ISSN: 2474-1353

Vasa et al. Int J Womens Health Wellness 2025, 11:165
DOI: 10.23937/2474-1353/1510165
Volume 11 | Issue 1
Open Access

International Journal of
Women's Health and Wellness

REVIEW ARTICLE

Spices, Oils, and Teas: A Comprehensive Review Exploring Impact on Female Fertility

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Abstract

Background: For generations, there has been conscious incorporation of various ingredients into diets with the goal of health improvement. Many studies have been conducted to evaluate impact of specific ingredients in conjunction with a spectrum of maladies; however, there has been a dearth of research exploring any impact on female fertility. In this review, we provide a comprehensive analysis evaluating the relationship between ingestion of specific spices, oils, and teas on female fertility.

Methods: Literature was gathered through use of several databases such as PubMed, Cochrane, Embase, and Google Scholar. An exhaustive list of search terms pertaining to the dietary items mentioned prior was used. Out of an initial 15,909 articles, only 30 studies met inclusion criteria. Inclusion criteria included: English studies between January 2012-May 2024, randomized controlled trials, case controls, cohorts, case series, case reports, systematic reviews, and meta-analyses. Exclusion criteria included: research completed prior to 2012, non-relevant, and non-English.

Results: 18.6% (11/59) spices, 22.2% (4/18) oils, and 6.7% (1/15) teas were studied with female fertility. The following spices have a dose-dependent negative impact on female reproduction: Mugwort, coriander, white wormwood, monosodium glutamate, ginkgo biloba; conversely, these spices have a dose-dependent positive impact: Dong quai, clove, cinnamon, turmeric, sage, and aloe vera. Further, evening primrose oil, extra virgin olive oil, sesame oil, and green tea ingestion show beneficial impact on female reproductive tract; while increasing levels of coconut oil have demonstrated a dose dependent negative relationship.

Conclusion: Though human studies have been limited, initial animal models have surprisingly revealed dose-dependent negative impact of specific spices, oils, and teas on the female reproductive system from manipulation of the tightly regulated hypothalamic-pituitary-gonadal axis to the physical disruption of reproductive organ structure. In addition, a select group of items reviewed demonstrate the converse relationship. It is important to be cognizant of consumption patterns, as certain ingredients may either hinder or improve female fertility.

Keywords

Female fertility, Spice, Oil, Tea, Infertility, Female reproduction

Abbreviations

PCOS: Polycystic Ovarian Syndrome; DHEA: Dehydroepiandrosterone; IGF-1: Insulin-like Growth Factor 1; MSG: Monosodium Glutamate; LH: Luteinizing Hormone; FSH: Follicle Stimulating Hormone; 3β-HSD: 3β-Hydroxysteroid Dehydrogenase; EPO: Evening Primrose Oil; GLA: Gamma-Linolenic Acid; AMA: Advanced Maternal Age; HCO: Hydrogenated Coconut Oil; EVOO: Extra Virgin Olive Oil; EGCG: Epigallocatechin-3-Gallate

Introduction

Female infertility can be attributed to structural anomalies of reproductive organs, hormonal imbalances, even inherent genetic abnormalities. Per the National

Citation: Vasa R, Choudhary M, Catala N, Sarmiento L, Khemlani A, Kaba A, et al. (2025) Spices, Oils, and Teas: A Comprehensive Review Exploring Impact on Female Fertility. Int J Womens Health Wellness 11:165. doi.org/10.23937/2474-1353/1510165

Accepted: February 20, 2025: **Published:** February 22, 2025

Institute of Health, approximately 11% of females in the United States and 17.5% of females worldwide struggle with infertility [1,2].

There has been an abundance of research elucidating specific causes of female infertility briefly outlined above; however, there are potentially modifiable risk factors pertaining to lifestyle habits that have piqued interest. Both exercise and dietary habits can potentially increase fertility outcomes. For example, moderate physical activity has been documented to improve ovarian function and improve fertility. In addition, monitoring caloric intake and strictly controlling different components of diet such as vitamin/mineral content, and protein/lipid/carbohydrate intake have been documented to positively alter differing factors of infertility such as ovulation rate [3].

