Formulation of Seed Bar with Menstrual Health Potentials

By

Sangami S S

(20PFN020)

Thesis submitted to

Avinashilingam Institute for Home Science and Higher Education for Women

Coimbatore – 641 043

In Partial Fulfilment of the Requirements for the Degree of

Master of Science in Food Science and Nutrition

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Certified as a Bonafide Research Work

Sangami. S.S

Signature of the Candidate

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Signature of Head of the Department

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INTRODUCTION

I. INTRODUCTION

Menstruation is the ordinary discharge of blood and tissue from the uterine wall through the vagina as part of a woman's monthly menstrual cycle. Menstruation takes place between menarche, a girl's first period, and menopause, the end of menstrual cycles (Sweet *et al*., 2012). Menstruation lasts about 5 days on an average in a menstruating woman. The menstrual cycle is the monthly process in which female hormones stimulate ovary to release the egg, thicken the uterine lining to support pregnancy, and then cause the uterus to shed this lining if no pregnancy occurs (Dasharathy *et al*., 2012). The average menstrual cycle lasts 28 days, but this varies from woman to woman and month to month. The menstrual cycle in adolescence can last from 21 to 45 days, but for most women, it lasts from 21 to 35 days (Dowell *et al*., 2007).

Irregular cycles, also known as irregular periods, are abnormal variations in the length of menstrual cycles. A typical menstrual cycle length for an adult who does not use hormonal contraception is between 24 and 38 days. Cycle lengths are frequently variable. Within the same year, the length between the longest and shortest cycles can vary by up to eight days while remaining within a regular range. A common variation for one cycle is considered to be 25 days long, followed by a cycle that is 33 days long (John and Sheila.,1996). Lengths ranging from eight to twenty days are considered moderately irregular. A variation of 21 days or more is considered extremely unusual. If the cycle is consistently shorter than 21 days or longer than 36 days, the condition is known as polymenorrhea or oligomenorrhea. Furthermore, irregular menstruation is common during adolescence. Within a year of menarche, a regular menstrual cycle can be established (Engle and Shelensnyak.,1934).

Hormones in women are a complex system that must be maintained in a delicate balance (Treloar *et al*.,1967). Women's hormones, on the other hand, are heavily influenced by diet, exercise, sleep, stress levels, and environmental toxins. This means that any of these factors can disrupt the delicate balance of hormones. As a result, a minor hormonal imbalance can

become the root cause of a variety of health issues, including irregular periods, acne, PCOs, thyroid disorders, and chronic fatigue (Vollman.,1977).

Most women produce enough hormones to support a healthy cycle. Oestrogen and progesterone levels fall during menopause, increasing the risk of heart disease and osteoporosis and causing symptoms such as hot flashes and weight gain (Bensing *et al*., 2020). Estrogen is produced in a regular cycle during the first 14 days of the follicular phase as eggs in the ovaries ripen. Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) levels rise just before ovulation, while estrogen levels fall just after. The luteal phase begins after an egg is released, and progesterone and estrogen levels gradually increase in a careful balance to support conception and implantation. If no implantation occurs, they will drop again before the next period (Dabrowski *et al*., 2019).

Hormonal contraception works by preventing ovulation. This means that while using contraceptives, a person does not have a true period. Instead, some people do not have a period at all, while others experience withdrawal bleeds that resemble a period. During the first few months of using the pill, patch, implant, or Hormonal Intrauterine Device (IUD), a person may experience irregular bleeding. This may become more frequent over time, or it may cease entirely (Hennegan *et al.*, 2020).

If a woman discontinues using hormonal birth control, she may experience irregular periods. It takes time for the body's hormonal cycle to return to normal. People typically experience a withdrawal bleed 2–4 weeks after discontinuing birth control pills (Awdishu *et al., 2009)*. A period is the next bleed. The cycle can take up to three months to settle into a regular pattern. People who had irregular periods before starting hormonal birth control may experience them again once they stop using it (Banh *et al*., 2020). Birth control containing the hormones estrogen and progesterone can help raise hormone levels, counteracting the effects of not ovulating. It can also make bleeds more regular and easier to manage, as well as alleviate symptoms (Hennegan *et al*., 2020).

Menstruation can be affected by both lack of body fat and an excess of body fat. Maintaining a healthy weight can lower insulin levels in those with PCOs who have a higher body weight (Kostopoulou *et al*., 2020). This results in lower testosterone levels and an increased likelihood of ovulating. If irregular periods are caused by stress, anxiety, depression, or an eating disorder, a doctor may advise seeking psychological help (Gurbuz and Gode., 2020).

People who have irregular periods may benefit from certain medications, depending on the cause. For people with PCOs, for example, a doctor may prescribe metformin (Deltsidou *et al*., 2010). This is a type 2 diabetes insulin-lowering oral medication that can help ensure ovulation and regular periods. Regardless of the country's economic status, the prevalence of dysmenorrhea was high, with more than two-thirds of young women reporting the presence of dysmenorrhea, regardless of geographical location. Menstrual symptoms had a significant impact on education, with one in every five young women nearly 20 per cent being absent and 40 per cent reporting that classroom performance had been negatively affected. The impact of dysmenorrhea on girls and young women on education is significant. Other activities, either directly related to school (such as sports) or social in nature, were also commonly affected by approximately in one-third of young women (Armour *et al.*, 2019).

Seed cycling is a natural remedy that claims to balance hormones by regulating estrogen in the first half of the menstrual cycle and progesterone in the second (Carlson *et al*., 2004). Consuming flax, pumpkin, sesame, and sunflower seeds at different times in prescribed quantities of the menstrual cycle is known as seed cycling. The practice is said to balance certain hormones, increase fertility, and alleviate menopausal symptoms, among other things. Seed cycling proposes to help not only those who have hormonal imbalances but also those who have healthy cycles (Mandl., 2019).

It's often recommended for menopausal and postmenopausal women who don't have a regular menstrual cycle to use the phases of the moon as a guide to cycle dates, with day one of their cycle falling on the new moon. An

entire lunar cycle lasts 29.5 days from one new moon to the next. In addition, the usual menstrual cycle lasts 28–29 days. Menstrual and lunar cycles do have synchrony, according to one study. The study included 826 women between the ages of 16 and 25, all of whom had regular menstrual cycles. During the new moon, a high number of participants menstruated (28.3 per cent). On other days, however, the rate of menstruation was substantially lower, ranging from 8.5 to 12.6 percent. The actual period, however, varies from person to person and month to month, ranging from 21 to 35 days (Salimgaraev., 2021).

Flax seeds, in particular, have been linked to slight increases in oestrogen, improved hormone metabolism, fewer hot flashes, decreased vaginal dryness and improved overall quality of life in menopausal and postmenopausal women (Rudman and Sarajean., 2019). Furthermore, flaxseed consumption has been linked to cancer fighting properties and a lower risk of breast cancer in postmenopausal women (Brown *et al*., 2018). The main bioactive compounds in flax seeds are Alpha-Linolenic Acid (ALA), lignans, and fibre. Whole flaxseed, ground flaxseed, flaxseed oil, and partially defatted flaxseed meal are the four most common forms of flaxseed available for human consumption. Flaxseed consumption also protects against menopausal symptoms (Aliani *et al*., 2011). Flaxseed, which is high in omega-3 and omega-6 fatty acids, protects the body from bacteria and viruses, improving the immune system. Flaxseeds, due to their anti-inflammatory properties, aid in the prevention of asthma and thus reduce inflammation. The estrogenic action of certain flax seed metabolites suggested potential beneficial effects on the postmenopausal symptoms. Flaxseed consumption should be avoided during pregnancy and lactation (Edel *et al*., 2017). India is expected to produce nearly 146 thousand metric tonnes of flaxseed by the end of the fiscal year 2022.

Pumpkin is a popular vegetable that is included in the regular diet and is also used in traditional medicine. Extracts contain biologically active components that have anti-diabetic, antibacterial, hypocholesterolemic, antioxidant, anticancer, antimutagenic, immunomodulatory, antihelmintic,

anti–bladder stone activity, and other properties (Krimer., 2020). Pumpkin seeds are high in antioxidants, which help to protect cells from disease and prevent inflammation in humans. Pumpkin seeds can help to get a better night's sleep if eaten before bedtime as they are high in tryptophan, an amino acid that helps one sleep. Pumpkin seeds have a high magnesium concentration, which helps to reduce and manage blood pressure. Magnesium-rich diets are linked to a lower incidence of stroke and mortality from heart disease. Caffeic, p-coumaric, ferulic, sinapic, protocatechuic, vanillic, syringic acid and p-hydroxybenzaldehyde are the most abundant phenolic acids found in pumpkins. The immune system can be boosted by eating pumpkin seeds. Pepitas have antifungal and anti-viral properties in addition to zinc and iron, which are both essential for immune function. They are also not a common allergen or intolerance trigger (Dahl., 2021). China is the largest producer of various pumpkin varieties and seeds. Pumpkin is grown extensively in India, Russia, Ukraine, and Mexico, and it is also grown in the United States of America and South Africa.

Sesame seeds contain numerous bioactive components that are widely used in the medical field. The seeds are recommended by Chinese herbal medicine to delay, and even reverse, common signs of ageing such as hearing loss, poor memory, grey hair, and poor eyesight. The iron and B vitamins in the seeds aid in the treatment of age-related symptoms. Sesame seeds contain calcium, which helps to keep bones strong (Bedigian and Dorothea., 2013). Zinc promotes bone health by strengthening and increasing bone density. The seeds are especially beneficial for older men and postmenopausal women who are at high risk of osteoporosis. The seeds are high in sesamolin and sesamin, two substances known for their ability to lower cholesterol levels. They also contain magnesium, which helps to keep blood pressure from rising (Bedigian and Dorothea., 2013). The antioxidants and phytochemicals in the seeds protect against certain diseases such as colon cancer. Asian and African countries dominate sesame cultivation and production. Sudan, Nigeria, Ethiopia, and Uganda are the major sesame producing countries in Africa, while India, Myanmar, China, and Bangladesh are the major sesame producing countries in Asia. In terms of area, India is

second only to Sudan (2.13 million ha), but it leads in production in 2016 (Wacal., 2021).

Sunflower seeds are the seeds of the sunflower plant. Sunflowers pack a lot of nutrients into its small seed. Sunflower seeds contain a lot of vitamin E and selenium. These act as antioxidants, protecting the body's cells from free radical damage, which is linked to a number of chronic diseases (Xanthopoulou *et al*., 2009). Sunflower seeds are also high in beneficial plant compounds such as phenolic acids and flavonoids, both of which act as antioxidants. Sunflower seeds, which contain vitamin E, magnesium, protein, and linoleic fatty acids, may help lower blood pressure, cholesterol, and blood sugar. While short-term inflammation is a normal immune response, chronic inflammation is a risk factor for cardiovascular disease (Siegmund and Murkovic., 2004). Sunflower seeds contain a variety of vitamins and minerals that can help the immune system and boost the body's ability to fight viruses. Zinc is essential for the immune system, as it aids in the maintenance and development of immune cells. In 2021 and 2022 crop years, Ukraine produced the most sunflower seeds of any country in the world. Ukraine produced approximately 17.5 million metric tons of sunflower seeds during the time period. Russia is also a major producer of sunflower seeds in the world, with 15.5 million metric tonnes produced in 2021 and 2022. India is expected to produce 266 thousand metric tonnes of sunflower seeds by the end of the fiscal year 2022. Domestic consumption of sunflower seed oil in India has increased by 10.5 per cent year on year since 2014. With 2,800 thousand metric tonnes in domestic consumption of sunflower seed oil in 2019, the country ranked first among other countries. Russia, China, and Turkey were ranked second, third, and fourth in the ranking, respectively (Greenfield., 2022).

The most common method instructs women to consume one tablespoon of freshly ground flax and pumpkin seeds per day during the first 13–14 days of their menstrual cycle, known as the follicular phase. Pumpkin seeds and flax seeds help improve estrogen levels while preventing excess estrogen during the first phase of the menstrual cycle (Siegmund and

Murkovic., 2004). Lignans, which are found in flax seeds, bind to excess estrogen. Pumpkin seeds are high in zinc, which aids progesterone production as the cycle progresses to the progesterone rise in the second phase (Dahl., 2021).

Seed cyclers eat one tablespoon of ground sunflower and sesame seeds per day during the second half of their cycle, known as the luteal phase, until the first day of their next period, when their cycle begins again (Diaz *et al*., 2006). Sesame and sunflower seeds help boost progesterone production during the second phase of the cycle. Sesame seeds are high in zinc, which helps boost progesterone production, and they also contain lignans, which help block excess estrogen while progesterone levels rise (Goldstuck., 2011). Sunflower seeds contain a lot of vitamin E and selenium. Vitamin E can help increase progesterone production, and selenium can help cleanse the liver of excess estrogen.

