

Does Our Feeding Affect Our Breeding?: The Role of Diet in Female Sexual Dysfunction

Ashleigh Krider

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Olya Glantsman, Department of Psychology

Yuki Miyamoto, Department of Religious Studies

### Abstract

Research into female sexual dysfunction is relatively new and is only now beginning to gain more attention. While determining prevalence rates and causes of female sexual dysfunction (FSD) have proved to be challenging, developing safe and effective treatments for FSD appear to be significantly more difficult. Aphrodisiacs have been used throughout history to promote sexual function. This paper seeks to address an alternative treatment for FSD, by reviewing the academic literature on the role of certain diets, specifically examining the literatures about *Cimicifuga racemose*, *Ginkgo biloba*, saffron, the Mediterranean diet, red wine, apple consumption, and chocolate and its relationship with FSD.

### Does Our Feeding and Affect Our Breeding?: The Role of Diet in Female Sexual Dysfunction

The food that people consume has a great effect on how the human body performs and functions. Many mass media articles make claims about how a certain food can provide one with more energy, make one happier, brighten one's skin, or even boost one's libido. The relationship between food and sex stems from Chinese, Egyptian, Roman and Greek cultures but the ancient Greeks invented a specific term that highlights this relationship and is still largely popular today (Melnyk & Marcone, 2011). The ancient Greeks defined any consumable substance that specifically improves sexual function as an *aphrodisiac*. Current research has found validity in the ancient Greek practice, which is incredibly important and applicable to the medical field.

Brody (2010) reviewed research on the benefits of sexual intercourse and found that it can lead to increased satisfaction with one's mental health, feeling more connected with a partner, better metabolism and cardiovascular health, pain relief, better immune function, longer life expectancy and even lower rates of cancer. The World Health Organization (WHO) defines sexual intercourse as "integration of somatic, emotional, intellectual, and social aspects in ways that are positively enriching and that will enhance personality, communication, and love" (Tsai, Yeh, & Hwang, 2011). At the same time, sexual dysfunction is sometimes seen as trivial and unnecessary to treat, which is unfortunate because of the numerous benefits of having satisfactory sexual function. A correlation between sexual dysfunction and negative psychosocial effects has also been found; however, research is limited to whether sexual dysfunction is the cause or the symptom of certain psychosocial disorders (Brody, 2010). For women in particular, consequences of sexual dysfunction were found to be highly distressing and have a significant negative impact on their life (Stephenson & Meston, 2015).

Treatment for sexual disorders have historically been Treatments for female sexual dysfunction are relatively new and uncommon, despite the staggering amount of women reporting sexual dysfunction, ranging from 43-76% compared to only 31% of men (Munarriz, Kim, Goldstein, & Traish, 2003; Tsai, Yeh, & Hwang, 2011). Several drugs have been tested in trials for Female Sexual Dysfunction (FSD), and one drug, *Addyi*, has been approved by the US Food and Drug Administration to treat female sexual dysfunction (FSD). While there is an FDA approved drug for female sexual dysfunction, it has serious side effects (Puppo, G. & Puppo, V., 2016) and has been criticized for being an incomplete treatment for female sexual dysfunction (FSD) due to the multiple variables involved with FSD (Berry, M. D., & Berry, P. D., 2013). Those who seek to avoid negative side effects, have increasingly sought alternative methods. One such alternative may be food and diet. This paper seeks to examine the scientific literature regarding diet and its role in FSD, which could potentially alter the way FSD is treated.

### Issues Surrounding Female Sexual Dysfunction

There are several issues surrounding the topic of FSD. FSD can present itself differently from woman to woman, and differently within the same female throughout her lifetime, making it rather complex, personal, and multi-faceted issue, both psychologically and physiological (Tsai, Yeh, & Hwang, 2011). Additionally, personal and cultural beliefs about the importance of proper sexual function vary significantly among women and FSD does not have enough of an impact on daily life to seek treatment for the disorder. Furthermore, due to the nature of the disease, many women feel uncomfortable discussing issues about sexual function with their medical care provider. Due to the multiple variables involved in FSD and the variability of importance in a female patients life, diagnosis of the disease and prevalence rates are hard to determine and vary drastically.