However, there has been a lack of investigation into the specific composition of food items that can potentially impact female reproduction. Specific regions around the world have increased infertility rates such as: The Americas, Europe, Africa, and the Western Pacific [4]. These regions are home to unique cultures with distinct flavor characteristics, each using a variety of spices, oils, and even ingesting certain teas that are integral to their culinary identity. There lacks comprehensive research elucidating the impact of specific ingredient usage and its contribution to female fertility status. Bhardwaj, et al. proposed that oxidative stress is a root cause of infertility, and states that this can potentially be exacerbated by ingestion of certain food items [5]. This hypothesis serves as the rationale behind consumption patterns inherent to specific regions of the globe that can potentially improve or even hinder female reproductive status.

Therefore, the goal of this comprehensive review article is to provide, in exhaustive detail, the impact that specific spices, oils, and teas have on female reproduction.

Materials and Methods

Database and search terms

This literature review was conducted utilizing the following databases: PubMed, Cochrane, Embase, and Google Scholar. Search terms utilized include the following spices: Aloe, Barberry, Black Cohosh, Blue Cohosh, Dong quai, Feverfew, Goldenseal, Juniper, Wild Yam, Motherwort, Autumn Crocus, Mugwort, Pokeroot, Sassafras, Comfrey, Mistletoe, Basil, Parsley, Sage, Rosemary, Dill, Mint, Thyme, Fennel, Ginger, Garlic, Turmeric, Monosodium glutamate, Cinnamon, St. John's Wort, Echinacea, Ginkgo Biloba, Pepper, Bay leaf, Coriander, Cloves, Green pepper, Nutmeg, Celery Seed, Cardamom, Saffron, Mustard, Basil, Lemon Grass, Dillweed, Oregano, Galangal (Laos), Tamarind, Sesame, Mace, Rosemary, Marjoram, Anise Seed, Caraway, Tarragon, Juniper, Capers, Horseradish, Fenugreek.

Search terms used to identify the teas include: English breakfast tea, Chamomile Tea, Green Tea, Ginger Tea, Lemon Balm, Peppermint Tea, Peppermint-Lemon Tea, Rose Tea, Red Rasberry Leaf Tea, Apple Tea, Nettle Tea, Fennel Tea, Thyme Tea, Sage Tea, Linden Tea.

Search terms used to identify specific oils include: Primrose oil, Rose oil, Basil oil, Clary Sage oil, Juniper berry oil, Rosemary oil, Jasmine oil, Nutmeg oil, Avocado oil, Canola Oil, Peanut Oil, Coconut Oil, Sunflower Oil, Corn Oil, Soybean Oil, Hemp seed oil, Extra-virgin olive Oil, Vegetable Oil.

Inclusion and exclusion criteria

Inclusion criteria utilized to identify appropriate studies included: English, published between January 2012-May 2024, randomized controlled trials, case controls, cohorts, case series, case reports, systematic reviews, and meta-analyses. Exclusion criteria included: studies completed prior to 2012, non-relevant, and non-English. Additionally, the reference section of salient articles was utilized and included as well in the final literature review. A total of 15,909 articles were initially identified using the term "fertility" and "infertility" in addition to the specific spice, tea, and oil listed above. After exclusion criteria was implemented, there was only a total of 30 studies reviewed (Figure 1).

Results

Given the extensive search terms used, only 18.6% (11/59) of spices, 22.2% (4/18) of oils, and 6.7% (1/15) of teas have been studied in relation to female fertility. Below is an extensive compilation of recent research on applicable spices, oils, and teas on differing aspects of the female reproductive system.