Only a very few Indian studies are available with the seeds in developing menstrual friendly products and keeping this in mind, an attempt was made in the present study titled **"Formulation of Seed Bar with Menstrual Health Potentials"** and was undertaken with the following objectives to:

- develop and standardize menstrual friendly seed bars
- evaluate the acceptability of the seed bars using sensory evaluation
- estimate the proximate principles present in seed bars
- analyze the physicochemical properties and phytochemicals of the seed bars

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The Review of Literature pertaining to the study **"Formulation of Seed Bar with Menstrual Health Potentials"** is presented under the following subheadings:

A. Importance of menstrual cycle for women
    i. Attributes of menstruation
    ii. Intricacies of menstruation
    iii. Menstrual ailments
    iv. Menstrual obliteration
B. Seed cycle - to regulate reproductive hormones
    i. Seed cycling in women health
    ii. Phases of menstruation
C. Importance of plant seeds in menstrual cycle
    i. Culinary and nutritional benefits of flax seeds
    ii. Nutritional importance of pumpkin seeds
    iii. Nutritional benefits of sunflower seeds
    iv. Culinary and nutritional importance of sesame seeds

A. Importance of menstrual cycle for women

Menstruation is the ordinary discharge of blood and mucosal tissue from the internal lining of the uterus through the vagina. The menstrual cycle is characterized by the aid of using the upward push and fall of hormones. Menstruation is caused with the aid of using falling progesterone tiers and is an indication that being pregnant has now no longer occurred. The first duration, a factor in time called menarche, typically starts off evolved among a long time of 12 and 15 (Schuiling and Likis., 2015). Menstruation beginning as young as eight years might nevertheless be taken into consideration as normal. The common age of the primary duration is typically later in the growing world, and in advance in the evolved world (Diaz *et al*., 2006).

The standard length of time between the first day of one period and the first day of the next is 21 to 45 days in young women. In adults, the range is between 21 and 31 days with the average being 28 days (Diaz *et al*., 2006). Up to 80% of women do not experience troubles sufficient to disrupt day by

day functioning either at some point of menstruation or in the days leading up to menstruation. Symptoms earlier to menstruation intervene with regular existence are referred to as Premenstrual Syndrome (PMS). Twenty to thirty per cent of women experience PMS, with three to eight per cent experiencing extreme symptoms (Biggs and Demuth., 2011), like acne, soft breasts, bloating, feeling tired, irritability, and temper changes.

i. Attributes of menstruation

The first menstrual duration happens after the onset of pubertal growth and is referred to as menarche. The common age of menarche is twelve to fifteen years (Karapanou and Papadimitriou., 2010). In 2005, the average age of menarche for Indian women was 13.76 years. It fell by three months, from 13.83 years for women born between 1955 and 1964 to nearly 13.62 years for women born between late 1985 and 1989. Menstruation is the most visible phase of the menstrual cycle and its beginning is used as the marker among cycles. The first day of menstrual bleeding is the date used for the Last Menstrual Period (LMP). The common duration is 28 days; one study predicted it at 29.3 days (Bull *et al.*, 2019). The variability of menstrual cycle lengths is maximum for women below 25 years of age and is lowest, that is, most regular for ages 25 to 39 years. The variability will increase barely for women aged 40 to 44 years (Chiazze *et al.*,1968).

A monthly menstrual cycle usually produces 35 millilitres of menstrual fluid, with a normal range between 10 and 80 millilitres. The flow of blood during menstruation is known as menstrual fluid, although many people prefer to call it menstrual blood as it is reddish-brown and slightly darker than venous blood (Carlson *et al*., 2004). Women's menstrual fluid contains about half-blood. The amount of sodium, calcium, phosphorus, iron, and chloride varies depending on the woman. The menstrual fluid contains human blood, cervical mucus, vaginal secretions, and endometrial tissue, and contains 14 proteins, including glycoproteins. The vaginal fluid mainly contains water, common electrolytes, organ moieties, and at least 14 proteins (Farage., 2013). Majority of women and girls experience blood clots during menstruation. Blood clots can appear as tissues. The tissue shed from a stillbirth or miscarriage can be

examined under a microscope to determine whether it was endometrial tissue or pregnancy tissue (Chiazze *et al*., 1968). The presence of menstrual clots or shed endometrial tissue can mistakenly be considered a sign that the embryo has been miscarried. During pregnancy, plasmin, an enzyme found in the endometrium, appears to be a factor in inhibiting the clotting of blood.

ii. Intricacies of menstruation

The menstrual cycle is normal and natural, however, some women experience problems sufficient to disrupt their everyday lives (Gudipally and Sharma., 2020). These include acne, tender breasts, fatigue, and premenstrual syndrome. Women who suffer from more severe conditions, such as premenstrual dysphoric disorder, can experience cramps in their abdomen, back, or upper thighs during their first few days of menstruation (Reed *et al*., 2018). Dysmenorrhea, also known as "period pain", (Nagy and Khan., 2020) occurs when cramps occur during the first few days of menstruation (Baker and Lee., 2018). It is not normal to have debilitating period pain and this can be the result of something more severe, such as endometriosis (Maddern *et al*., 2020). These conditions can negatively impact the health and quality of life of a woman, but timely intervention can help to address these issues (Matteson and Zaluski., 2019).

Debilitating period pain is not normal and can be a sign of something severe such as endometriosis. These issues can significantly affect a woman's health and quality of life and timely interventions can improve the lives of these women. The menstrual cycle is often mistakenly attributed to a woman's normal mood variation. Although the research on mood fluctuations during the luteal and menstrual phases is lacking, there seems to be a very small increase during these periods, and a corresponding decrease during the rest of the cycle (Farage., 2013)

Moods and Pre Menstrual Syndrome (PMS) - Premenstrual syndrome is defined as emotional and physical symptoms that typically occur one or two weeks before the start of a period. Symptoms usually resolve as the period begins (Dickerson *et al*., 2003). Different women experience different

symptoms. It is common for emotional symptoms to include irritability and mood changes as well as physical symptoms such as bloating, tender breasts, headaches, and fatigue (Biggs and Demuth., 2011). Symptoms usually lasts up to six days. An individual's pattern of symptoms may change over time. The condition does not appear during pregnancy or following menopause.

The diagnosis is made based on a pattern of physical and emotional symptoms occurring after ovulation and before menstruation that interfere with daily activities (Dickerson *et al*., 2003). The psychological symptoms do not occur during the initial part of the period. A daily journal of symptoms over a few months may be helpful. Other disorders that cause similar symptoms must be excluded before the diagnosis can be made (Biggs and Demuth., 2011).

PMS sufferers without severe symptoms are typically advised to reduce salt, alcohol, caffeine, and stress, and increase exercise as a means of dealing with their symptoms. The cause of PMS remains unknown, but certain changes in hormone levels are believed to be involved. Supplementing with calcium and vitamin D may help some; anti-inflammatory drugs such as ibuprofen or naproxen may help with physical symptoms. Birth control pills or spironolactone may be helpful in those with more severe symptoms (Biggs and Demuth., 2011).

Cramps - Among adult women, pain is severe enough to affect daily activity in only 2% to 28% (Jones *et al.,* 2014). Severe symptoms that disrupt daily activities and functioning can be identified as premenstrual dysphoric disorder. These signs and symptoms can be intense enough to affect a person's overall performance at work, school, and in regular activities in a small per cent of women. When extreme pelvic pain and bleeding abruptly arise or get worse at some point in a cycle, this will be because of ectopic pregnancy and spontaneous abortion. This is checked by the use of a pregnancy test, preferably as soon as uncommon pain begins, because ectopic pregnancies can be life-threatening (Goldstuck., 2011).

The most common remedy for menstrual cramps is Non-Steroidal Anti-Inflammatory Drugs (NSAIDs). NSAIDs can be used to lessen mild to extreme pain, and all seem similar (Latthe and Champaneria.,2014). About 1 in 5 women do not reply to NSAIDs and require alternative therapy, which includes simple analgesics or heat pads (Oladosu *et al*., 2018). Other medicinal drugs for pain control encompass aspirin or paracetamol and mixed oral contraceptives. Although mixed oral contraceptives can be used, there may be inadequate proof of the efficacy of intrauterine progestogens (Latthe and Champaneria., 2014).

Menstrual cramps can be alleviated by eating foods that reduce inflammation in the body. Fruits, vegetables, whole grains, legumes, nuts, and seeds are among these foods. Both vegetarian and a plant-based eating pattern have been demonstrated to reduce inflammation in the body. This decrease is due to the high amount of antioxidants and plant compounds found in plant diets, which aid in proper bodily function (Durain., 2004).

iii. Menstrual ailments

The infrequent or irregular biological process is named oligoovulation (Galan., 2008). The absence of ovulation is called anovulation. Normal menorrhoea will occur without ovulation preceding it: an anovulatory cycle. In some cycles, vesicle development might begin but not be completed; nevertheless, steroids are shaped and stimulate the female internal reproductive organ lining. Anovulatory flow ensuing from a thick mucous membrane caused by prolonged, continuing high estrogen levels is called estrogen breakthrough hurt. Anovulatory bleeding triggered by an unforeseen visit of estrogen levels is called withdrawal bleeding (Weschler., 2002).

Anovulatory cycles usually occur before menopause and in ladies with polycystic ovary syndrome. Little or no flow is named hypomenorrhea. Regular cycles with intervals of twenty-one days or fewer are polymenorrhea; a frequent however irregular period is thought of as metrorrhagia. Unexpected heavy flows or amounts bigger than eighty millilitres are termed menorrhagia (Sasaki., 2021). Heavy menstruation that happens often and on an irregular

basis is menometrorrhagia. The term for cycles with intervals of exceptional thirty-five days is oligomenorrhea (Hernandez., 2018). Amenorrhoea refers to over three to six months while not menses throughout a woman's generative years. The term for painful periods is dysmenorrhea (Oriel and Schrager., 1999).

Dysmenorrhea - Dysmenorrhea, also known as painful periods or menstrual cramps, is pain at some point of menstruation (Osayande and Mehulic.,2014). Its typical onset happens across the time that menstruation begins. Symptoms generally last less than three days. The pain is usually in the pelvis or lower abdomen. Other signs and symptoms may consist of backache, diarrhoea or nausea (Osayande and Mehulic., 2014).

The main symptom of dysmenorrhea is pain targeted within the lower abdomen or pelvis (Osayande and Mehulic., 2014). It's also unremarkably felt in the right or left facet of the abdomen. It may radiate to the thighs and lower back. Symptoms often co-occurring with menstrual pain embody nausea and vomiting, diarrhoea, headache, dizziness, disorientation, fainting and fatigue (Gomathy *et al*., 2019). Symptoms of dysmenorrhea often begin right away when ovulation and may last till the tip of menstruation. This is because dysmenorrhea is often related to changes in secretion levels in the body that occur with ovulation. In particular, prostaglandins induce abdominal contractions that may cause pain and epithelial duct symptoms. The utilization of certain kinds of contraception pills will forestall the symptoms of dysmenorrhea because they stop ovulation from occurring. Dysmenorrhea is related to exaggerated pain sensitivity and serious discharge bleeding (Payne *et al*., 2017).

Estimates of the proportion of women of reproductive age affected range from 20% to 90%. It is the most common menstrual disorder. Typically, it starts within a year of the first menstrual period (Carlson *et al*., 2004). When there may be no underlying reason, frequently the pain increases with age or following having a child. In the years leading up to the end of menstruation, when a woman stops menstruating completely and becomes no longer fertile, perimenopause occurs, along with a decline in a woman's fertility. Menopause

is defined medically as an absence of menstrual periods for one year, occurring between 45 and 55 years of age in Western countries (Carlson *et al*., 2004). Women who go through menopause before the age of 45 are considered premature in industrialized countries. The age at which women go through menopause is largely influenced by cultural and biological factors. Menopause may occur earlier than usual due to certain illnesses, certain surgeries, or medical treatments (Mishra *et al*., 2019).

iv. Menstrual obliteration

Hormonal contraception - The use of progesterone or progestins can postpone menstruation. For this purpose, oral progesterone or progestin administration on cycle day 20 has been proven to effectively delay menstruation for at least 20 days, with menstruation beginning 2–3 days after the regimen is stopped (Goldstuck., 2011). Hormonal contraception affects the frequency, duration, severity, volume, and regularity of menstruation and expelling symptoms. The foremost common hormonal contraception is the combined contraception pill, which contains each steroid and progestogen. Though the first operation of the pill is to stop pregnancy, it should be used to improve some expelling symptoms and syndromes that affect menstruation, corresponding to Polycystic Ovary Syndrome (PCOS), endometriosis, adenomyosis, amenorrhea, menstrual cramps, menstrual migraines, symptom, menstruation-related or fibroid-related anaemia and pain by making regularity in menstrual cycles and reducing overall menstrual flow (Curtis., 2016).

Using a combined contraception pill helps additionally for a girl to delay or utterly eliminate menstrual periods, a follow known as menstrual suppression. Some girls do that merely for convenience within the short term, whereas others choose to eliminate periods once possible. This may be done either by skipping the placebo pills, or victimization associated with extended cycle combined birth control device pills, that were initially marketed within the U.S. in the early 2000s. This continuous administration of active pills while not the placebo will result in the action of symptoms in 80% of users within one year of use (Strandjord., 2015).

Breastfeeding - Breastfeeding causes poor remarks to arise on pulse secretion of Gonadotropin-Releasing Hormone (GnRH) and Luteinizing Hormone (LH). Depending on the strength of the poor comments, breastfeeding women can also additionally experience entire suppression of follicular development, follicular development however no ovulation, or ordinary menstrual cycles can additionally resume (McNeilly., 2001). Suppression of ovulation is much more likely whilst suckling happens more regularly (Kippley.,1996). The manufacture of prolactin in reaction to suckling is crucial to retaining lactational amenorrhea (Stallings.,1996). On average, women who're completely breastfeeding whose babies suckle regularly enjoy a return of menstruation at fourteen and a half months postpartum. There is a huge variety of reactions amongst individual breastfeeding women, however, with a few experiencing go back of menstruation at months and others last amenorrheic for up to 42 months postpartum (Stallings.,1996).