Additionally, determining normal stages of sexual function or response in woman has been challenging and highly debated (Salonia, Giraldi, Chivers, Georgiadis, Levin, Maravilla, & McCarthy, 2010). The female sexual response was originally based on a linear model developed by Masters and Johnson (1966) involving four phases (i.e., excitement, plateau, orgasm, and resolution). The Masters and Johnson model had a tremendous impact on the field of female sexual function research, but was inconsistent with the diversity of experiences reported both between different women and differences between experiences within the same woman (Tsai, Chung, & Hwang, 2009). A three phase model was then developed by Kaplan (1969) with three key phases: desire, excitement, and orgasm, which addressed the psychological, psychosocial, and physiological factors of sexual desire and was used to define FSD in the 4th edition of the DSM (Tsai et al., 2011). The most recent model has been proposed by Basson (2005). It is a circular model that combines biological, social, and psychological aspects and diverges from Kaplan's model through noting that sexual arousal and physiological measures do not always correlate and that orgasm and resolution are not critical for the sexual response cycle. However, this model focuses on intimacy and may exclude women who do not correlate intimacy and sexual desire (Tsai et al., 2011). Having an established model to base female sexual function on is important in order to be able to classify diagnosis and better understand female sexual dysfunction.

Furthermore, classifying female sexual dysfunction as a disease or primary pathology is also problematic because FSD can be induced by certain drugs or conditions making it a side effect or a symptom rather than a disease (Latif & Diamond, 2013). For example, it has been shown that antidepressants, specifically selective serotonin reuptake inhibitors (SSRIs), such as *fluoxetine* can induce FSD (Kashani et al., 2013). This can be problematic because women are

more at risk for mood disorders that are commonly treated using SSRIs (Kashani et al., 2003). Several drugs, *sildenafil*, *bupirone*, *cyproheptadine*, *bupropion*, and *amantadine* have been used to treat FSD induced by SSRIs, but significant negative side effects have been reported (Kashani et al., 2013). These negative effects may lead to low adherence rates. However, some of the side effects of the drugs used to treat FSD induced by SSRIs, have been reported to reverse the effect of the SSRI.

Additionally, ethical constraints severely limit the extent that FSD or, generally, sexual function can be studied in humans, causing much of the current knowledge on sexual function to be acquired from animal studies (Salonia et al., 2010). Correspondingly, many of the mechanisms in female sexual function are unknown and have been hypothesized by researchers. Research on sexual function and response has largely been focused on men, but recently more of a focus has been given to women. Furthermore, the specific mechanisms of sexual response and function in humans has historically been studied using mainly male rats. Since males and females have very different sexual responses due to the difference in hormones and biological anatomy, the of the research on the mechanisms is largely inapplicable.

#### Diagnosis and Classification of Female Sexual Dysfunction

Since classifying stages of sexual function is still an ongoing debate, defining FSD is rapidly undergoing change and debate. In 1998, nineteen experts on FSD were brought together by *The Sexual Function Health Council of the American Foundation for Urologic Disease* to redefine the classification of FSD in order to include personal distress criterion and psychogenic components of the disease in the DSM IV. The panel classified FSD into four categories: sexual desire disorders, sexual arousal disorders, orgasmic disorder, and sexual pain disorders (Tsai et

al., 2011). Throughout this paper, these four classifications will be generalized as FSD. Some studies that are reviewed throughout this paper look at treatments specifically for a certain classification of FSD. Unfortunately, due to the time constraints the paper will not explore each disorder individually.

Currently, it is accepted that the most accurate way to assess female sexual function is in a naturalistic setting, which presents several obvious challenges because research conducted in laboratory settings sets heavy limitations on human and animal subjects. Nonetheless there are several other ways to assess FSD. Assessment of FSD can range from an interview of the couple together and each partner individually, noting medical and sexual history, a physical and gynecological exam, and evaluation of any mood disorders (Tsai et al., 2011). Recently, neuroimaging such as PET scans have been used to measure metabolic and vascular factors, such as blood flow and blood oxygen, and fMRIs have been used to assess patterns in brain activity of individuals engaging in sexual intercourse (Salonia et al., 2010). These can be helpful in diagnosis, studying or assessing FSD because neuroimaging can help detect definitive physiological changes that the body undergoes in response to sexual stimuli or an elicited sexual response. However, these responses can also be highly variable between different women. Due to the difficulty of assessing FSD, Rosen (2002) developed a widely used assessment called the *Female Sexual Function Index* (FSFI) which is a self-reported questionnaire consisting of 19 questions that are assigned to six separate domains: desire, sexual arousal, lubrication, orgasm, satisfaction, and pain. The questionnaire asks women to respond to questions about the previous 4 weeks using a rating scale from 1-5, and sometimes 0, 0 and 1 being *no to little* sexual activity or response and 5 being *almost always or high* (Rosen et al., 2000, p.198). Scores can range from 2.0 to 36.0, with 2.0 being indicative of FSD, and 36.0 being a woman who is completely

