmint tea in hirsutism and PCOS, specifically peppermint tea has been found to modulate hormone levels in laboratory research. In further laboratory studies, peppermint tea exposure also reduced total testosterone



and increased FSH and LH levels [69].

With regards to inflammation and of relevance to the human trial with spearmint infusion [62], a biological extraction/metabolism of high-rosmarinic acid spearmint has been shown to have inhibitory effects on pro-inflammatory lipopolysaccharide (LPS)-induced prostaglandin E(2) (PGE(2)), nitric oxide (NO) and glycosaminoglycan (GAG) release in laboratory research (70,71). Other laboratory research suggests that spearmint extract has anti-inflammatory, analgesic and antipyretic effects which supports its use as an anti-inflammatory in traditional medicine [72].

## Discussion

Few reviews of herbal infusions have focused to date on aspects of women's health. Given the popularity of herbal teas amongst women this a gap in the scientific literature. Women are increasingly turning to herbal infusions for their flavour, lack of caffeine and, assuming they are drunk without milk and sugar, their lack of calories. Herbal infusions, whilst growing in popularity, are still relatively novel and enhance the choice of beverages both inside and outside the home.

Although women consume herbal infusions for their general health and wellness benefits, the more specific health attributes of herbal infusions are less well known and appreciated. In this review we have focused on three specific herbal infusions where clinical trials have shown beneficial links with specific aspects of women's health including menstruation (chamomile and rose hip infusion) and hormones (spearmint infusion). Other health issues, whilst not specific to women, are of interest to women, such as sleep and anxiety (German chamomile infusion) and glucose and insulin metabolism (German chamomile infusion).

Every woman experiences natural periods of hormone imbalance or fluctuations at particular times in their lives, including most obviously the menarche (first occurrence of menstruation - usually in teenage girls), the menstrual cycle, pregnancy and menopause. However, hormonal imbalances can also occur when various endocrine glands do not function properly. For women these could include the ovaries and the feedback loop for female hormones through the pituitary gland and the hypothalamus. Hormonal imbalances (not specific to but of concern to women) include those linked with the pancreas (diabetes mellitus), the thyroid and parathyroid glands and the adrenal glands. Because of their pivotal role in the body, even small hormonal imbalances can have a significant impact on health.

With regards to the main female hormones (oestrogen and progesterone), statistics from the non-peer reviewed literature in the United States suggest that as many as 80% of women may suffer from hormone imbalance [73]. Knowledge of hormonal imbalances appears to be quite poor. Whilst many women may

be aware that menstrual irregularities and menopause are linked to hormonal imbalances, US data also show that 70% of women may be unaware that conditions like Polycystic Ovary Syndrome (PCOS) are associated with hormonal imbalance.

That two controlled studies in women with PCOS conducted in different countries show that two cups of spearmint infusion daily improve FSH and LH levels as well as reducing testosterone levels is promising [56,61]. However, these studies involved small numbers of women and were of short duration. More controlled studies with more women involved in the interventions are needed to confirm these promising findings.

German chamomile, another infusion we focused on for this review has, in a controlled clinical study, been found to reduce menstrual pain, distress and anxiety [13]. In a clinical trial chamomile extract was effective in controlling menstruation related mood disorders [26] whilst in a meta-analysis of 8 RCT's, chamomile extract has been found to help in Premenstrual Syndrome (PMS) due to its suggested anti-inflammatory, anti-spasmodic and anxiolytic effects [28]. German chamomile extract has also been found to reduce menstrual bleeding [25] and in a meta-analysis of seven clinical trials to reduce both pain and menstrual bleeding [27].

Rose hip tea has traditionally been used to manage menstrual irregularities, particularly menstrual pain. Again, it is promising that a clinical trial has evaluated rose hip tea with a positive outcome for this purpose, this time in a reasonably lengthy study of 6 months duration in 130 women [42]. Mechanistically, a wealth of laboratory evidence shows that rose hip has powerful anti-inflammatory activity reducing pro-inflammatory cytokines and C-reactive protein [37] but better studies evaluating biochemical markers for inflammation are needed.