B. Seed cycle - to regulate reproductive hormones

i. Seed cycling in women health

Seed cycling is a developing concept that claims to regulate hormones, increase fertility, and alleviate menopause symptoms. To balance specific hormones entails eating flax, pumpkin, sesame, and sunflower seeds at different periods of the month. Seed cycling is a natural therapy that claims to balance hormones by balancing oestrogen during the first half of the menstrual cycle and progesterone during the second half. It is said to help regulate periods, reduce acne, treat the polycystic ovarian syndrome, endometriosis, and infertility, and alleviate menopause symptoms like hot flashes, night sweats, lethargy, and mood swings (Mandl., 2019).

Seed cycling is the application of specific seeds in every cycle that follows the woman’s menstrual cycle, or in 2-week “phases.” throughout the follicular phase. The seed cycle aims to improve the balance of two important hormones: estrogen and progesterone. During the first half of a typical menstrual cycle, commonly known as the follicular phase, oestrogen levels are high. During the second part of the luteal phase of the menstrual cycle,

progesterone levels climb. Menstrual abnormalities, painful periods, acne, and PCOD can all be symptoms of an imbalance between these two hormones (Rudman and Sarajean., 2019).

The phases would be on a 14-day rotation of a 28-day cycle, with phase one commencing on the new moon and phase two beginning on the full moon, according to conventional ideas. In reality, a 28-day cycle does not always occur. The cycle of a woman might last anywhere from 21 to 35 days. Being separated and disconnected from nature, as well as chronic levels of mismanaged everyday stress, might contribute to cycles deviating from traditional regularity. Using the seed cycling technique, on the other hand, can assist in synchronizing menstrual cycles with what is best for the body. It's also beneficial to spend as much time as possible, spending time outdoors and practising earthing, as well as to start tracking the moon phases and staring at the moon multiple times throughout the month (Dahl., 2021).

ii. Phases of menstruation

Follicular phase - The ovaries contain a finite range of egg stem cells, granulosa cells and theca cells, along with kind early follicles (Tortora., 2017). At around twenty weeks into gestation, some seven million immature eggs have already shaped in an ovary. This decreases to around two million by the time a woman is born, and 300,000 by the time she had her first period. On an average, one egg matures and is discharged throughout the biological process monthly when menarche (Ugwumadu., 2014) starting at puberty, these mature into primary follicles severally during the menstrual cycle.

The advancement of the egg is called oogenesis and just a single cell endures the divisions to anticipate preparation. Different cells are disposed of as polar bodies, which can't be fertilized (Schmerler., 2011). The follicular stage is the initial segment of the ovarian cycle and it closes with the finish of the antral follicles (Sherwood., 2016). Meiosis stays deficient in the egg cells until the antral follicle is shaped. During this stage normally just a single ovarian follicle completely develops and prepares to deliver an egg. The follicular stage abbreviates essentially with age, going on around 14 days in

women who matured 18 to 24 contrasted and 10 days in women who matured 40 to 44 days (Tortora., 2017).

Through the impact of an ascent in Follicle Stimulating Hormone (FSH) during the primary days of the cycle, a couple of ovarian follicles are invigorated. These follicles, which have been creating for pretty much a year in an interaction known as folliculogenesis, contend with one another for predominance. Everything except one of these follicles will quit developing, while one prevailing follicle - the one that has the most FSH receptors - will proceed to development. The excess follicles kick the bucket in a cycle called follicular atresia (Johnson., 2007). Luteinizing Hormone (LH) invigorates further improvement of the ovarian follicle. The follicle that arrives at development is called an antral follicle, and it contains the ovum (Tortora., 2017).

The theca cells foster receptors that tight spot LH, and accordingly discharge a lot of androstenedione. Simultaneously the granulosa cells encompassing the developing follicle foster receptors that tight spot FSH, and accordingly begin discharging androstenedione, which is changed over to oestrogen by the catalyst aromatase. The oestrogen restrains further creation of FSH and LH by the pituitary organ (Watchman., 2020). This negative criticism directs levels of FSH and LH. The prevailing follicle keeps on emitting oestrogen, and the rising oestrogen levels make the pituitary more receptive to GnRH from the nerve centre. As oestrogen expands this turns into a positive criticism signal, which causes the pituitary to emit more FSH and LH. This flood of FSH and LH generally happens one to two days before ovulation and is liable for invigorating the burst of the antral follicle and the arrival of the oocyte (Sherwood., 2016).

Flax seeds, which contain phytoestrogens that adapt to the body's oestrogen needs throughout this phase, are cycled to maintain oestrogen levels in check. The lignans in flaxseeds can bind to excess oestrogen and remove it from the body if oestrogen levels become too high. Pumpkin seed is another seed that is cycled during this phase. Zinc is abundant in pumpkin seeds, which aids progesterone production in the next phase. The omega-3

fatty acids found in the seeds help to minimise inflammation and keep reproductive functions in check (Reed *et al*., 2018). On days 1 to 14 of the menstrual cycle, which is known as the follicular phase, women are instructed to eat 1 or 2 tablespoons each of freshly ground flaxseeds and pumpkin seeds (Akhila., 2021).

Luteal phase - Going on around 14 days, (Jones *et al*., 2014) the luteal stage is the last period of the ovarian cycle and it compares to the secretory period of the uterine cycle. During the luteal stage, the pituitary chemicals FSH and LH make the leftover pieces of the prevailing follicle change into the corpus luteum, which produces progesterone (Johnson., 2007). The expanded progesterone begins to instigate the development of oestrogen. The chemicals created by the corpus luteum likewise stifle the creation of the FSH and LH that the corpus luteum necessities to keep up with itself. The degree of FSH and LH fall rapidly, and the corpus luteum atrophies (Ugwumadu., 2014). Falling degrees of progesterone trigger periods and the start of the following cycle. From the hour of ovulation until progesterone withdrawal has made the feminine cycle start, the interaction ordinarily requires around fourteen days. For a woman, the follicular stage regularly changes long from one cycle to another; paradoxically, the length of luteal stage will be genuinely steady from one cycle to another at 10 to 16 days (Tortora., 2017).

Sesame seeds, which are high in zinc and selenium inhibit excess estrogen, throughout the follicle period. The condition is critical for hormone balance during the follicle stage. Sunflower seeds are another seed that is abundant in vitamin E and necessary for maintaining progesterone levels. Gamma-Linolenic Acids (GLA) found in the seeds can help enhance progesterone and minimise inflammation during menstruation time (Sadler., 2019).

C. Importance of plant seeds in menstrual cycle

i. Culinary and nutritional importance of flax seeds

Flax seeds *(Linum usitatissimum)* occur in 2 basic varieties/colours that are brown and yellow (Ramicharitrar., 2005). Most kinds of these basic varieties have similar nutrition characteristics and equal numbers of short-chain omega-3 fatty acids. Yellow flax seeds, referred to as solin, have an analogous oil profile to brown flax seeds and each is high in omega-3 Alpha-Linolenic Acid (ALA) (Sargi., 2013). Flax seeds manufacture an oil referred to as flaxseed oil or linseed oil, which is one of the oldest business oils. It's an edible oil obtained by expeller pressing and generally followed by solvent extraction. The solvent-processed flax seed oil has been used for several centuries as an animal oil in painting and varnishing. Though brown flax seed varieties are also consumed as promptly as the yellow ones and are being used for thousands of years, these varieties are more normally utilized in paints, for fibre, and cattle feed. ALA, lignans, and fibre are the key bioactive ingredients in flaxseed. Whole flaxseed, ground flaxseed, flaxseed oil, and partially defatted flaxseed meal are the four most frequent types of flaxseed accessible for human consumption (Sargi., 2013).

Whole flaxseed, ground flaxseed, flaxseed oil, and partially defatted flaxseed meal are the four most frequent types of flaxseed accessible for human consumption (Parikh, Netticadan and Pierce., 2018). Because of its high amount of Alpha-Linolenic Acid (ALA), it is prone to oxidation. Off flavours and a musty scent will result from the oxidation and consequent rancidity and hence rejected in taste tests. Flaxseed's antioxidant content, which is provided by its Secoisolariciresinol Di-glucoside (SDG) concentration, is extremely useful in preventing oxidation. Furthermore, flaxseed has been described as having a "nice nutty scent and aroma" (Ramicharitrar *et al*., 2005), making it potentially suitable for use in a wide range of meals. Flaxseed has been successfully included in snack bars, muffins, bagels, bread, buns, tea biscuits, cinnamon rolls, and pasta in research studies (Rodriguez *et al*., 2013).

Flavour attributes will, of course, be influenced by the amount of flaxseed in the diet (Pohjanheimo *et al*., 2006). Prior to baking, flaxseed was included in foods for human consumption at concentrations ranging from 5 to 28 per cent of total ingredients. Flaxseed has been taken in amounts as high as 40 to 50 g per day over a long period (Dodin *et al*., 2005). A survey conducted in 2013 found that there is a lower incidence of breast cancer among females who consumed flaxseed regularly. Also, in 2018, the authors concluded that flaxseed may help reduce the risk of breast cancer after menopause (Pohjanheimo *et al*., 2006).

A 100-gram portion of ground flaxseed provides about 2,234 kilojoules of food energy, 41 grams of fat, 28 grams of fibre, and 20 grams of protein (Henk.,2009). Whole flax seeds are added with chemicals and are stable, however, ground flaxseed meal, owing to oxidation, might go rancid once left exposed to air at a temperature in as little as a week. Refrigeration and storage in sealed containers can keep ground flaxseed meal for an extended period before it turns rancid. Under conditions just like those found in business bakeries, trained sensory panellists couldn't sight variations between bread made with freshly ground flaxseed and bread created with flax seed that had been processed four months earlier and kept at room temperature (Malcolmson., 2006). If packed instantly while not exposed to air and light, milled flax seed will be stable against excessive chemical reaction once stored for nine months at room temperature (Chen.,1994) and below warehouse conditions, for twenty months at close temperatures. Three phenolic glucosides secoisolariciresinol diglucoside, p-coumaric acid glucoside, and ferulic acid glucoside are present in business breads containing flax seed (Strandas., 2008).

Flax seeds have 7 per cent of water, 18 per cent protein, 29 per cent carbohydrates, and 42 per cent fat. In 100 grams as a reference amount, flax seeds provide 534 calories and contain high levels of protein, dietary fibre, several B vitamins, and dietary minerals (Gemma., 2015). Flax seeds are especially rich in thiamine, magnesium, and phosphorus. As a percentage of total fat, flax seeds contain 54 per cent omega-3 fatty acids, 18 per cent

omega-9 fatty acids (oleic acid), and 6 per cent omega-6 fatty acids; the seeds contain 9 per cent saturated fat, including 5 per cent palmitic acid. Flaxseed oil contains 53 per cent 18:3 omega-3 fatty acids and 13 per cent 18:2 omega-6 fatty acids (Pan *et al.*, 2009).

Lignans are a bunch of phytochemicals shown to possess feeble estrogenic and antiestrogenic properties. Two specific lignans, enterodiol and enterolactone, are absorbed after formation within the viscus tract from plant precursors notably extensive in fibre-rich food and are excreted in the urine (Phipps.,1993). When it comes to the nutritional value of flax seeds, there are several vital nutrients to be gained from this superfood. The total fat present is 42g, out of which 3.7g of saturated fat, 29g of polyunsaturated fat, and 8g of monounsaturated fat are present. It has 0 mg of cholesterol. A 100g of flaxseed also has 30mg of sodium and 813mg of potassium. The total carbohydrate content is 29g with 27g of dietary fibre present and 1.6g of sugar. It also has 18g of protein, 25per cent of the daily recommended dose of calcium, One per cent of vitamin C, 31per cent of iron, 25per cent of vitamin B-6, and a whopping 98% of magnesium. However, it has 0 per cent of vitamin A, B-12, and D (Phipps.,1993). India is expected to generate around 146 thousand metric tonnes of flaxseed by the end of the fiscal year 2022.

ii. Nutritional importance of pumpkin seeds

Pumpkins are categorized into five species in the *Cucurbitaceae* family: *Cucurbitaceae pepo, Cucurbitaceae moschata, Cucurbitaceae mixta, Cucurbitaceae maxima*, and *Cucurbitaceae stilbo* (Dotto and chacha., 2020). Pumpkin has been increasingly used in the healthcare business in recent years due to its high nutraceutical and therapeutic potential. Although pumpkin seeds are sometimes eaten as snacks or used as a protein supplement in some areas, they are usually discarded after the oil is extracted (Xanthopoulou., 2009). Because of their biological and pharmacological potentials, pumpkin seeds are gaining popularity as functional foods. Pumpkin seeds contain vitamins, carotenoids, squalene, phytosterols, cucurbitacin, and phenolic compounds in addition to carbohydrates, protein, and other basic nutrients (Wang *et al*., 2017).

Antioxidation, disease resistance, plant colour production, and other tasks are all performed by phenol, which has one or more aromatic rings and hydroxyl groups (Dai and Mumper., 2010). Even though plant polyphenols have been extensively studied as natural antioxidants, there is a paucity of information on phenolic chemicals found in pumpkin seeds (Enneb *et al*., 2020).