satisfied with her sexual function. The FSFI has been used in many different clinical trials to assess female sexual function. Most of the studies reviewed in this paper determined that a score of 23 or below was indicative of FSD. As discussed previously women have different perceptions of importance of sexual function within their lives. It is critical to emphasize that this variability in perception causes some women to see poor sexual function as a disease that has significant negative impacts on their life, in contrast to women with FSD who do not consider it a disorder and report it having little negative impact on their life. The difference of importance adds to the debates about whether certain FSDs should be considered a disease or not.

### Basic Physiology and Anatomy of Female Sexual Function

The anatomy of the body and the structures within the body are arranged to assist in the physiology and function of process in the body, which is accurate in female sexual response. The female genitalia has two divisions: the internal genitalia, which includes the vagina, cervix, uterus, fallopian tubes, and the ovaries, and the external genitalia or vulva, which includes the mons pubis, the clitoris, and the labia majora and minora surrounding the urogenital cleft. These structures have been found to be directly involved in female sexual response because they are richly innervated by the autonomic and somatic nerves, which convey sensory stimuli through afferent pathways to the spinal cord and brain (Salonia et al., 2010).

Physiologically, female sexual function is extremely complex because there are many different components of female sexual function, in order to maintain the brevity of the topic a very basic understanding of the physiology of female sexual function will be addressed in order to ensure a basic understanding of female sexual function. Variability in sexual function occurs early in development, when biological sex is determined, since that is also what dictates what

hormones are secreted and produced by the body (Salonia et al., 2010), men have higher amounts of testosterone and women have higher amounts of estrogen. Rather than just one behavior, female sexual function is a series of behaviors described by Salonia et al. (2010), as

“motivation to seek partners, evaluation of critical stimuli, motor execution of the behavior, and rewarding physiological processes, which eventually reinforces the behavior so it will be subsequently repeated” (p. 2639).

The female sexual response can be defined as two parts: arousal and orgasm. Sexual arousal can be observed physiologically through vulvar swelling, vaginal lubrication, heavy breathing, and increased sensitivity of the genitalia and psychologically as a subjective feeling of pleasure or excitement (Salonia et al., 2010). Physiologically when orgasm occurs there is a peak heart rate, blood pressure and respiration, contractions of the pelvic floor muscles and the rectum (Levin, 2014). Salonia et al. (2010) further explain that each of these behaviors uses several regions in the brain. The brain contains critical nodes that gather the information and produce the proper behavioral response. The neurons in the critical nodes contain steroid receptors, which create a hormonally sensitive neural network. At the core of the network are regions that control motor behavior, creating a variety of pathways in response to different stimuli. Although a specific male or female pathway has not been thoroughly developed, the motor patterns between men and women are significantly different because of the different hormones produced within the body. The way hormones influence the neural network can be described by the genetic differences in specific kinases enzymes, and/or receptors. There is overwhelming evidence that the cerebral cortex is responsible for the mechanisms involved in sexual behavior and that the central nervous system (CNS) guides female sexual behavior, which is highly unstudied in humans (Salonia et al., 2010).

There are certain pathways that influence female sexual behavior that are important to address because the chemicals found in certain foods can stimulate the pathways to help elicit a sexual response. There are many pathways involved in female sexual response, however they appear to be largely not well understood. Throughout many of the studies which address aphrodisiacs or food and FSD, the nitric oxide pathway appears to be one of the more significant pathways for sexual arousal. The nitric oxide pathway uses enzymes, which increase the arterial blood supply through a reduction in the sympathetic innervation (Salonia et al., 2010). This mechanism is helpful in female sexual response because the vagina is rich in endothelial tissue. When blood flow is increased to different areas of the vagina, it can stimulate lubrication, relaxation of smooth muscles, inflammation, and overall increased sensation, which are all important aspects in female sexual response (Salonia et al., 2010).