Spices

Mugwort (*Artemisia vulgaris*): Shaik, et al. analyzed the impact that Mugwort, or *Artemisia vulgaris*, has on female fertility through use of female rats [6]. In female rats exposed to this spice, there was a statistically significant decrease in successful implantation in addition to a significant increase in uterine weight through elevated estrogen levels [6]. Specifically, female rats exposed to 600 mg/kg dose of this spice had an implantation rate of zero, while female rats exposed to the 300 mg/kg dose had 50% implantation rate. Further, Mok performed a randomized control trial on females struggling with fertility in South Korea whereby Mugwort was heated and transferred through the body through moxibustion, which let to successful pregnancy in about 14.7% of participants [7]. Though this spice has been previously touted for its anti-inflammatory properties in addition to possible menstrual regulation, it may be beneficial to avoid its use for those patients seeking to get pregnant. However, there are no further studies elucidating this relationship.

Dong quai: Dong quai is a traditional Chinese

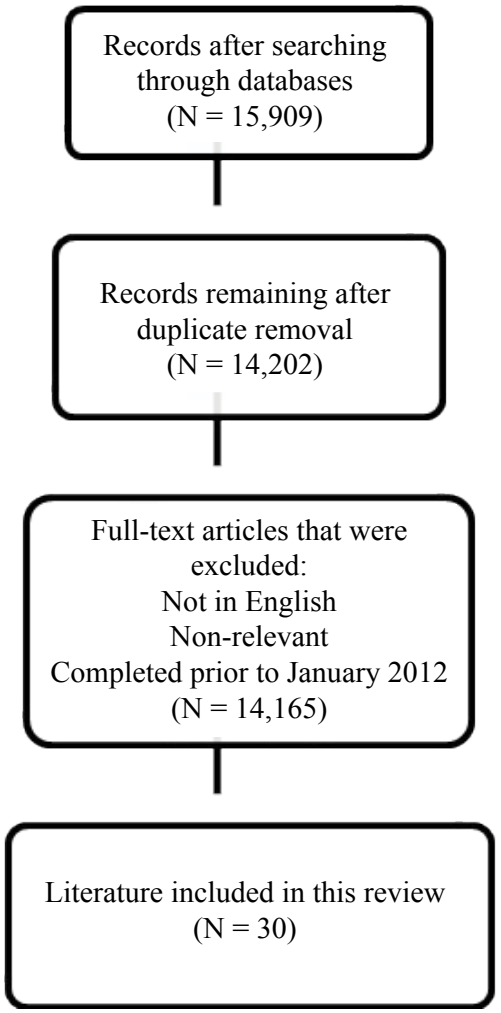

Figure 1: Flowchart of the literature screening and selection for the review.

medicinal herb which has been previously touted to treat pre-menstrual symptoms such as breast swelling/tenderness, bloating, headache, dysmenorrhea, in addition to symptoms commonly associated with menopause such as hot flashes. While dong quai is most commonly known for its pro-estrogenic effects, there has been limited clinical data supporting these claims [8]. Bain and Dillard reported that dong quai actually has minimal direct interaction within the female endocrine system, suggesting that its pro-estrogenic effects occur through an alternate mechanism that has yet to be elucidated [8,9]. Yet again, there lacks further studies correlating these findings to the female reproductive system (Table 1).

Coriander (*Coriandrum sativum*): *Coriandrum sativum* or coriander is a popular herb in the culinary world and has been proposed to have anti-inflammatory, neoplastic, hyperglycemic, hyperlipidemic effects [10]. Surprisingly, it has also been used in traditional Iranian medicine to provide relief from anxiety and insomnia [11]. Despite its widespread properties, this spice may be associated with anti-fertility properties. There is concern about the negative effect of coriander on fertility. Abdoon, et al. most recently provided evidence that exposure of this spice in obese female rats promoted fertility; however, this is the only study has been documented examining the relationship this spice has on female reproduction [12]. It is postulated that the anti-inflammatory properties of coriander in a dose-dependent fashion improves the overall reproductive environment; however, the exact mechanism is still not known [12] (Table 1).