The phenolic acids in pumpkin (*Cucurbita pepo*) seeds and hulls were studied, and P-hydroxybenzoic acid was shown to be the most abundant phenolic acid in the hull-less seeds with green skin. Caffeic, ferulic, and vanilic acids are also present (Pericin *et al*., 2009). Roasting is a time-honoured method of enhancing the nutritional worth and sensory appeal of a variety of foods. Furthermore, roasting has an impact on a product's antioxidant capability. Roasting is required to produce the fragrance components of pumpkin seed oil, with the roasting temperature above 100°C (Siegmund and Murkovic., 2004).

The roasting temperature has a substantial impact on the content and concentration of volatile chemicals. The content of aldehydes and alcohols tends to be higher at lower temperatures. The synthesis of various pyrazines, which were thought to be the primary fragrance components of pumpkin seed oil, was triggered by high temperatures (Poehlmann and Schieberle., 2013). The volatile components of roasted pumpkin seeds were evaluated directly instead of pumpkin seed oil in a study using headspace solid-phase microextraction followed by gas chromatography and mass spectrometry. It was discovered that at 150°C, Polycyclic Aromatic Hydrocarbons (PAHs) were produced, which could be genotoxic and carcinogenic (Potocnik and Kosir., 2016).

Plant protein has recently been investigated as a possible animal protein substitute due to its cost-effectiveness (Moreno and Carciofi., 2020). Pumpkin seed cake has a high protein level (after oil extraction) and an amino acid composition close to soybean protein (Vinayashree and Vasu., 2021). Many investigations have found that pumpkin seed protein includes all required amino acids, with lysine being the first limiting amino acid, followed by

arginine and glutamic acid (Glew *et al*., 2006). As a result, pumpkin seeds are regarded as a good plant protein source. There are few studies on pumpkin seed roasting and nutritional qualities. The effect of roasting on the protein profile of pumpkin seeds may help to promote their use in food systems and increase their commercial worth (Rezig *et al*., 2013).

Dried and roasted pumpkin seeds contain 2 per cent water, 49 per cent solids, 15 per cent carbohydrates, and 30 per cent protein. In a 100-gram reference serving, the seeds are high in calories and a rich source of protein, fibre, niacin, iron, zinc, manganese, magnesium, and phosphorus (Poehlmann and Schieberle., 2013). The seeds are a moderate source of riboflavin, folic acid, pantothenic acid, sodium, and potassium. The main fatty acids in pumpkin seeds are linoleic acid and oleic acid, with smaller amounts of palmitic acid and stearic acid (Poehlmann and Schieberle., 2013). Madhya Pradesh is the leading producer of pumpkin seeds in the country, with 532.82 tonnes produced each year.

iii. Nutritional benefits of sunflower seeds

Sunflower seeds are officially the sunflower plant's fruits (*Helianthus annuus*). The seeds come from the plant's huge flower heads, which can reach a diameter of more than 12 inches (Zoumpoulakis *et al*., 2017). Up to 2,000 seeds can be found in a single sunflower head. Sunflower crops are divided into two categories. The seeds are cultivated for one type, while the oil is grown for the other. The inedible black and white striped shells, sometimes known as hulls, surround the sunflower seeds consumed. The shells of those used to extract sunflower oil are solid black. Sunflower seeds are mildly nutty in flavour and have a solid but tender texture. They're usually roasted to enhance the flavour. Sunflower is an essential oilseed crop that is grown all over the world as a source of high-quality oil and dietary fibre that is beneficial to human health (Shane *et al*., 2011). Sunflowers may be more competitive than other crops such as maize, soybeans, and sorghum in some regions, such as India and South Africa (Zoumpoulakis *et al*., 2017). The demand for edible sunflower seeds, oil, and byproducts has increased as the human

population has grown, and there is a need to step up efforts to boost sunflower output to satisfy the need (Shane *et al*., 2011).

Sunflower seeds are one of the most important oil producers on the planet. The plants are drought resistant and hardy, making them ideal for colder or dry climates where many other non-oilseed crops fail. Sunflower seeds are normally revealed at the apical section of the plant after maturation (Brennan., 2020). The seeds have three layers: an epicarp on the outside, a mesocarp in the middle, and an endocarp on the inside. The seeds are contained within an achene, which is made up of a lignin and cellulolytic materials shell that covers the kernel and accounts for 80 per cent of its total weight. Sunflower seeds contain about 25 per cent oil when raw, but this has climbed to 40 per cent. Cold extraction and hot pressing are two methods for extracting seed oil (Leather., 1987).

Cold press oil is commonly used in salad dressing, cooking, and margarine manufacture, but hot press oil is mostly utilized in industries for derivable products such as paints, soaps, detergents, and pest treatments (Ciarka *et al*., 2009). Vitamin E, B, folate, and niacin are abundant in sunflower seeds, as minerals such as calcium, copper, iron, magnesium, manganese, selenium, phosphorous, potassium, sodium, and zinc.

Dried whole sunflower seeds provide 584 calories per 100-gram meal, with 5% water, 20% carbohydrates, 51% total fat, and 21% protein. Protein, dietary fibre, several B vitamins, and vitamin E are all abundant in the seeds (Ciarka *et al*., 2009). Dietary elements such as magnesium, manganese, phosphorus, iron, and zinc are also abundant in the seeds. Fat accounts for half of a 100-gram serving, with monounsaturated and polyunsaturated fats, primarily linoleic acid, accounting for the other half. Furthermore, the seeds include phytosterols, which may help to decrease blood cholesterol levels (Blount.,1980). Karnataka, with a production of 3.04 lakh tonnes from an area of 7.94 lakh hectares, is India's largest sunflower producer, followed by Andhra Pradesh, Maharashtra, Bihar, Orissa, and Tamil Nadu. Sunflower agriculture covers around 1.48 million hectares in India, with an average yield

of 0.6 metric tonnes per acre. In the fiscal year 2021, India consumed around 2.3 million metric tonnes of sunflower seed oil.

iv. Culinary and nutritional importance of sesame seeds

Sesame seed is one of the oldest domesticated oilseed crops, dating back over 3,000 years. Many other species of *Sesamum* exist, the majority of which are wild and native to Sub-Saharan Africa. The cultivated type, *Sesamum indicum*, is from India (Ogasawara, Chiba and Tada., 1988). It thrives in drought-stricken areas, while other crops have failed. The oil content of sesame is among the greatest of any seed. It's a common component in cuisines all across the world because of its rich, nutty flavour (Hansen., 2011). Dried whole sesame seeds contain 573 calories per 100 g and are made up of 5% water, 23% carbs, 50% fat, and 18% protein (Heuze *et al*., 2017). Several B vitamins and dietary minerals, including iron, magnesium, calcium, phosphorus, and zinc, are abundant in whole sesame seeds. Sesame oil meal, a byproduct of oil extraction from sesame seeds, is high in protein and is used as feed for poultry and livestock (Bohn, Meyer and Rasmussen., 2008). Whole sesame seeds, like many other seeds, contain a considerable quantity of phytic acid, an anti-nutrient that binds to certain nutritional elements taken at the same time, particularly minerals, and hinders absorption by dragging them along as they pass through the small intestine. The amount of acid in the seeds is reduced when they are heated or cooked (Gouveia *et al*., 2016).

Sesame seeds are widely used in a variety of cuisines. It has a deep, nutty flavour and is used whole in cooking. Sesame seeds can be found in a variety of bread, including bagels and hamburger bun toppers (Laino and Charlene. ,2009). They're frequently made into crackers in the form of sticks. The seeds are eaten on bread in Sicily and France. The seeds are frequently utilized in Greek cakes. In West African cuisine, the entire sesame plant was employed extensively.

The seeds might be roasted and infused in water to make a coffee-like drink, or they could be used as a thickening in soups and puddings (Voeks *et al*., 2013). Sesame oil, which is derived from the seeds, can be used as a

butter alternative or as a cake shortening. Furthermore, the mucilage-rich leaves of mature plants can be used as a laxative as well as a cure for dysentery and cholera (Bedigian and Dorothea., 2013). Slaves grew the plant after arriving in North America as a subsistence staple and nutritious supplement to their weekly meals (Carney *et al*., 2009). They've been used in a variety of American cuisines since then. In Caribbean cuisine, sugar and white sesame seeds are combined into a bar resembling peanut brittle and sold in stores and street corners, like Bahamian Benny cakes (Voeks *et al*., 2013).

In India, sesame seeds and oil are widely used. Sesame seeds mixed with heated jaggery, sugar, or palm sugar are fashioned into balls and bars that are similar to peanut brittle or nut clusters and eaten as snacks in most sections of the country. Black sesame is utilized in the making of chikki and cold-pressed oil in Manipur. Sesame seeds might be roasted and infused in water to make a coffee-like drink, or they could be used as a thickening in soups and puddings (Voeks *et al*., 2013). Gujarat produces the most sesame, accounting for 22.3 per cent of total production, followed by West Bengal (19.2%), Karnataka (13.5%), Rajasthan (9.8%), Madhya Pradesh (9.06%), Tamil Nadu (4.7%), Andhra Pradesh (4.52%), and Maharashtra (4.52%). (4.52 per cent) (Carney *et al*., 2009).

METHODOLOGY

III. METHODOLOGY

The methodology used in the current study, titled "**Formulation of Seed Bar with Menstrual Health Potentials**" is presented under the following sub-headings:

A. Selection of edible seeds
B. Development and standardization of seed bar
C. Assessment of sensorial parameters of seed bar
D. Evaluation of seed bars for proximate principles, physicochemical properties and phytochemicals
E. Statistical analysis and interpretation of data
F. Ethical clearance

A. Selection of edible seeds

Menstrual health is a dynamic state of overall physical, mental, and social well-being, not just the absence of disease or infirmity with reference to the monthly cycle. Irregular periods, also known as oligomenorrhea, can be caused by a variety of factors. Many of them have something to do with hormone levels. The primary hormones that regulate the menstrual cycle are oestrogen, progesterone, and follicle-stimulating hormone. It can promote menstrual irregularities if something disturbs or changes the way these hormones rise and decrease during each cycle (Pathak, 2021).

Seeds that are plant-based contain heart-healthy lipids, fibre, and minerals. Literature has shown that seeds such as flax seeds, pumpkin seeds, sunflower seeds and sesame seeds are a rich source of proteins, omega-3-fatty acids and omega-6-fatty acids which helps to reduce cholesterol levels and the risk of heart diseases (Olsen., 2018). They help in reducing stress hormones, and also improve and balance the sex hormones. Hence the seeds namely flax seeds, pumpkin seeds, sesame seeds and sunflower seeds were selected for the present study. The scientific name of the seeds are *Linum usitatissimum*, *Cucurbita maxima*, *Sesamum indicum*, and *Helianthus annuus* respectively and is presented in Table I.

Table I gives the common name and scientific name of the selected seeds.

TABLE I

NAMES OF SELECTED EDIBLE SEEDS

Edible seed	Scientific name	Common name
Flaxseed	*Linum usitatissimum*	Aali vithai Aviselu ginjalu
Pumpkin seed	*Cucurbita maxima*	Poosani vithai Gumidikai vittanam
Sesame seed	*Sesamum indicum*	Ellu Nuvvu ginjalu
Sunflower seed	*Helianthus annuus*	Suriyakanthi vithai Proddutirugudu vitanam

B. Development and standardization of seed bars

Selection of seeds

The seeds selected namely flaxseed, pumpkin seeds, sesame seeds and sunflower seeds were purchased in large quantities from the local supermarket located in Saibaba Colony, Coimbatore. The seeds selected for the study are divided into two groups based on phases of the menstrual cycle and two seed bars were developed and standardised. The phases include the follicular phase and luteal phase. In the follicular phase, flaxseeds and pumpkin seeds are used while in the luteal phase sunflower seeds and sesame seeds are used. One tablespoon of each seed was used for the preparation of seed bars. Initially, the seeds were roasted to a golden brown colour until the raw taste disappears. It is then ground coarsely to a powder and stored in airtight containers. All four seeds were roasted separately and stored for further product development (Plate I).

Development and standardization of seed bar

Seed bars were developed in step by step process by the following methods:

Method 1

15 grams of flaxseed and 15 grams of pumpkin seeds are weighed using a weighing balance. Sugar of weight equal to the seeds are also measured and kept aside. The pan was heated and 5 ml of water was added along with the measured quantities of sugar. When the sugar syrup attains the hard ball stage the flame was turned off and the seeds was added and stirred well. The mixture was then transferred to the plate immediately and shaped. Since the seeds are not roasted, the raw smell retained in the bar.

Method 2

15 grams of flaxseed and 15 grams of pumpkin seeds were taken and an equal weight of sugar to the seeds was also taken. The seeds were roasted to enhance the flavour. To make the sugar syrup, 5ml of water was taken in a pan and heated. Then the measured quantities of sugar was added to it. Once the sugar syrup reached the hard ball stage, flame was turned off and seeds were added and combined well. The mixture was then poured on a plate and shaped accordingly. In this method the seeds did not bound well in sugar syrup and the bar appeared to be chewy.

Method 3

An equal amount each 15 grams of flaxseed and pumpkin seeds was taken and an equal amount of sugar was also measured and kept aside. The measured amount of seeds were roasted to enhance the flavour. Then the flaxseed was taken in a mixer jar and ground in pulse mode to coarse powder. Pumpkin seeds was added to it and ground again. To the ground mixture, sugar was added and ground again. Then the mix was poured in a plate and made into required shapes. The moisture content present in the sugar helped to mold the bar.