### Physiology of FSD

Adding to complexity of FSD is has been found that changes in physiology do not necessarily induce FSD, and that FSD may occur with a seemingly normal physiology. Thus, Salonia et al. (2010) suggested that FSD is divided into an objective genital and extra-genital categories, which correlates with the different categories of FSD. For example sexual pain disorders or orgasmic disorders may be due to more of a genital effect. Levin (2014), suggested that the contraction of muscles of the pelvic floor can become over or underactive, inhibiting pleasure obtained at orgasm. In contrast, sexual arousal or desire disorders may be more extra-genital based which was observed by in a study performed by Maravilla and Yang (2008), who found that healthy women without FSD had decreased activation in the bilateral temporal lobe, which is associated with moral judgment or embarrassment, when presented with a visual sexual stimulation, than women who had been diagnosed with a FSD (Salonia et al., 2010). These

findings suggest that FSD may, at least in part, be triggered by over-activation of pathways in the brain. Additionally, Arnou et al. (2009) studied females with FSD and no FSD and found that women with FSD had more activity in the medial frontal and right inferior frontal gyri. They proposed that the increase in activation in the medial frontal and right inferior frontal gyri was caused by the women with FSD directing more of their attention to self-evaluation of their response, interfering with the normal sexual arousal response (Salonia et al., 2010). Because hormones and cluster of neurons regulate the neural pathways used in sexual function, biological, psychological, and psychosocial factors that influence these neurons and hormones affect the physiological sexual response (Clayton, 2010).

#### Current Drugs in treatment of FSD

Currently there is a new drug approved by the US Food and Drug Administration in order to treat FSD in premenopausal women. The drug is called *Addyi*, or *flibanserin* and it is an anti-depressant, and the mechanism used to treat FSD is not known. However, one of the side effects of *flibanserin* can be severely low blood pressure, which results in loss of consciousness (Puppo, G. & Puppo, V., 2015). Additionally, the side effects become higher and more severe if combined with alcohol. Low blood pressure to the point of loss of consciousness is already dangerous, but because this drug is used specifically in the treatment of FSD, the side effects become even more dangerous. For example, if a woman is taking *flibanserin* to treat FSD, she is most likely taking the drug prior to engaging in sexual activity, and if this drug is causing loss of consciousness this could be especially problematic and may be putting women in a dangerous situation. Health care providers have been advised to prescribe with caution and assess likelihood that the patient abstains from alcohol (FDA, 2015).

The drug creates several issues for the prescribers, patients, and the drug company which makes *Addyi*, Sprouts Pharmaceuticals. Because of the context *flibanserin* would be used in, this could potentially result in lawsuits if a women were inappropriately touched or raped due to a loss of consciousness produced by the drug. While adherence to *flibanserin* has not been thoroughly studied, the severity of the side effects of *flibanserin*, combined with the fact that alcohol cannot be used, may lead to low adherence rates to the drug. Ideally, a treatment would only be effective if it had high adherence rates, because if people do not adhere to a treatment, the treatment is essentially useless. In order to treat FSD, treatments that do not have potentially dangerous side effect need to be explored. A safe and effective alternative to a drug treatment could be a diet modification.

Additionally the development of drugs for FSD has been met with a lot of pushback and criticism. Sex therapist argue that pharmacotherapy is a unidimensional treatment option that cannot is corrupt in its clinical applications, yielding little evidence for their effectiveness, and promotes a pill taking mentality, rather than solving for the cause of the problem (Berry, M. D., & Berry, P. D., 2013). Many sex therapist also argue that using a pill to treat FSD does not address the complex psychological and psychosocial aspects of the disease, and that models need to more integrative, focusing on a biopsychosocial model (Berry, M. D., & Berry, P. D., 2013).