Clove (*Syzygium aromaticum*): *Syzygium aromaticum* or clove is a dried flower bud indigenous to Indonesia known to have antioxidant, antimicrobial, and antiparasitic properties [13]. Clove's powerful antioxidant properties have been documented to mitigate polycystic ovarian syndrome (PCOS). Soltani, et al.'s examined the effect cloves have on female rats with medication-stimulated PCOS in a randomized control trial [13]. Soltani, et al. found that female rats treated with low-dose cloves had decreased ratio of lueinizing hormone (LH) to follicle stimulating hormone (FSH) and testosterone compared to both the control group and the group treated with high-dose cloves [13]. Further, the low-dose treatment group was also found to have less oxidative stress markers and greater inhibition of autophagy. While the study findings are compelling, there has been no further studies translating these findings to human subjects [13] (Table 1).

White wormwood (*Artemisia herba alba*): *Artemisia herba alba* or white wormwood is a perennial shrub native to North Africa, the Arabian Peninsula, and West Asia. It has been traditionally used as a treatment for bronchitis, diarrhea, hypertension and diabetes [14]. Though no studies have been done evaluating this spice's impact on fertility, one study had evaluated its impact on pregnancy. Matsabisa, et al. had described a randomized control study on pregnant female rates with exposure to this spice at four and twelve weeks of gestation [14]. Interestingly, the results showed a time-dependent reduction in viable pregnancies with no significant effect after four weeks, but a significant reduction in pregnancies after twelve weeks [14]. Though the study findings are quite shocking, there has been no further studies translating these findings to human subjects (Table 1).

Cinnamon (*Cinnamomum verum*): Cinnamon, also known as *Cinamomum verum*, is a popular aromatic spice with global culinary and traditional medicinal use. In fact, there are two main varieties of this spice: *Cinnamomum zeylanicum* (endemic to Sri Lanka and parts of Southern India) and *Cinnamon cassia* [15]. Interestingly, the latter has been documented to have increased levels of potentially toxic coumarin [15]. Dou, et al. conducted a randomized control examining the impact that this particular spice has on Dehydroepiandrosterone (DHEA)-induced PCOS mouse models. In fact, the mouse models exposed

Table 1: Relationship between specific spices and various aspects of the female reproductive capability.

Name of Spice	Impact on female reproductive system	Reference
Mugwort (***Artemisia vulgaris***)	- Statistically significant decrease in successful implantation rate (dose-dependent) - Statically significant increase in uterine weight (dose-dependent) - Improved implantation in females through moxibustion	Mok [7] Shaik, et al. [6]
Dong quai	- Pro-estrogenic effect providing management of pre-menstrual symptoms such as breast swelling/tenderness, bloating, headache, dysmenorrhea - Demonstrated to provide relief of menopausal symptoms such as hot flashes	Bain [8] Dillard [9]
Coriander (***Coriandrum sativum)***	- Statistically significant dose-dependent anti-implantation effect - Associated with a decrease in progesterone, with possible abortifacient effect - Alternatively, exhibited to promoted fertility in a dose-dependent fashion in obese female rats	Abdoon, et al. [12] Mahleyuddin, et al. [10]
Clove ***(Syzygium aromaticum)***	- Decreased ratio of luteinizing hormone/ follicular stimulating hormone and testosterone - Produced less oxidative stress markers and allowed for greater inhibition of autophagy; thereby, mitigating diagnostic markers of polycystic ovarian syndrome	Soltani, et al. [13]
White wormwood ***(Artemisia herba alba)***	- Time-dependent reduction in viable pregnancies with no significant effect after four weeks, but a significant reduction in pregnancies after twelve weeks	Matsabisa, et al. [14] Mohamed, et al. (2010)
Cinnamon (Cinnamomum verum)	- Polycystic ovarian syndrome affected mouse models had adequate restoration of a regular menstrual cycle, improved ovarian morphology, and decreased luteinizing and follicular stimulating hormone levels	Dou, et al. [15]
Turmeric (***Curcuma longa***)	- No effect on ovarian follicle number about 50 days post-tubal ligation; however, anti-mullerian serum levels were better preserved though the relationship was not statistically significant	Destici, et al. [16]
Monosodium glutamate (MSG)	- No significant difference in luteinizing hormonal, testosterone, and estradiol levels between both control and MSG-treated rats; other studies provided evidence that MSG has the potential to decrease luteinizing hormone and growth hormone levels - Decreased size of the thyroid, pituitary, adrenals, and gonads - Increased wall thickness, cellular hypertrophy, and distortion of the endosalpinx which could explain finding of increased oviduct weight - Decreased oocyte count and increased follicular cysts - Four-fold increase in the intensity of AMH staining on antral follicles in MSG exposed female rats, with no statistically significant difference in staining on preantral follicles and total follicle staining	Abdulghani, et al. [18] Gaspar, et al. [17]
Sage (*Salvia officinalis*)	- Statistically significant increase in serum FSH, LH, estrogen, and progesterone levels in a dose dependent fashion in female rats - Increase in growing and matured graafian cells	Abdrabou, et al. [20] Wahdan, et al. [19] Al-Bediry, et al. [21]
Aloe vera	- Statistically significant increase in estrogen and decrease in progesterone in aloe vera-treated rats with stimulated polycystic ovarian syndrome - Reduced testosterone and improved progesterone and estradiol levels in female rats with induced polycystic ovarian syndrome - Reduction in both androgen and luteinizing hormone receptor expression in the ovaries of rats impacted by polycystic ovarian syndrome - Regained normal follicular development with a concurrent decrease in atretic follicles, and normal ovarian function was restored	Helal, et al. [23] Radha, et al. [24]
Ginkgo Biloba	- No impact on ovarian weight; however, dose-dependent decrease in uterine weight - In high doses it significantly decreased percentage of primordial, growing, and antral follicles - Increased prolactin and estradiol levels at high doses and decreased progesterone, follicular stimulating hormone, and luteinizing hormone levels	El Mazoudy & Attia [25]