Similarly all the three methods was tried out using sesame seeds and sunflower seeds. As method 3 came out well and was acceptable method 3 was used as standard. Three variations using different types of sugar was prepared. The sugars used for the variations include jggery, brown sugar and palm jaggery.

i. Follicular phase (1-14 days)

Variation I - Flaxseed-pumpkin seed bar with jaggery (FPJ)

Measured quantities i.e. 15 grams of flaxseed and 15 grams of pumpkin seeds are weighed in a weighing balance. The seeds are roasted to enhance the flavour and to remove the raw flavour. After roasting, the seeds are ground in pulse mode in a mixer. In this process, flaxseed was ground separately and pumpkin seeds are then added and ground. Further, jaggery of weight which is equal to the total seed was added to it and ground thoroughly. The jaggery present in the mix provided the moisture content. The mix was then put up on a square plate, pressed tightly and cut into required sizes.

Variation II - Flaxseed-pumpkin seed bar with brown sugar (FPB)

In a weighing balance, measured quantities, such as 15 grams of flaxseed and 15 grams of pumpkin seeds, are weighed. The flavour of the seeds is enhanced by roasting them. After roasting, the seeds are crushed in a mixer in pulse mode. Flaxseed was processed separately in this method, and pumpkin seeds were then added and ground. Furthermore, brown sugar equal in weight to the whole seed was added to it and well pulverised. The moisture content was given by the brown sugar in the mix. The mixture was then placed on a square plate, pressed firmly, and cut into the desired sizes.

Variation III - Flaxseed-pumpkin seed bar with palm jaggery (FPP)

The required amounts of seeds namely 15 grams of flaxseed and 15 grams of pumpkin seeds are weighed using a weighing balance. The flavour of these seeds is enhanced by roasting them. The seeds are roasted and then ground in a mixer in pulse mode. Flaxseed was ground separately first, and then pumpkin seeds were added and ground. It was then mixed with palm jaggery of the same weight as the total seed and thoroughly ground. The moisture was provided by the palm jaggery in the mix. The mixture was then pressed tightly onto a square plate and cut into the required sizes.

ii. Luteal phase (15-28 days)

Variation I - Sunflower seed-sesame seed bar with jaggery (SSJ)

Weighed 15 grams of sunflower seeds and 15 grams of sesame seeds. The flavour of these seeds was enhanced by roasting them. The seeds are roasted and then ground in a mixer in pulse mode. Sunflower seeds are ground separately, and sesame seeds are added and ground as well. It was then mixed with jaggery of the same weight as the seeds and completely pulverised. The mixture was then moulded and cut into a bar. The moisture in jaggery helped to mould the seed bar.

Variation II - Sunflower seed-sesame seed bar with brown sugar (SSB)

15 grams of sunflower seeds and 15 grams of sesame seeds were weighed. Roasting these seeds brought out their full flavour. The seeds are roasted before being ground in a pulse mode mixer. Sunflower seeds and sesame seeds are ground separately and then combined. It was then completely pulverised with brown sugar of the same weight as the seeds. After that, the mixture was moulded and cut into a bar. Brown sugar's moisture helped to mould the seed bar.

Variation III - Sunflower seed-sesame seed bar with palm jaggery (SSP)

15 grams of sunflower seeds and 15 grams of sesame seeds were weighed. The full flavour of these seeds was brought out by roasting them. As a result, the seeds are roasted before grinding in a pulse mode mixer. Sunflower and sesame seeds are ground separately before being combined. The seeds were then completely pulverised with palm jaggery of the same weight. The mixture was then shaped and cut into a bar. The moisture in palm jaggery aided in the formation of the seed bar.

Plate 2 gives the steps involved in the development and standardisation of seed bars. Plate 3 presents the developed seed bars for both the phases along with three variations.

Pumpkin seeds ⟵ Follicular phase ⟶ Flax seeds

(1-14 days)

Sunflower seeds ⟵ Luteal phase ⟶ Sesame seeds

(15-28 days)

Jaggery

Brown sugar

Palm jaggery

Plate 1

Selection of seeds and sugars

Weighing of seeds

Roasting

Grinding

Moulding

Cutting

Plate 2

Development of seed bars

Standard – Groundnut bar

FPJ

FPB

FPP

SSJ

SSB

SSP

FPJ - Flaxseed-pumpkin seed bar with jaggery

FPB - Flaxseed-pumpkin seed bar with brown sugar

FPP - Flaxseed-pumpkin seed bar with palm jaggery

SSJ - Sesame-sunflower seed bar with jaggery

SSB - Sesame-sunflower seed bar with brown sugar

SSP - Sesame-sunflower seed bar with palm jaggery

Plate 3

Seed bars

C. Assessment of sensorial parameters of seed bars

Sensory analysis (or sensory evaluation) is a scientific discipline that uses concepts of experimental design and statistical analysis to evaluate consumer products through the use of human senses. Appearance, colour, flavour, taste and texture decide the acceptance of the food (Sethi *et al*., 2001). Thus, sensory evaluation of the seed bars with two sets of seeds was carried out. Sensory evaluation should be conducted in a quiet, well-lit space free of odours. In the testing room, a temperature of around 20°C and relative humidity of 62 per cent is considered optimum (Granato., 2009).

The nine-point hedonic scale is the most prevalent, scale used for evaluating a food product with 1 indicating extreme dislike and 9 indicating extreme like. The hedonic scale assumes that participants' preferences are on a spectrum and their responses can be classified into two categories: like and dislike (Lawless & Heymann., 2013). Panel members are a group of testers who have been selected to take part in a sensory test and have been asked to rate the food quality of the items under consideration. Thirty semi-trained panel members who are pursuing their post-graduation from the Departments of Food Science and Nutrition and Food Service Management and Dietetics were involved since they have knowledge about the sensory evaluation and its criteria to be assessed.

The products are prepared in the Foods Lab, Avinashilingam Institute for Home Science and Higher Education for Women, which is part of the Department of Food Science and Nutrition. Sensory evaluation was conducted in the Food Sensory Laboratory at a time between 10:30 am to 12 pm and 3 to 5 pm. The panel members were served with two seed bars separately with a standard and three variations to taste at various times. All of the products had consistent and uniform portion sizes.

During the sensory review, each panel member was given their own time to analyse the product. The final products are carefully organised and labelled as Standard, Variation I, Variation II, and Variation III before being delivered to the panel members. A pen and an evaluation form were distributed to the panel members. Between tastings, the evaluator was given a glass of water to rinse the mouth.

The evaluation card was prepared legibly such that it was easily understood by the panel members, and the material was organised in a logical order for the examination that is required for each test. The panel member's scores were used to determine the acceptability and organoleptic scoring of the preparations. The results of the panel member's sensory evaluation of the products was recorded, and the mean scores for each product was determined. Each product's overall acceptability and mean scores was evaluated, and the product with the highest total and mean scores was deemed the most acceptable.

The score card used for assessing the seed bar is appended in Appendix II. The sensory evaluation as tested by the panel members is presented in Plate 4.

Appearance

Colour, surface qualities such as smoothness of a surface, dry surface, glossy surface, or exterior appearance features such as lump formation, thickness or thinness, layering, and so on can all be used to assess a food's appearance (Heredia., 2007).

Colour

A food's colour creates a certain level of product expectation. The colour of the environment or the lighting can also affect how a person perceives food. Colour is one of the most important factors that influence consumer perceptions of quality that has a strong influence on food acceptance and can predict non-sensory characteristics such as moisture content, over-processing, and pigment content. It can also be used to determine the quality of fruits, beverages, oils, and non-dairy emulsions directly. Sensory analysis is crucial in food characterization because colour perception interacts with other sensory properties such as sweetness, creaminess, flavour, and overall acceptance (Hutchings, 2005).

Flavour

Taste and odour are the two subcategories that make up the flavour. The sensory information produced by the combination of taste and fragrance

is used to determine a food's flavour. The temperature at which food is presented may have a significant impact on one's capacity to notice and assess flavour. The ideal temperature range for evaluating flavour is 20-30°C (Chaaban *et al*., 2021).

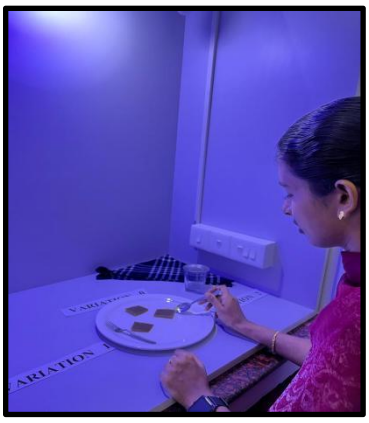
Taste

Individuals respond to a product on the basis of their sensory perception and judge the product quality differently. The auditory sense is the least used in appreciation of food quality, however, the senses for taste stimulation have a strong influence on the acceptability of food quality (Rios *et al*., 2019). Taste sensations which the taste buds register are sweet, salt, sour and bitter.

Texture

Graininess, softness, chewiness, brittleness, and other descriptive parameters are used to describe the texture of food. The appearance of a product and its evaluation in the mouth are both influenced by its textural qualities. The texture properties of a dish that are perceived in the mouth are referred to as mouthfeel. Seed bars had a thick and coarse texture, making them crunchy when eaten (Guinard and Mazzucchelli., 1996).

Delivering the product and the score card for evaluation in the Sensory Lab through the counter



Sensory evaluation of the seed bar by panel members

Plate 4

Sensory evaluation of seed bars

D. Evaluation of seed bars for proximate principles, physicochemical properties and phytochemicals

The proximate principles, present in the seed bar, physicochemical properties of the seed bar and qualitative presence of phytochemicals present in the seed bar was analysed to the best acceptable variable as evaluated by the panel members in both the seed bars developed for follicular phase and luteal phase.

i. Analysis of proximate principles

The nutrients in the seed bars are tested using conventional protocols in the Nutrition Laboratory of the Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. Moisture, ash, protein, fats, carbohydrate, selenium, zinc, potassium, iron, phosphorous, and magnesium are among these nutrients. All the analysis was conducted in triplicates to get concordant values (Plate 5).

Moisture

One of the most commonly conducted measurements in food analysis is moisture estimation. When food is heated to a temperature not much higher than that of boiling water or left to stand overnight over a dehydrating chemical, or heated under a vacuum, moisture is lost (AOAC, 1990).

Ash

By continuous heating, the substance gets charred which can be used for the determination of minerals present (AOAC, 1990).

Protein

The given sample is digested with concentrated sulphuric acid in a macro kjeldahl flask when nitrogen is transformed into ammonium sulphate. In a macrokjeldahl steam distillation system, ammonia is freed by the action of strong alkali. By absorbing 2% boric acid, nitrogenous material is transformed to ammonium borate, which is then titrated against N/70 sulphuric acid. The acid equivalent to the ammonia from which protein is estimated is the volume

of acid required to bring the test sample to the colour of the blank (AOAC, 1990).

Fats

Ether extraction of crude fat in vegetable products is done in a continuous extractor, which is an apparatus in which the ether is volatized, condensed, and allowed to work on the material after dissolving a portion of the fat in the material and discharging into the extraction flask. Until the extraction is complete, the phases in the process are repeated continuously and automatically. The intermittent movement of a glass siphon is used in the soxhlet extraction. The ether condenses gradually into the extraction tube containing the substance until it reaches the top, at which point it is emptied into the extraction flask (AOAC, 1990).

Carbohydrate

Glucose is dehydrated to hydroxyl methyl furfural in a hot acidic media. When combined with phenol, this produces a green-coloured compound with a maximum absorption wavelength of 490 nm (www.biocyclopedia.com).

Selenium

The method is based on measuring the fluorescence of a piazselenol derived from selenite and the carcinogenic reagent DAN (2,3-diaminonaphthalene). Detection limits as low as 0.2 g L1 can be obtained; this is suitable for these types of determinations, but it requires a stage of prereduction and complex extraction in an organic solvent (AOAC, 1996).

Zinc

The zinc content of food can be determined using a flame atomic absorption spectrophotometer. The zinc absorption is measured after the concentrate is introduced into the flame. The product was weighed at 1g before being placed in a digestion vessel. The samples are kept in microwave digestion vessels. The vessels are left open for at least 30 minutes to allow gasses to escape. After that, the vessels are digested in a microwave

digestion system. Spiked samples were prepared in the same way, resulting in the expected spike concentration of 2 ppm.

This method was used to create the sample blanks and spikes. All samples are prepared in duplicate. Following digestion, the samples are diluted further to ensure that the expected concentration remained within the calibration range (Anastasia G, 2021).

Potassium

By directly aspirating the filtered or digested and filtered sample into an air-acetylene sample, potassium is determined using atomic absorption spectroscopy. Effluent samples must be pre-digested with nitric acid before being stabilised with hydrochloric acid (AOAC, 1990).

Iron

With ignition or oxidation, the food sample is oxidised. Iron, in the form of ferric iron, reacts with ammonium thiocyanate or potassium thiocyanate to produce ferric thiocyanate, which is red in colour. Colorimetrically, the colour, which is a measure of concentration, is measured (AOAC, 1990).

Phosphorous

Phosphomolybdic acid is formed when the ash solution is treated with ammonium molybdate. Phosphomolybdic acid is reduced with 1,2,4 Amino Naphthol Sulfonic Acid reagent to produce a blue colour that appears to be a mixture of molybdenum oxides. The amount of phosphorus present is measured by the intensity of the colour developed (AOAC, 1990).