### Diet and the Brain

Several studies have demonstrated a relationship between nutrition and the brain (Cooper, 2014). For example antioxidants, which can come from several foods, have been found to inhibit or repair oxidative stress in the brain through suppressing reactive oxygen species, sequestering metal ions, scavenging free radicals, and stimulating antioxidant enzymes (Parletta, Milte, &

Meyer, 2013). Phytochemicals are phenolic and polyphenolic compounds with antioxidant properties and are found in most plant derived food such as fruit, vegetables, grains, nuts, red wine, tea, olive oil, herbs, and spices (Parletta et al., 2013). Phytochemicals all have one aromatic ring structure with at least one hydroxyl group and can be classified in to ten different classes (Parletta et al., 2013). Flavonoids are the largest group of phytochemical and are arguably most important because they can transverse the blood brain barrier (Parketta et al., 2013). This is important because that means food containing flavonoids can directly affect pathways within the brain. Because the mechanisms of female sexual function is controlled by the brain and because food innately has chemicals and macromolecules which can alter neuropathways, it has been proposed that changing one's diet has a potential to alter sexual function. Due to the time constraints of this paper and limited research in the field, it is not possible to discuss every potential aphrodisiac, thus, only a few will be discussed.

### Female Sexual Dysfunction and Diet

Food can be defined as any substance that enters the stomach, provides energy, or sustains normal metabolism, which includes dietary supplements (Cooper, 2014). In the United States, the FDA regulates any claims for health benefits that come from food. Dietary supplements include vitamins, mineral, herbs, or other botanical, amino acids, and enzymes. It is important that a dietary supplement is not confused with a drug as drugs must be approved by the FDA and studied to show effectiveness, while dietary supplements are not as well regulated. At the same time, the manufacturers and sellers of such supplements are not allowed to make claims about preventing or curing a disease without scientific evidence (Cooper, 2014). As previously discussed certain foods contain phytochemicals that can pass through the blood brain barrier and affect neurotransmitters in the brain. Because sexual activity is controlled by neural networks in

the brain, it has been hypothesized that food can affect sexual function, which stems from the ancient Greek idea of the aphrodisiac. A variety of aphrodisiacs will be addressed in their relation to sexual function.

### Aphrodisiacs

The definition of an aphrodisiac is a food or drug that arouses or enhances sexual desire. Many aphrodisiacs are found in the form of supplements and are sold at health food store. Aphrodisiacs have been sought after throughout history by many different cultures. Substances such as Yohimbine, ground rhinoceros horn, the mandrake plant, and the Spanish fly, which is toxic, have been used to treat sexual dysfunction (Singh, 2013). In traditional Ayurvedic medicine, aphrodisiacs are one of the seven branches of the medical system. Rasayana therapy refers to the use of herbs in the treatment of sexual disorders and Vajakarna uses aphrodisiacs for the treatment of erectile dysfunctions, infertility, and spermatogenesis. Aphrodisiacs are thought to directly activate the reproductive tissues and help promote the creative transformation of sexual energy. The aphrodisiacs alter the level of specific neurotransmitters or specific sex hormones within the body (Singh, 2013). Recently aphrodisiacs have garnered more attention from the research community and it has been found that women are more likely to have preference for herbal products due to the belief that they are more natural and safe, which is not always the case. As a result, the researchers have begun exploring the potential benefits as well as dangers of such supplements in the human population (Mazaro-Costa, Andersen, Hachul, & Tufik, 2010).

*Cimicifuga racemosa* for Menopausal and Post-Menopausal Women

Many of the herbs studied have been found to have an effect on FSD in menopausal or post-menopausal women. *Cimicifuga racemosa* is an herb native to North America, and has been found to improve sexual disorders and vaginal dryness of postmenopausal women (Mazaro-Costa et al., 2010). Mazaro-Costa et al. (2010) also found that *Cimicifuga racemosa* increases the number of superficial vagina cells in post-menopausal women, which is similar to the job of estrogen. It is hypothesized that *Cimicifuga racemosa* may be especially helpful in anxiety induced FSD because it was shown to significantly improve sexual desire due to its impact on the serotone an dopaminergic systems (Mazaro-Costa et al., 2010). *Cimicifuga racemosa* acts as a selective estrogen receptor modulator and helps improve serotonin and dopaminergic systems, which are involved in sexual functioning. While use of *Cimicifuga racemosa* has been found to be safe, many of the trials using *Cimicifuga racemosa* are rather short and long term use has not yet been explored (Mazaro-Costa et al., 2010).