Our findings in this review have provided further evidence for the anti-inflammatory effect of rose hip in that studies have indicated that rose hip extract reduces pain in osteoarthritis [48] and possibly rheumatoid arthritis [35]. Spearmint too has demonstrable anti-inflammatory effect due to its content of rosmarinic acid. In this review we identified a clinical trial evaluating an intervention of one cup daily of high rosmarinic acid spearmint tea in men and women with diagnosed knee osteoarthritis [62] in which the intervention group experienced reduced pain and stiffness.

Incidence of diabetes continues to increase in the UK with statistics from Diabetes UK showing that 4.9 million people in the UK suffer from this condition with 13.6 million now at increased risk of type 2 diabetes. With regard to risk reduction, weight loss where appropriate should be recommended with a focus on healthy food and drink in accordance with the UK Eatwell Guide. In two clinical trials [15,16] German chamomile tea was found to improve markers of metabolic (glucose, insulin, blood lipids)

control. Laboratory studies have shown that spearmint, too, may reduce blood glucose [65,66] although no clinical trials have been conducted and no studies with tea. One clinical study has shown that rose hip extract reduces body weight [49] and 40 g of rose hip powder in the form of a drink was shown to improve blood pressure and concentrations of LDL cholesterol [50].

Sleep plays an integral role in health [74]. Lack of sleep or poor quality sleep has a negative impact on mental and physical health. Poor sleep can lead to depression and anxiety whilst the reverse is also true that poor mental health can lead to poor sleep. Not surprisingly, the COVID-19 pandemic has had a deleterious impact on sleep. A 2020 study by Kings College London and Ipsos MORI with 52% of women saying their sleep has been disturbed more than usual, somewhat more than the 46% of men who say their sleep remained the same. Women have a lifetime risk of insomnia that is around 40% higher than that of men [75]. Women experience sleep differently than men and present with different sleep challenges and disorders due to life events and hormonal changes of childbirth, menstruation, pregnancy and menopause. Whilst research on women's sleep issues is in its infancy, studies are beginning to unravel the fundamental roles that female hormones play in sleep regulation [75,76].

German chamomile tea has long been used for its mild sedative effects to help sleep and the findings of the clinical trial in 80 new mothers that one cup of German chamomile tea reduced both poor sleep and symptoms of depression [14] should be re-evaluated in a larger study as well as in other studies looking at sleep issues throughout women's lifecycles. Ample mechanistic evidence suggesting that specific German chamomile ingredients have sedative and anxiolytic effects [30] as well as its traditional use for this indication make such research worth pursuing.

The findings from our review indicate significant potential health benefits for German chamomile, rose hip and spearmint for women's health consumed in amounts of 1-3 cups daily and infused for 5-15 minutes before consumption. However, much more research needs to be conducted, specifically human intervention trials involving women with teas that are appropriately characterised so that ingredients are known and health outcomes can be well validated. Whilst many teas on the market are mixtures and not single ingredients, it is important to establish the health effects of infusions containing a single plant.

Apart from the specific health outcomes evaluated for these three teas in this review, herbal infusions can be considered to be healthy drinks largely devoid of caffeine and which can be consumed without sugar. They are pleasant to taste and also pleasing to look at particularly when served in a glass and can be enjoyed for their contribution to overall physical and mental wellness.

## Conclusion

The evidence from human trials collected for this review indicates that German chamomile, rose hip and spearmint tea could have beneficial effects in women's health, improving hormone levels, reducing menstrual pain and PMS and improving sleep, including after childbirth. Clinical trials also showed benefit in other health areas of concern, if not specific, to women, including metabolic control and reducing pain and stiffness in arthritic conditions. These findings suggest that women could include herbal infusions as part of their daily routine to help maintain health and wellness.

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