Magnesium

A flame atomic absorption spectrophotometer is used to determine the magnesium content of food. After the concentrate is introduced into the flame, the magnesium absorption is measured. Before being placed in a digestion vessel, the product was weighed at 1g. Microwave digestion vessels contain the samples. To allow gases to escape, the vessels are left open for at least 30 minutes. The vessels are then digested in a microwave digestion system.

Spiked samples were prepared similarly, yielding the expected spike concentration of 2 ppm.

The sample blanks and spikes are created using this method. All samples were prepared in duplicate unless otherwise stated. Following digestion, the samples are further diluted to ensure that the expected concentration was within the range of calibration (Anastasia G, 2021).

Iron estimation

Carbohydrate estimation

Calcium estimation

Phosphorous estimation

Plate 5

Analysis of proximate principle in seed bars

ii. Physicochemical properties

The physicochemical properties analysed for both the seed bars include Measurement of Texture, Total Soluble Solids and Measurement of colour. All the analysis was conducted in triplicates to get concordant values (Plate 6).

Measurement of Texture

Texture Profile Analysis is a common double compression test used to determine the textural properties of foods. It is used in a variety of other industries, including pharmaceuticals, gels, and personal care. During a TPA test, samples are compressed twice with a texture analyzer to provide information about how the samples behave when chewed. Because the texture analyzer mimics the biting action of the mouth, the TPA test was often referred to as the "two-bite test" (Peleg., 1976).

Total Soluble Solids

The amount of total soluble solid present in a unit volume of solution is referred to as total soluble solids. Using a refractometer, it determines the sugar content of sugar solutions (honey, juices, and syrup) in which sugar is the main component. The index of refraction determines the total soluble solids content of a solution. This is measured with a refractometer and is known as the degrees, Brix. Brix is a unit of measurement for sugar concentration. Brix is usually considered equivalent to the percentage of sucrose in the solution at 20°C (Bavaneethan., 2018).

The method is best suited for ripe and juicy fruit with high sugar content. TSS is measured using a refractometer in 0.1 per cent increments as °Brix. There are both hand-held and digitally operated refractometers available. Placed a small amount of test sample onto the refractometer's prism. Examined the eyepiece while pointing the prism in the direction of bright light (not directly at the sun). Concentrated and recorded the percentage sugar (°Brix) based on where the base of the blue colour sits on the scale. The Abbe design is convenient and is used for the study (Gooch., 2007).

Measurement of Colour

Given the general method for detecting colour, colour readers are mostly used on flat surfaces. A colour sensor is a type of "photoelectric sensor" that emits light through a transmitter and then detects the light reflected back from the detection object through a receiver. Some colour sensors do not recognise colours in the traditional sense, instead of focusing on light wavelengths. In addition to the visible range, these devices can be configured to locate wavelengths in the near-infrared (750 nm to 2500 nm wavelength range), far infrared (600 to 15.00-micron wavelength range), and ultraviolet (50 to 350 and 400 nm wavelength range). The most common type of colour sensor is one that reads the visible range. They use an RGB colour model to measure colour (red, green, blue). These three colours can produce a large portion of the visible spectrum (380 nm to 750 nm wavelength) (Wat., 2020).

Measurement of Total Soluble Solids (TSS)

Measurement of colour

Plate 6

Analysis of physicochemical properties

iii. Phytochemical analysis of seed bars

Plants naturally create phytochemicals, which are secondary metabolites. Phytochemicals have a significant part in the regulation of plant cell processes as well as providing colour, scent, and flavour to plants. Furthermore, growing research has revealed that phytochemicals have significant medical value with few negative effects. As a result, phytochemical characterisation and evaluation is a crucial step in the pharmacological discovery of plant-derived therapies. Standard phytochemical assays necessitate extracting active phytochemicals from plant materials as well as detecting and analyzing target phytochemical levels.

Qualitative analysis of phytochemicals namely tannins, terpenoids, phenols, flavonoids, saponins, quinones, glycosides,and coumarins was done in the aqueous and solvent extracts (ethanol and methanol extracts) of the seed bar. All the tests are done in triplicates to get concordant values (Plate 7).

Preparation of aqueous extract

5g of the sample was taken and added 10 ml of water. The solution was centrifuged and the supernatant clear liquid was collected for further analysis.

Preparation of solvent extract

The pulverized material was mixed with sufficient quantity of solvents viz., methanol and ethanol. It was kept in rotary shaker at 100 rpm overnight and filtered with Whatman No.1 filter paper (Doughari., 2012). The methanol and ethanol extracts of seed bars was prepared using the above standard method.

The phytochemical analysis was done with aqueous and solvent extracts (methanol and ethanol) of seed bars. The phytochemicals analysed are:

Tannins - About 0.5g of the dried sample was boiled in 20ml of water in a test tube and filtered. A few drops of 0.1% ferric chloride were added and observed for brownish green or a blue-black colouration (AOAC, 2005).

Terpenoids - To 0.5 ml of extract, 2ml of chloroform was added and concentrated sulphuric acid was added carefully. The formation of red-brown colour at the interface indicates the presence of terpenoids (AOAC, 2005).

Phenols - To 1ml of the extract, 2ml of distilled water followed by a few drops of 10% ferric chloride was added. The formation of blue or green indicates the presence of phenols (AOAC, 2005).

Flavonoids - To 2ml of plant extract, 1ml of 2N sodium hydroxide was added. The development of yellow colour indicates the presence of flavonoids (AOAC, 2005).

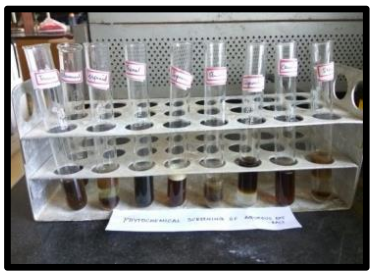
Saponins (Foam test) - The 5ml sample extract was dissolved in 2.5 ml of dilute water and shaken vigorously till a stable persistent froth was obtained. The froth was mixed with 3 drops of olive oil and shaken vigorously and then emulsion was observed (AOAC, 2005).

Quinones - To 1ml of extract, 1ml of concentrated sulphuric acid was added. The formation of red colour indicates the presence of quinones (AOAC, 2005).

Glycosides - To 2ml of the extract, 3 ml of chloroform and 10% ammonia solution were added. The formation of pink colour indicates the presence of glycosides (AOAC, 2005).

Coumarins - To 1ml of the extract, 1ml of 10% sodium hydroxide was added. The formation of yellow colour indicates the presence of coumarins (AOAC, 2005). The physical, physicochemical and phytochemical tests were done in triplicates to get concordant values.

Aqueous, ethanol and methanol extracts of FPJ and SSJ



Aqueous extract **Ethanol extract** **Methanol extract**

Plate 7

Phytochemical analysis of seed bar

E. Statistical analysis and interpretation of data

To evaluate the sensory qualities of the developed seed bars with menstrual health potentials, the data was consolidated, collated, and statistically evaluated.

F. Ethical clearance

The study was presented in the Institutional Human Ethics Committee, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore and the approval was obtained. The human ethical clearance approval number is AUW/ IHEC/ FSN -21-22/XPD-20 (Appendix I).

The Research Design of the study is presented in Figure I.

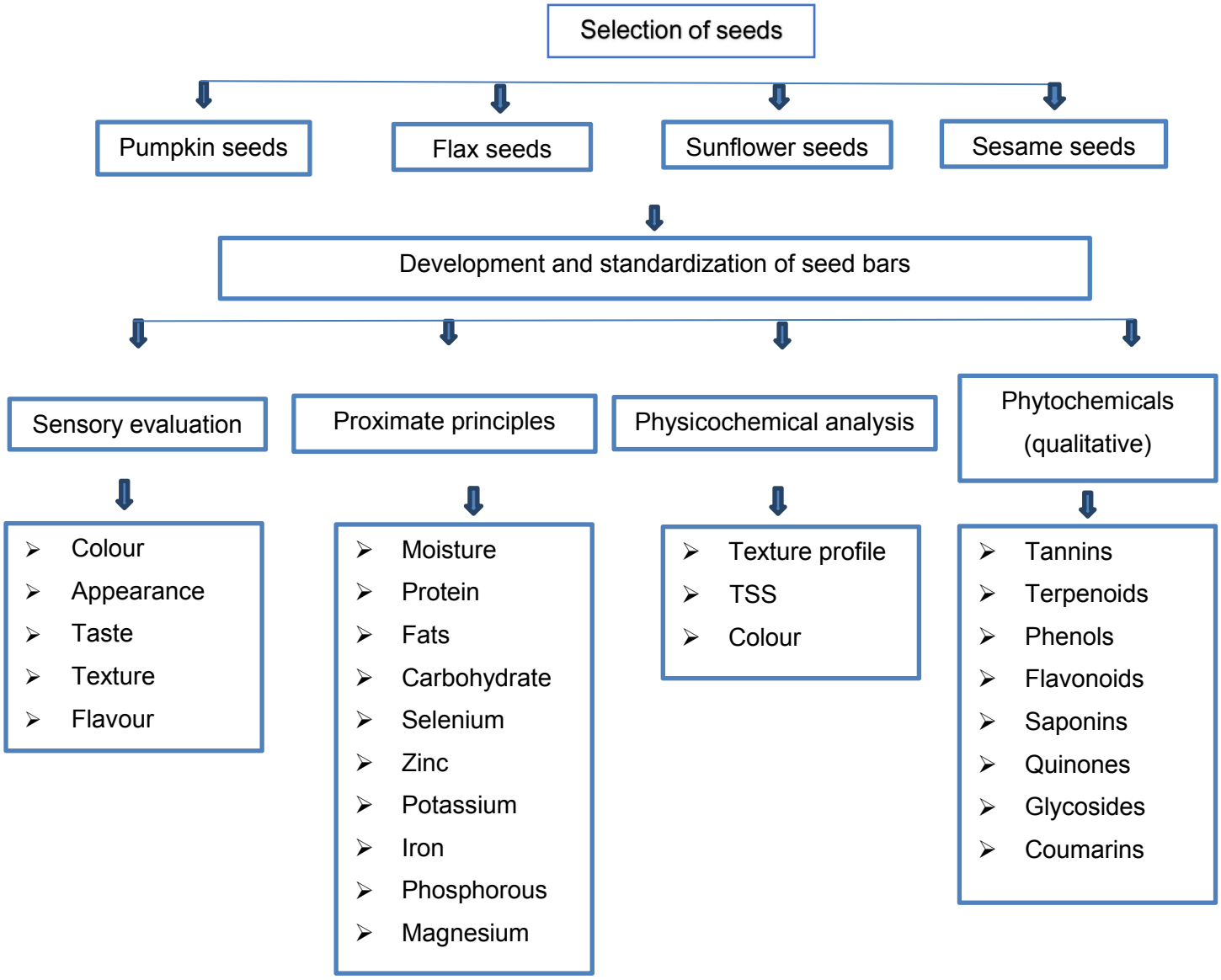


Figure I

Research Design

RESULTS AND DISCUSSION

IV. RESULTS AND DISCUSSION

The Results and Discussion pertaining to the study **"Formulation of Seed Bar with Menstrual Health Potentials"** is presented under the following sub-headings:

A. Sensory attributes of seed bar
B. Proximate principles of seed bar
C. Physicochemical properties of seed bar
D. Phytochemical content of seed bar

A. Sensory attributes of seed bar

Food can be nutritious and cost-effective, but the key to a successful product is that it smells, looks, feels, and tastes good (Vieira, 1996). Food sensory aspects are measured by experimental psychologists using taste intensities, flavour profile evaluation, food texture, consistency, and appearance assessment. In addition to sensory variables, important attitudinal and socioeconomic factors are likely to be involved in hedonic rating, and sensory evaluation must work in tandem with market research to satisfy consumer acceptance and community health needs (Drewnowski and Moskow, 1985).

Seed cycling is claimed to balance hormones, boost fertility, and ease symptomes of menopause. It involves eating flaxseeds, pumpkin seeds, sesame seeds and sunflower seeds at various times of the month to balance certain hormones. All the four seeds are rich in fiber, manganese, magnesium, copper, thiamine, vitamin E, and healthy fats. These nutrients are vital to good health, including reproductive health. Since they cannot be eaten in raw form, a product has been made using the seeds. The seeds were made into bars using different types of sugars namely jaggery, brown sugar, and palm jaggery as variations I, II and III respectively. The variations of flaxseed and pumpkin seed bar are known as FPJ (variation I), FPB (variation II) and FPP (variation III). The variations of sesame seed and sunflower seed bar are mentioned as SSJ (variation I), SSB (variation II) and SSP (variation III).

Sensory attributes of flaxseed-pumpkin seed bar

Table II and Figure I posturizes the sensory attributes of the flaxseed-pumpkin seed bar.