### *Ginkgo biloba*

*Ginkgo biloba* is a tree that the Chinese have held sacred due to its medicinal properties (Meston, Rellini, & Telch, 2008). *Ginkgo biloba* is a well known herb that is currently prescribed for several purposes including asthma, fatigue, tinnitus, and memory improvement (Mazaro-Costa et al., 2010). *Ginkgo biloba* contains two major classes of substances: flavonoids and terpenes (Mazaro-Costa et al., 2010). It has been studied and found that *Ginkgo biloba* promotes blood flow in arteries and capillaries, which is important in sexual arousal and lubrication in the female sexual response. It has also been found that *Ginkgo biloba* relaxes muscular cells in blood vessels and inhibits platelet activating factors, which are also both involved in the female sexual function. Additionally, recent research has shown the *Ginkgo biloba* stimulates the nitric oxide pathway which stimulates blood flow to endothelial tissues in the vagina. In several trials *Ginkgo*

*biloba* has shown improvement in antidepressant-induced sexual dysfunction in 91% of cases in females (Meston et al., 2008). Additionally in a study of women with FSD, not antidepressant-induced, Meston et al., (2008) used vaginal photoplethysmography, which measures vaginal pulse amplitude, a physiological indicator of sexual arousal, in response to sexual stimuli. The researchers found that vaginal pulse amplitude was significantly higher in women who had received *Ginkgo biloba*, 90 minutes before a sexual stimulus, than women who had received a placebo (Meston et al., 2008). Furthermore, adverse side effects to *Ginkgo biloba* are rare and usually mild and reversible, rendering the herb to be relatively safe (Mazaro-Costa et al., 2010).

### Saffron

Saffron is a plant that is frequently used in cooking and has historically been used in traditional medicine (Kashani et al., 2012). Saffron has been shown to have antidepressant and anti-dementia properties. Saffron is made up of crocin and safranal. Crocin specifically has been shown to have positive effects on sexual function in several human and animal studies. For example, in a study, which examined the use of saffron to treat FSD induced by an antidepressant called fluoxetine, it was determined, using the FSFI, that taking saffron supplements improved arousal, lubrication, and pain domains in FSD (Kashani et al., 2012). The mechanism of saffron in anti-depressant induced FSD is unknown, yet it is thought to have anti-inflammatory, anti-oxidative, neuroprotective, and antiepileptic properties (Kashani et al., 2012). It is thought that saffron significantly improved pain domains in anti-depressant induced FSD because it has been found to be very beneficial for opiate withdrawal, indicating that it is involved in the opiate pathway in the brain (Kashani et al., 2012).

### Mediterranean Diet

The Mediterranean population has extremely low rate of disease, which has caused the health field to examine what was significantly different about this culture. The Mediterranean diet appeared to have the most significant impact on improved health outcomes due to its amount of nutritionally dense foods (Giugliano et al., 2010). The diet has been associated with reduced risk of mortality, cancer, and cardiovascular disease. The diet consists mainly of plant-based foods, including fruits, nuts, legumes, cereals, and fish. In the Mediterranean diet olive oil is the primary source of fat, which is monounsaturated. The diet often includes a low intake of wine, red meat, and poultry. When the Mediterranean diet was studied in women with type II diabetes, higher adherence to the Mediterranean diet was linked to lower prevalence of FSD (Giugliano et al., 2010). While the exact reason for this association is unknown, the researchers suggested that this correlation may have been due to high macronutrient intake which produces oxidative stress and produces systemic inflammation or a proinflammatory state. Thus, fiber content of food regulates cytokine concentrations, which can cause a proinflammatory state. Giugliano (2010) explains

“As dietary fiber may have anti-inflammatory roles [37], it may be that the fiber content of the Mediterranean diet, eventually magnified by some other components with antioxidant capability, may influence the transient oxidative stress that occurs after macronutrient ingestion” (p.1888).

However Giugliano et al.’s (2010) study used only women with type II diabetes, so the effects of the Mediterranean diet and improved sexual functioning need expanded research in order for the results to be applicable to all women.