to cinnamon not only had adequate restoration of a regular menstrual cycle, but also had improved ovarian morphology with a decreased luteinizing hormone and follicular stimulating hormone level [15]. Serum levels of insulin and insulin-like growth factor 1 (IGF-1) were also noted to be attenuated in the treated group [15] (Table 1).

Turmeric (*Curcuma longa*): Turmeric, also known as *Curcuma longa*, is known for its anti-inflammatory and antioxidant properties. Destici, et al. developed a study investigating the impact of turmeric's active ingredient, curcumin, has on ovarian reserve in those with tubal ligation [16]. Though no studies have been conducted evaluating specific impact of this spice on female fertility, Destici, et al. provided evidence that there was no effect on ovarian follicle number about 50 days post-tubal ligation; however, anti-mullerian serum levels were better preserved though the relationship was not statistically significant [16] (Table 1).

Monosodium glutamate (MSG): Gaspar, et al. and Abdulghani, et al. evaluated the impact of MSG on hormone levels and endocrine gland size in female rats [17] and found no significant difference in luteinizing hormonal levels, testosterone, and estradiol levels between both control and MSG-treated rats. In addition exposure to MSG demonstrated lengthier menstrual cycles [17]. In addition, high dose ingestion of MSG demonstrated a decrease in the size of the thyroid, pituitary, adrenal, and gonad size [17] (Table 1).

Interestingly, reproductive organ morphology was extensively studied, and MSG-treated rats had ovaries and uterus lighter in mass per Gaspar, et al. [17]. Meanwhile, contradictory to these findings, Abdulghani, et al. found no significant difference in ovary weight between the control and MSG-treated groups [18]. Microscopically, Wahdan & Alazouny found the oviducts in MSG-treated rats to have an increased wall thickness, cellular hypertrophy, and distortion of the endosalpinx which could explain Abdulghani, et al.'s finding of increased oviduct weight [19]. In addition, samples of the oviduct cells were noted to exhibit a strong immune reaction augmenting the inflammatory environment of these structures in MSG affected female rats.