TABLE II

SENSORY ATTRIBUTES OF FLAXSEED-PUMPKIN SEED BAR

N= 30

Criteria	Standard	FPJ	FPB	FPP
Appearance	8.83 ± 0.53	8.5 ± 0.50	7.63 ± 0.49	7.63 ± 0.49
Colour	8.90 ± 0.30	8.36 ± 0.49	7.66 ± 0.47	7.73 ± 0.44
Flavour	8.73 ± 0.58	8.70 ± 0.43	7.66 ± 0.47	7.73 ± 0.44
Texture	8.66 ± 0.66	8.55 ± 0.50	7.53 ± 0.57	7.76 ± 0.43
Taste	8.86 ± 0.34	8.63 ± 0.49	7.60 ± 0.49	7.56 ± 0.49
Overall acceptability	8.93 ± 0.25	8.66 ± 0.47	7.80 ± 0.40	7.83 ± 0.37
F value Standard *vs* variation		3.930**	3.500^{NS}	1.246^{NS}

** - Significant at 5% level, NS - Not significant

Sensory evaluation of flaxseed-pumpkin seed bar revealed that that the mean values for appearance for standard was 8.83, followed by FPJ, 8.5, FPB, 7.63 and FPP 7.63. The mean values obtained for colour was 8.90 for standard, 8.36 for FPJ, 7.66 for FPB and 7.73 for FPP. The mean scores obtained for the flavour in flaxseed-pumpkin seed bar ranged from 7.73 to 8.73, the maximum score obtained for standard with the mean value of 8.73, followed by FPJ with 8.70, FPB with 7.66 and FPP with 7.73. With regard to texture standard showed the best result with a mean value of 8.66 followed by FPJ with 8.55, FPB with 7.53 and FPP with 7.76. The taste of the standard scored maximum mean value of 8.86 followed by 8.63, 7.60 and 7.56 for FPJ,

FPB and FPP respectively. The overall acceptability of flaxseed - pumpkin seed bar revealed that FPJ had a maximum mean score of 8.66 and was comparable with the standard of 8.93. This was followed by FPB and FPP with the mean scores 7.80 and 7.83 respectively. Statistical analysis revealed that the overall acceptability of flaxseed-pumpkin seed bar prepared using jaggery was significant at 5% level when compared with seed bar using brown sugar and palm jaggery.

Sensory attributes of sesame seed-sunflower seed bar

Table III and Figure II posturizes the sensory evaluation of sesame seed-sunflower seed bar.

TABLE III

SENSORY ATTRIBUTES OF SESAME SEED-SUNFLOWER SEED BAR

N= 30

Criteria	Standard	SSJ	SSB	SSP
Appearance	8.5 ± 0.34	8.73 ± 0.44	7.66 ± 0.50	7.56 ± 0.47
Colour	8.86 ± 0.53	8.53 ± 0.50	7.56 ± 0.50	7.46 ± 0.50
Flavour	8.83 ± 0.53	8.6 ± 0.49	7.63 ± 0.49	7.53 ± 0.50
Texture	8.86 ± 0.34	8.63 ± 0.49	7.63± 0.50	7.53 ± 0.49
Taste	8.83 ± 0.37	8.63± 0.49	7.5 ± 0.50	7.46 ± 0.50
Overall acceptability	8.83 ± 0.37	8.73± 0.49	7.6 ± 0.49	7.43 ± 0.49
F value Standard *vs* variation		3.303^{**}	2.510^{NS}	2.302^{NS}

** - Significant at 5% level, NS - Not significant

From the above Table III, it was found that the appearance of the bar made from sesame seeds and sunflower seeds for standard, SSJ, SSB, and

SSP, standard scored the best result with mean value of 8.5, SSP scoring a decreased score of 7.56. In terms of colour, standard and three variations got mean scores from 8.86 to 7.46. SSJ and SSB had a mean value of 8.53 and 7.56 respectively. The maximum mean score for colour was for standard with 8.86. The mean scores obtained for flavor ranged from 7.53 to 8.83, the minimum score 7.53 for SSP, 7.63 for SSB and 8.6 for SSJ and 8.83 for standard. Regarding texture, mean scores of standard showed a value of 8.86, SSJ and SSB with 8.63 and 7.63 and SSP with 7.53. Taste contributed mean scores from 7.46 to 8.83.The maximum mean value obtained for standard was 8.83 followed by SSJ with 8.63, SSB with 7.5 and SSP with 7.46. It was observed that the overall acceptability was statistically significant at 5% level when standard and sunflower seed-sesame seed bar prepared with jaggery was compared. It also revealed that the seed bars prepared with brown sugar and palm jaggery were not significant statistically when compared with standards.

Overall acceptability of flaxseed-pumpkin seed bar and sesame seed-sunflower seed bar

Table IV reveals the overall acceptability of flaxseed-pumpkin seed bar and sesame seed-sunflower seed bar.

TABLE IV

OVERALL ACCEPTABILITY OF FLAXSEED-PUMPKIN SEED BAR AND SESAME SEED-SUNFLOWER SEED BAR

Seed bars	Standard	Variation I	Variation II	Variation III
Flaxseed-Pumpkin seed bar	8.93 ± 0.25	**FPJ** 8.66 ± 0.47	**FPB** 7.80 ± 0.40	**FPP** 7.83 ± 0.37
Sesame seed-Sunflower seed bar	8.83 ± 0.37	**SSJ** 8.73 ± 0.49	**SSB** 7.4 ± 0.49	**SSP** 7.63 ± 0.49

The overall acceptability of flaxseed and pumpkin seed bar showed that, standard scored a mean maximum value with 8.93, followed by FPJ with 8.66, FPB with 7.80 and FPP with 7.83. For sesame seed and sunflower seed bar, the maximum overall acceptability secured for standard with mean value of 8.83, SSJ with 8.73, SSB with 7.4 and SSP with 7.63.

The overall results indicate that variation I i.e. FPJ and SSJ with jaggery had maximum (8.66 and 8.63) overall acceptability when compared with FPB, FPP, SSB and SSP. Hence the seed bars can be made with jaggery instead of other sugars which may enhance the nutritional value of the bar consumed.

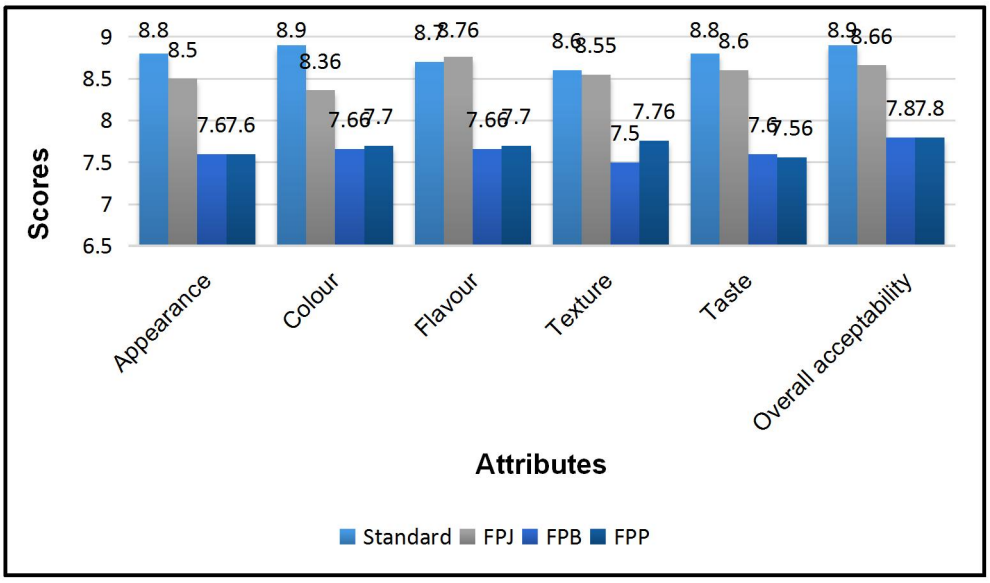


Figure II
Sensory attributes of flaxseed-pumpkin seed bar

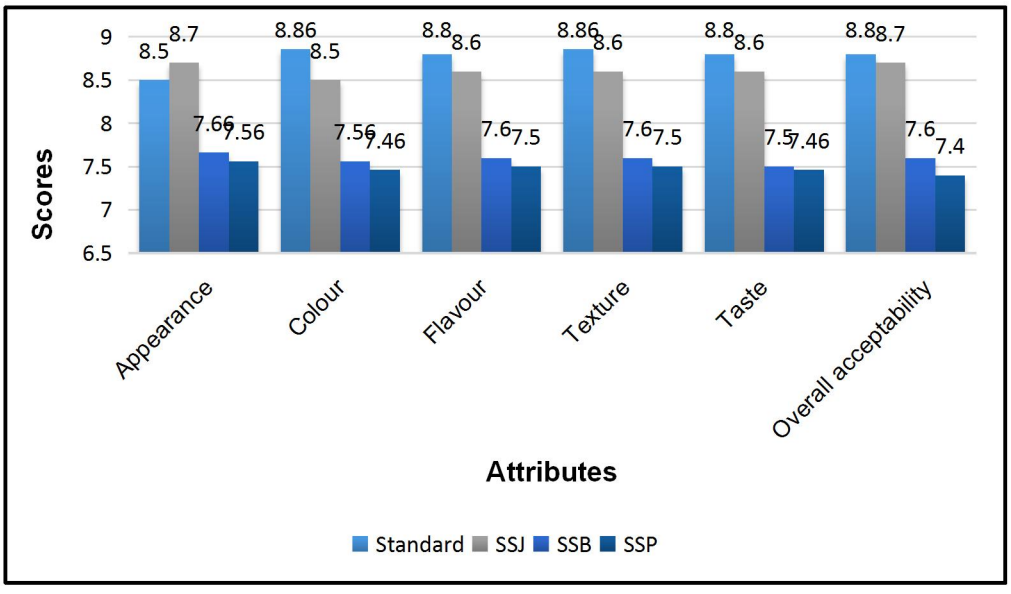


Figure III

Sensory attributes of sesame seed-sunflower seed bar

B. Proximate principles of seed bar

The nutrient content of flaxseed and pumpkin seed bar is depicted in Table V and VI.

TABLE V

QUANTITATIVE ANALYSIS OF PROXIMATE PRINCIPLES IN FLAXSEED-PUMPKIN SEED BAR

Proximate principles	Flaxseed (Values per 100g)	Pumpkin seed (Values per 100g)	RDA	FPJ (Values per 100g)
Moisture (%)	6.09	6.1	-	3.7 ± 0.80
Ash (g)	3.4	4.78	-	11.5
Protein (g)	18.29	19	46g/d	12.3 ± 3.7
Fat (g)	42.16	19	35g/d	20.3 ± 4.3
Carbohydrates (g)	28.88	54	130g/d	41.5 ± 2.7
Selenium (mg)	2.54	0.94	40mcg/d	0.015 ± 0.03
Zinc (mg)	4.34	4.34	13mg/d	2.77 ± 0.70
Potassium (mg)	813	919	3500mg/d	541± 5.11
Iron (mg)	5.7	3.3	29mg/d	4.84 ± 1.7
Phosphorous (mg)	642	1233	1000mg/d	234 ± 3.72
Magnesium (mg)	392	262	325mg/d	328 ± 3.89

Each value represents the mean ± SD of three determinations

From the above table it can be concluded that the nutritive value of the seeds namely flax and pumpkin seeds meet out nearly 1/3 of Recommended Dietary Allowance (RDA) for women (ICMR., 2020).

Flaxseed has a moisture content of 6.09 per cent whereas pumpkin seed has a moisture content of 6.1 per cent. The mean value for the moisture content of FPJ was 3.7 per cent per 100g of bar. Ash value was 3.4g for flaxseed and 4.78g for pumpkin seed and the mean score for the ash content of FPJ was 11.5g. The protein content of FPJ was 12.3g with the protein content of flax and pumpkin seed were 18.29g and 19g. In terms of fat, FPJ got the mean value of 20.3g while the fat content of flaxseed was 42.16g and the fat content of pumpkin seed was 19g. The carbohydrate content for flaxseed was 28.88g, pumpkin seed was 54gand FPJ was noted to be 41.5g.

The micronutrients analyzed include selenium, zinc, potassium, iron, phosphorous, magnesium. The amount of selenium present in FPJ was 0.015mg, in flaxseed was 2.54mg and in pumpkin seed was 0.94mg. Zinc present in 100g of flaxseed was 4.34mg and in pumpkin seed was 4.34mg and in FPJ was 2.77mg. Potassium contributes the mean scores of 541mg in FPJ and the potassium content of flaxseed was 813mg and pumkin seed was 919mg.

Iron content of flaxseed and pumpkin seed were 5.7mg and 3.3mg respectively. While the mean value for the iron content of FPJ was 4.84mg. The phosphorus content of FPJ was 234mg and for flaxseed the phosphorous content was 642mg and for pumpkin seed the phosphorous value was 1233mg. The magnesium content of flaxseed was 392mg and for pumpkin seed was 262mg. The mean score for magnesium content of FPJ was 328mg.

TABLE VI

QUANTITATIVE ANALYSIS OF PROXIMATE PRINCIPLES IN SESAME SEED-SUNFLOWER SEED BAR

Proximate principles	Sesame seed (Values per 100g)	Sunflower seed (Values per 100g)	RDA	SSJ (Values per 100g)
Moisture (%)	7.40	3.1	-	5.1 ± 0.77
Ash (g)	4.2	4.49	-	10.4
Protein (g)	18	19.69	46g/d	12.7 ± 4.2
Fat (g)	50	53	35g/d	8.1 ± 1.56
Carbohydrates (g)	23	18.72	130g/d	56.3 ± 3.74
Selenium (mg)	3.44	5.3	40mcg/d	2.6 ± 1.9
Zinc (mg)	7.8	5.29	13mg/d	1.38 ± 0.58
Potassium (mg)	468	850	3500mg/d	447 ± 4.2
Iron (mg)	15	3.8	29mg/d	3.6 ± 1.44
Phosphorous (mg)	629	1115	1000mg/d	162 ± 2.68
Magnesium (mg)	351	129	325mg/d	285 ± 2.54

Each value represents the mean ± SD of three determinations

From the above table it can be concluded that the nutritive value of the seeds namely sesame and sunflower seeds meet out nearly 1/3 of Recommended Dietary Allowance (RDA) for women (ICMR., 2020).