### Moderate Red Wine Consumption

Additionally, Mondaini, Cai, Gontero, Gavazzi, Lombardi, Boddi, & Bartoletti (2009) looked at a certain feature of the Mediterranean diet and found that moderate intake (i.e., 1-2 glasses a day) of red wine had been linked to higher FSFI scores in the domains for sexual desire, lubrication, and overall sexual function, which may be even more significant considering that the moderate wine drinkers had a higher overall mean age, at 41.3 compared to the other two groups, 38.5 and 27. While conducting their study, Mondaini et al. (2009) found that women who consumed a moderate amount of red wine, as compared to women who drank other alcohol occasionally or women who denied any alcohol intake within a year, had lower rates of FSD. The researchers suggested that this was due both to the psychological effects alcohol can illicit and the high polyphenol and flavonoid content found specifically in red wine as opposed to other types of alcohol. Yet, while alcohol may increase psychological factors involved in female sexual function, it lowers physiological arousal, demonstrating the variety of psychological and physiological factors involved in female sexual response. Mondaini et al. (2009) proposed that the flavonoids in the wine promoted vaginal and clitoral lubrication and engorgement by directly ameliorating the nitric oxide pathway. The nitric oxide pathway is a key component of the female sexual response cycle, because it regulates endothelial nitric oxide synthase, which is an enzyme that regulates endothelial tissues, which is found in abundance in the vagina and causes vasodilation of the tissues. Mondaini et al. (2009) also suggested that effects of red wine could also be indirectly favoring a healthy cardiovascular system. However this data should be used with some caution because the researchers relied on self-reported data both for alcohol intake and the FSFI scores due to a lack of laboratory tests at the time. Moreover, the population of women they studied was narrow. Finally, the researchers limited alcohol intake to two glasses a

day, in order to avoid potential issues of alcohol abuse with the participants, however it can be argued that the amount they choose is not definitive enough to determine what amount of wine is beneficial in treating FSD.

### Apple Consumption

Additionally, two other foods have been researched in coordination with FSD. Apples and chocolate have both been thought to have a positive impact on women's sexual health due to the high level of polyphenols, antioxidants, and phytoestrogens in them (Cai et al., 2014). When Cai et al. (2014) reported apple consumption and the corresponding scores on the FSFI, people who consumed more than one apple a day had significantly higher overall scores, 27.9 compared to 24.1. Additionally, people who ate more than one apple a day had higher scores in the desire, arousal, and lubrication domains. The lubrication domain is noteworthy because it is physiological domain and the group that consumed one apple or more a day had significantly higher scores of the FSFI (4.4) compared to the group that reported eating 0-0.5 apples a day with mean scores of 2.2 (Cai et al., 2014). While this studied should be used with caution due to the reliance on self-reported data, the correlation between apple consumption and increased lubrication was statistically significant, which is especially interesting since lubrication is generally a measurable physiological response (Cai et al., 2014). However, pathways that the apples stimulate are unknown and are not discussed in the context of FSD. Thus, the study simply determined that apples improve overall health status. It was suggested that the apples must be eaten with the peel on because that is where the majority of antioxidants are found (Cai et al., 2014).

### Chocolate

Chocolate was first used medicinally by the Mayan people. When the Spanish discovered the New World in the 1500's, they also discovered cacao. Cacao, an unsweetened form of chocolate, spread across Europe quickly and was used to treat a wide variety of diseases, including sexual dysfunctions (Dillinger, Barriga, Escárcega, Jimenez, Salazar, & Grivetti, 2000). Today, researchers have found that plain dark chocolate improves the cardiovascular system in humans due to the dense amount of flavonoids and antioxidants (Salonia et al., 2006). Chocolate has also been demonstrated to have large impact on elevating mood due to its drug like chemical makeup (Salonia et al., 2006). Chocolate contains biologically active phytochemicals which may elicit psychopharmacological, psychological, and behavioral reactions found in other addictive substances. In a study by Salonia et al., (2006) women who ate one or more than one ounce chocolate cube had higher overall scores on the FSFI. However when the study was adjusted for age the FSFI scores were similar (Salonia et al., 2006). Salonia et al. (2006) speculated that the lack of relationship between sexual function and chocolate in their study may have been due to the fact that the FSFI is not a sensitive enough instrument. It is important to highlight that this study was small, with only 153 women who self-reported their FSFI score and filled out a questionnaire on their personal chocolate consumption. The researchers explained that although their data did not find substantial correlations between chocolate consumption and improved sexual functioning, there is substantial amount of research supporting the chocolate in the treatment of SD because of chocolates extraordinary amount of flavonoids. Salonia et al., (2006) stated that "high-flavonoid chocolate consumption significantly improved endothelium-dependent flow mediated dilation of the brachial artery" and that flavonoids are thought to stimulate the nitric oxide pathway (p.480). They continued by noting that chocolate could be responsible for peripheral vasodilation, which has a role in female genital

sexual arousal. However, Salonia et al. (2006) did not specify what kind of chocolate the women were eating which is important because there are a higher amount of flavonoids and antioxidants in dark chocolate than white or milk. This study could be improved upon by having women consciously eat a one or more than one-ounce cube of dark chocolate every day and take the FSFI over a period of time and compare the scores to women who rarely or never eat chocolate.