In addition, Abdulghani, et al. and Gasper, et al. both demonstrated a statistically significant decreased oocyte count and increased follicular cysts [17,18]. Conflicting evidence exists in relation to number of atretic follicles with a statistically significant decrease by Abdulghani, et al., however, an increase in atretic follicles was noted by Gasper, et al. [17,18]. In addition, Gasper, et al. also noted a four-fold increase in the intensity of AMH staining on antral follicles in MSG exposed female rats, with no statistically significant difference in staining on preantral follicles and total follicle staining [17] (Table 1).

Sage (*Salvia officinalis*): Sage, also known as *Salvia officinalis*, has been shown to have a statistically significant increase in serum FSH, LH, estrogen, and progesterone in a dose dependent fashion in appropriately treated rats as documented by both Abdrabou, et al., Al-Bediry, et al., and Alrezaki, et al. [20-22]. Abdrabou, et al. provided evidence that low dose sage had no effects of serum FSH and LH hormone concentration; however, when high dose sage was given to female rats there was a statistically signficiant increase in FSH/LH hormones in addition to an increase in growing and matured graafian cells [20]. Meanwhile, Alrezaki, et al. found no significant difference in testosterone levels [22]. With regards to germ cell maturation, Alrezaki, et al. observed no significant difference in the number of primordial follicles; however, an increase in growing follicles was noted in the group receiving the higher dose of sage, and a decrease in abnormal follicles was noted in all rats who were exposed to sage [22] (Table 1).

Aloe vera: Helal, et al. found a statistically significant increase in estrogen and a decrease in progesterone in aloe vera-treated rats with stimulated PCOS [23]. Helal, et al. discovered that healthy rats treated with aloe vera had prolonged proestrus and estrus phases in addition to a statistically significant increase in estrogen and decrease in progesterone levels [23]. Meanwhile, Radha & Laxmipriya observed reduced testosterone and improved progesterone and estradiol levels in PCOS rats treated with aloe vera [24]. Interestingly, Radha & Laxmipriya identified a reduction in both androgen and LH receptor expression in the ovaries of rats impacted by PCOS [24]. Especially in PCOS treated rats, ovarian 3β-hydroxysteroid dehydrogenase (3β-HSD) and 17β hydroxysteroid dehydrogenase (17β-HSD) activities were returned to normal levels as opposed to the elevated levels in the PCOS environment [24].

Morphologically, PCOS rats treated with aloe regained normal follicular development with a concurrent decrease in atreitic follicles, and normal ovarian function was restored [24]. Moreover, a decrease in insulin resistance in PCOS rats was documented [24] (Table 1).

Ginkgo Biloba: Elmazoudy & Attia found that ginkgo biloba did not affect the weight of the ovaries; however, it was noted to decrease uterine weight in a dose-dependent manner [25]. Ginkgo was found to have no effect on any of the follicular stages at low doses; however, at high doses it significantly decreased the percentage of primordial, growing, and antral follicles [25]. Overall, at increased dosages this spice has been documented to decrease the percentage of healthy follicles and increase the percentage of atretic follicles [25]. In addition, it increased prolactin and estradiol at high doses and decreased progesterone, FSH, and LH [25] (Table 1).

Oils

Evening Primrose oil (EPO): Evening primrose oil (EPO) is derived from seeds of the *Oenothera biennis*

plant which contains an essential fatty acid: Gamma-linolenic acid (GLA). GLA is associated with anti-inflammatory properties has been documented to improve dysmenorrhea, arthritis, eczema, and other inflammatory conditions [26].

Ku, et al.'s prospective cohort study provided evidence that EPO supplementation led to significantly lower fecundability in women [27]. However, this finding is limited because only five percent of women consumed EPO in this study, and the lowest percentage of the cohort compared to consumption of other supplements [27]. However, this remains the only human study that evaluated the relationship between female fertility and EPO use.