### Conclusion

FSD is a diverse disorder involving anatomical, physiological, neurobiological, endocrine mechanisms, psychosocial behavioral, and other cultural aspects. Currently research in the area of women's sexual health is growing rapidly. While a drug has been developed and approved by the FDA, it comes with many negative and potentially life threatening side effects and it is argued that pharmacotherapy is unidimensional and isn't effective at treating the multiple factor involved in FSD. Finding safe and effective treatments that women will adhere to is important for the treatment of FSD. Examining the validity of the aphrodisiac and overall diet and its relationship on FSD is uniquely challenging because of the diverse nature of factors contributing to the disorder. Diet influences many aspects of both mental and physiological health and sexual function is influenced by mental and physiological factors, so the relationship is significant to its role in treating FSD. Consumption of *Cimicifuga racemose*, *Ginkgo biloba*, saffron, the Mediterranean diet, red wine, and apples have all been found to have a positive impact of the symptoms of FSD. Consumption of other aphrodisiacs has also been found to improve upon the symptoms of FSD, however it was not within the scope of the paper to address all of them. The research done on these relationships is rather new and provides a good basis to support further research into the effect of diet on FSD.

### Limitations

There were several limitations in this research, but most notably was time. There is a seemingly endless amount of research addressing the diet and the brain and sex and the brain, however there was not enough time to explore every physiological pathway in FSD and connect the phytochemical to both the food and the pathway it may impact. There was also very limited research directly addressing diet and sexual function and the few studies that were found used self-reported data and hypothesized what was happening within the body instead of being able to directly answer why they got certain results. The studies that directly addressed sexual function and food were also often small, so their validity may be questionable. It also appears that much of the research dealing with sexual function used male rates and because of the large differences in sexual function between men and women, experiments using male rates could not be used to support any correlations about FSD and diet. It was disappointing to find a lack of experiments dealing with female rats. Currently, there are few instruments that are able to measure the physiological factors involved in the female sexual response so much of the research relies on self-reported data, which is problematic because it is largely subjective.

### Further research

There are many aspects that future research could expand upon in regards to FSD. Generally, more research on female rats would be helpful in determining the specific mechanisms that certain biomolecules have on both female sexual function and sexual dysfunction. Moreover, many studies were oddly specific focusing on a certain sub-category of women or circumstances surrounding FSD and thus, future studies could focus on more diverse groups of women. Furthermore, almost all of my studies relied on self-reported data which is

largely subjective, so improvements in both the instruments yielding more accurate data and generally conducting more studies using instruments that have already been developed could hold a significant amount of benefits. Additionally, almost every study suggested that it could be improved upon by having a larger sample size, so generally larger research projects would be helpful.

It is also hard to examine diet without looking into other health statuses and lifestyle factors because diet is so influential in overall health status. A large part of the Mediterranean diet and lifestyle is physical activity, so looking at the role of exercise, both exclusive of diet, and in addition to diet, would greatly expand on the current research. While some studies included lifestyle factors such as smoking, their role in FSD were not heavily focused on.

While we generally use animal research to benefit humans, applying the role of diet to sexual function in animals could be significantly important because of the increasing amount of habitat destruction. If certain species experience habitat destruction, which, in turn, would affect their food supply and diet, examining how those diet changes affect their mating patterns could be undeniably important to preserving keystone species. Salonia et al., (2010) explain how neural influences are more significant in animals than in humans saying

“The basic principles of the neural control of sexual behavior apply to an impressively broad range of species, from fish to nonhuman primates; the importance of the biological mechanisms regulating reproduction in animals is much greater than that in humans.” (p. 2638).

Finally, as the debates about our food system and the use of GMO's continue, understanding how ability to reproduce should be well understood and taken into account. Many

biochemical molecules are being looked at to see what will treat FSD, but it would be beneficial to also consider what biomolecules may induce FSD, and see if those may be coming either from altering the chemical makeup of our food or by the increased use of pesticides on our food today.

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