In addition, Atteia, et al. conducted a randomized control trial with female rats focusing on EPO's impact on fertility, via examination of serum hormone levels and histopathological examination of ovaries in dietary obese rats [28]. Dietary obese female rats treated with EPO showed a significant decrease in prolactin, testosterone, and estrogen levels along with an increase in progesterone, FSH and LH. At baseline, histopathologic examination of the dietary obese-control female rats showed ovarian cysts, atretic follicles, and congested, dilated ovarian vessels. However, the dietary obese female rats treated with EPO showed significant improvement with no cysts, many primordial and secondary follicles, and mild to moderate improvement with remnant congested vessels. Additionally, ovarian fibrosis initially noted in the dietary obese-control female rats showed improvement with EPO treatment. EPO was found to modulate systemic and reproductive consequences of obesity in female rats, implying EPO's potential effectiveness in improving not only baseline female reproductive hormone levels but altering the reproductive organ environment [28] (Table 2).

Coconut oil: Interestingly, Nehra, et al. had examined reproductive performance in rats of advanced maternal age (AMA) by comparing diet rich in either omega-3 fatty acids versus a diet deficient in essential fatty acids such as hydrogenated coconut oil (HCO) [29]. Interestingly, an omega-3 rich diet successfully reproduced; however, the litter size was noted to be smaller. On the other hand, the AMA rat groups fed an omega-6 rich diet with primarily HCO did not reproduce viable offspring [29]. Similarly, in Gunasekaran, et al. randomized control trial in which female rats were fed virgin coconut oil, the offspring were noted to have statistically significant lower body weight secondary to the induction of increased medium chain fatty acids while decreasing presence of essential fatty acids crucial for growth and development [30] (Table 2).

Extra virgin olive oil (EVOO): Though no specific studies have been conducted evaluating extra virgin olive oil (EVOO) on female fertility, a randomized control trial evaluated a specific compound composing this substance called, oleocanthal. This compound not only has anti-inflammatory properties, but also antioxidant effects. Because oleocanthal reduces oxidative stress, it creates an environment that improves the overall environment for ideal uterine function by limiting any extraneous uterine stress [31]. In fact, preliminary studies evaluating diets rich with EVOO have provided some evidence that it may provide symptomatic relief for patients with dysmenorrhea [31] (Table 2).

Sesame oil (*Sesamum indicum*): This is a popular oilseed crop originally consumed and used for therapeutic purposes in various parts of Asia and the

Table 2: Relationship between specific oil consumption and various aspects of the female reproductive capability.

Name of oil	Impact on female reproductive system	Reference
Evening primrose oil (EPO)	- Significantly lower fecundability in women - Dietary obese female rats treated with EPO showed a significant decrease in prolactin, testosterone, and estrogen levels along with an increase in progesterone, FSH and LH - Dietary obese female rats treated with EPO showed significant improvement with no cysts, many primordial and secondary follicles, and mild to moderate improvement with remnant congested vessels - Improvement in ovarian fibrosis	Sharifi, et al. [26] Ku, et al. [27] Atteia, et al. [28]
Coconut oil	- Decrease in viable offspring in female rats of advanced maternal age - In female rats that were fed virgin coconut oil, offspring noted to have statistically significantly lower body weight	Gunasekaran, et al. [30] Nehra, et al. [29]
Extra virgin olive oil (EVOO)	- Oleocanthal (specific compound composing EVOO) has both anti-inflammatory and anti-oxidative properties - May provide symptomatic relief with dysmenorrhea	Chiu, et al. [31]
Sesame oil (*Sesamum indicum*)	- Has antioxidant, anti-inflammatory, and lipid lowering properties - Has been demonstrated to induce menses - When co-treated with Tamoxifen it has been demonstrated to show a statistically significant increase in diameter and number of uterine glands	Al-Kadhi, et al. [33] Yavari, et al. [32]

Middle East. This substance has been documented to have antioxidant, anti-inflammatory, and lipid lowering properties. In fact, in limited studies it has been documented that sesame oil has the ability to potentially induce menses and even fetal abortion [32].

Yavari, et al.'s randomized control trial compared the use of sesame oil to induce menses against a standard hormonal treatment of medroxyprogesterone. The results, though not statistically significant, showed that seventy-two percent of patients experienced bleeding with sesame oil consumption compared to ninety-three percent of patients who experienced bleeding with medroxyprogesterone [32]. Even though the sesame consuming participants experienced a lower rate of menses onset than the progesterone group, the fact that menses were documented indicates the potential of this oil to play a role in the female reproductive system [32].

Further, Al-Kadhi, et al. evaluated the impact that sesame seed oil has on the physiological parameters in female mice treated with tamoxifen [33]. In female rats co-treated with tamoxifen and sesame seed oil, there was a statistically significant increase in diameter and number of uterine glands [33] (Table 2).

Teas

Green tea: Made from the leaves of *Camellia sinensis*, green tea is one of the most popular drinks consumed worldwide. Green tea (specifically its biologically active compound epigallocatechin-3-gallate [EGCG]) is associated with anti-oxidative, anti-fibrotic, anti-proliferative, and pro-apoptotic mechanisms. It has been demonstrated to enhance ovulation and reduce cyst formation and even improve hyperalgesia and reduce uterine contractility [34]. Roychoudhury, et al. provided evidence that catechins present in green tea have reduced excess reactive oxygen species during *in vitro* fertilization [35]. The reduced reactive oxygen species actually decrease granulosa cell apoptosis and allow for improved oocyte maturation [35]. However, further studies are needed to study the effect of green tea catechins *in vivo* (Table 3).

Discussion

Amongst the extensive evaluation of the applicable studies on the different spices, oils, and teas, each has a documented impact on fertility whether through use of primarily animal and/or human models. It is important to note that there lacks substantial human data for most of the substances that were evaluated, and even so the majority have still not been thoroughly evaluated. The mechanisms by which these items impact female fertility range from generating an overall inflammatory environment in the reproductive organs thereby changing inherent physical composition, altering the endocrine landscape, and even playing a role in offspring viability.

Based on the limited evidence that is currently available, the following substances have a generally positive impact on female fertility: Mugwort, cloves, cinnamon, turmeric, sage, aloe vera, and green tea. Meanwhile, coriander, white wormwood, MSG, and ginkgo biloba seem to have a more negative impact on female fertility. Both coconut oil and sesame oil seem to have positive impacts on female reproductive health, while primrose oil, and extra virgin olive oil neither have a definitive positive nor negative impact on female fertility.

Amongst the exhaustive list of about 104 different oils, spices, and teas this review originally aimed to evaluate, initial search with specific terms yielded only 37 studies. However, only 17 of them were included after implementation of appropriate exclusion criteria. There simply is a lack of studies focusing on the impact of specific spices, teas, and oils on female fertility.

Nevertheless, there is a need for future research with large-scale clinical trials geared towards a more concrete definition of these correlations through experimental studies. Currently there are no clear guidelines on oil, spice, and tea consumption for women seeking to improve their fertility status, despite the indisputable evidence of the role of diet on a variety of health outcomes. Yet another future direction would be to identify the adequate dosage of the oils, spices, and teas to ingest and incorporate into daily diets to harness more beneficial results on female fertility status.

Despite the limited breadth of this study, it is the first of its kind to provide a comprehensive guide evaluating the literature on what exists between the variety of oils, spices, and teas in relation to female fertility.

Table 3: Relationship between tea consumption and various aspects of the female reproductive capability.

Name of tea	Impact on female reproductive system	Reference
Green tea	- Associated with anti-oxidative, anti-fibrotic, anti-proliferative, and pro-apoptotic mechanisms - Enhances ovulation and reduces cyst formation - Improves hyperalgesia and reduces uterine contractility - Catechins present in green tea have reduced excess reactive oxygen species during *in vitro* fertilization - Reduced reactive oxygen species actually decrease granulose cell apoptosis and allow for improved oocyte maturation	Kamal, et al. [34] Roychoudhury [35]

Acknowledgements

We would like to thank the State University of New York Downstate Health Sciences University Library for granting us access to pertinent databases.

Sources of Support

We would like to thank the State University of New York Downstate Health Sciences University Library for granting us access to pertinent databases.

Author Contribution

All authors listed above were involved with conception of the project, data collection, and production of the manuscript.

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