Sesame seed has a moisture content of 7.40 per cent whereas sunflower seed has a moisture content of 3.1 per cent . The mean value for the moisture content of SSJ was 5.1 per cent per 100g of bar. Ash value was 4.2g for sesame seed and 4.49g for sunflower seed and the mean score for the ash content of SSJ was 10.4g. The protein content of SSJ was 12.7g with

the protein content of sesame and sunflower seed were 18g and 19.69g. In terms of fat, SSJ got the mean value of 8.1g while the fat content of sesame seed was 50g and the fat content of sunflower seed was 53g. The carbohydrate content for ssame seed was 23g, sunflower seed was 18.72g and SSJ was noted to be 56.3g.

The micronutrients analyzed include selenium, zinc, potassium, iron, phosphorous, magnesium. The amount of selenium present in SSJ was 2.6mg, in sesame seed was 3.44mg and in sunflower seed was 5.3mg. Zinc present in 100g of sesame seed was 7.8mg and in sunflower seed was 5.29mg and in SSJ was 1.38mg. Potassium contributes the mean scores of 447mg in SSJ and the potassium content of sesame seed was 468mg and sunflower seed was 850mg. Iron content of sesame seed and sunflower seed were 15mg and 3.8mg respectively. While the mean value for the iron content of SSJ was 3.6mg. The phosphorus content of SSJ was 162mg and for sesame seed the phosphorous content was 629mg and for sunflower seed the phosphorous value was 1115mg. The magnesium content of sesame seed was 351mg and for sunflower seed was 129mg. The mean score for magnesium content of SSJ was 285mg.

Potassium is the major intracellular cation in the body which is required for the normal cellular function. Severe deficiency of potassium is characterized by hypokalemia. The consequences of hypokalemia include cardiac arrythmia, muscle weakness, and glucose intolerance (Seldin *et al*., 2004). Iron is a major component of the cytochromes functioning in cellular respiration and RBCs require iron in haemoglobin, for the well-functioning (Soetan *et al.,* 2010).

Phosphorus is a significant constituent of adenosine triphosphate (ATP) and nucleic acid and crucial for acid-base balance, bone and tooth formation (Soetan *et al.,* 2010). Magnesium plays a crucial role in the body, such as supporting muscle and nerve function and energy production. Low magnesium usually don't cause symptoms. However, chronically low levels can increase the risk of high blood pressure, heart disease, type 2 diabetes and osteoporosis (Dodd *et al.,* 2011) .

Figures IV and V represents the macro and micronutrients present in the seed bars of variations FPJ and SSJ respectively.

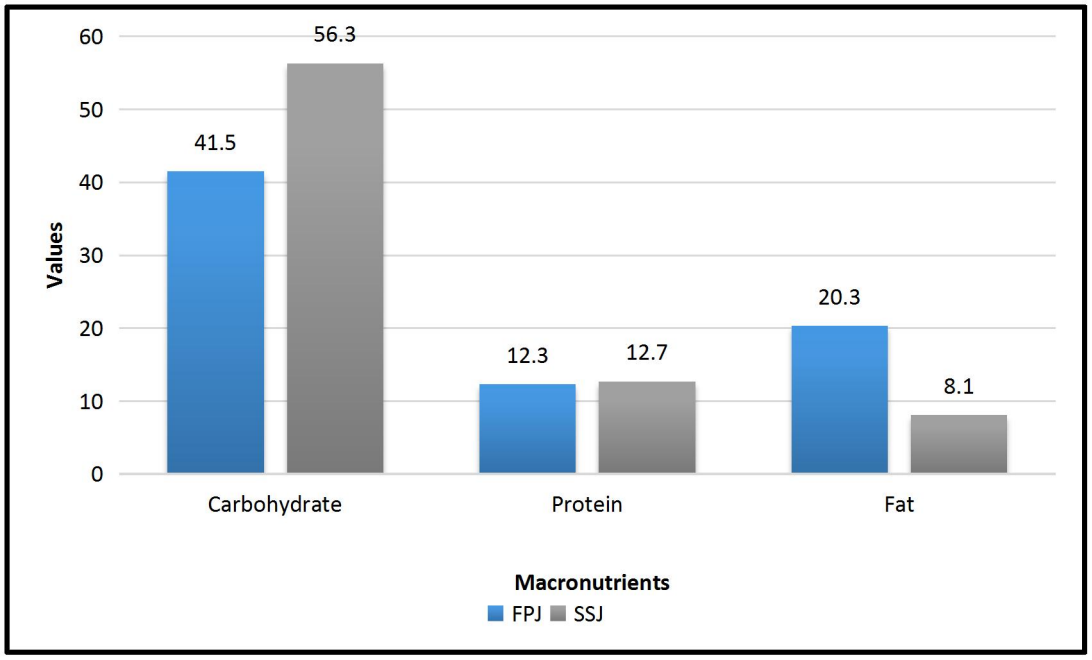


Figure IV
Macronutrients in seed bar

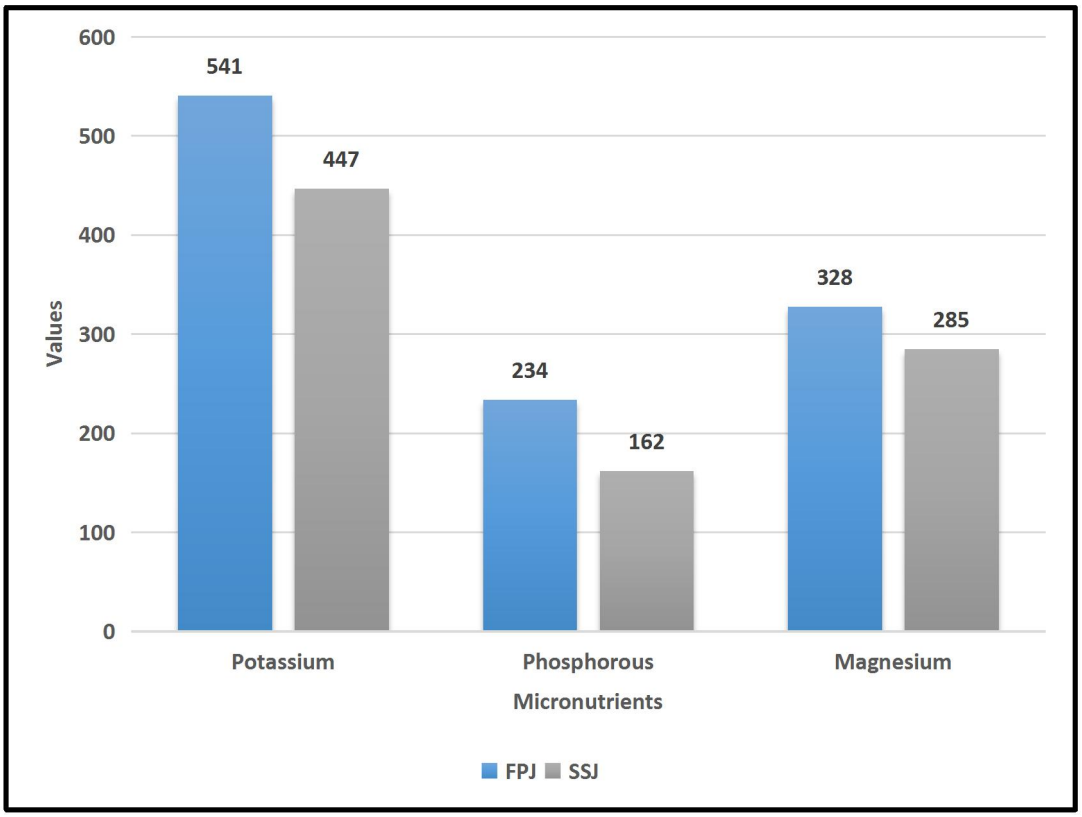


Figure V
Micronutrients in seed bar

C. Physicochemical properties of seed bar

The physicochemical properties of the seed bars FPJ and SSJ are depicted in the Tables VII and VIII.

TABLE VII

PHYSICOCHEMICAL PROPERTIES OF SEED BAR

Seed bar	FPJ	SSJ
Total soluble solids (%)	7.2 ± 1.4	9.7 ± 2.3
Colour (L*a*b)	43.2*-1.02*12.61*	63.4*3.7*18.27*

Total soluble solids denotes the amount of total soluble sugar solid present in the unit volume of solution. Brix is a measure of total soluble solids (TSS) Iin the case of pure sucrose solutions. The TSS present in FPJ was measured as 7.2 per cent and in SSJ was measured as 9.7 per cent.

Colour of the seed bars were measured in terms of L*a*b where L* represents black or white, a* represents red or green and b* represents yellow or green and is calculated using the formula $\Delta E^*ab=\sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$. The three-dimensional rectangular L, a, b colour space for FPJ is 43.2, -1.02 and 12.61 respectively. This indicates that FPJ is more inclined towards white colour with green and yellow colour. The three-dimensional rectangular L, a, b colour space for SSJ is 63.4, 3.7 and 18.27 respectively. This indicates that SSJ is more inclined towards black colour with green and yellow colour. The L*a*b* colour space was modelled after a colour opponent theory stating that two colours cannot be red and green at the same time or yellow and blue at the same time. As shown in the table, Deltas for L* (ΔL*), a* (Δa*) and b* (Δb*) may be positive (+) or negative (-). The total difference, Delta E (ΔE*), however, is always positive.

TABLE VIII
TEXTURE OF SEED BAR

Seed bar	FPJ	SSJ
Speed	1mm/sec	1mm/sec
Test type	Compression	Compression
Hardness	19.6	13.3
Adhesiveness	0.273	0.233

Texture is an index of food quality. Food texture is assessed by its ability to flow, bend, strtch or break and is often done subconsciously by the consumer. Measuring texture of foods involves use of physical techniques to objectively evaluate food quality, such as texture analysis. Texture analysers are used to measure properties , such as hardness, brittleness, adhesiveness, etc, on a vast range of products.

The hardness of the seed bars FPJ and SSJ were measured to be 19.6 and 13.3. The variation FPJ is more hard which may be due to dense bioplymer network and reduced pore size. The values 0.273 and 0.233 were the adhesiveness of seed bars FPJ and SSJ respectively. The variation FPJ tends to stick more to the palate of mouth and relieved after passing the tongue through bottom of it and slowly got soluble in the saliva.

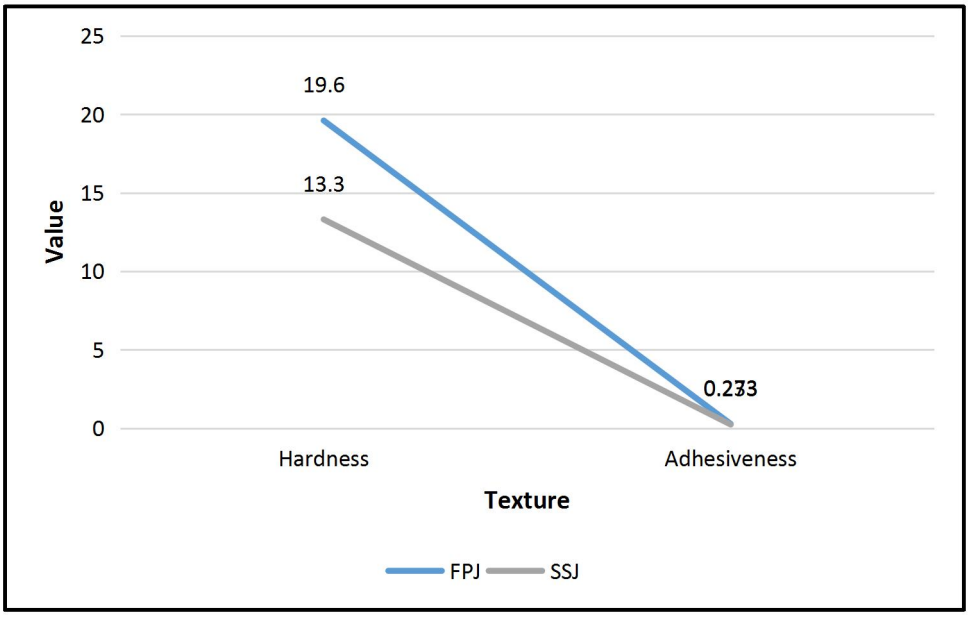


Figure VI
Texture of seed bar

D. Phytochemical content of seed bar

The qualitative analysis of phytochemicals in seed bars is depicted in the Table IX and Table X.

TABLE IX
PHYTOCHEMICALS IN FLAXSEED-PUMPKIN SEED BARS

Phytochemical	FPJ		
	Aqueous Extract	Ethanol Extract	Methanol Extract
Tannins	-	-	+
Terpenoids	+++	+++	++
Phenols	+	+++	++
Flavonoids	+	+	+++
Saponins	-	-	+
Quinones	++	-	+
Glycosides	-	-	++
Coumarins	++	+	++

+++ Strongly present, ++ Present, + Weakly present, - Absent

Phytochemicals play a crucial role in preventing and managing of modern diseases such as cancers, diabetes, Alzheimer‘s diseases and cardiovascular diseases (Andrae-Marobela *et al*., 2013). Qualitative analysis of phytochemicals was done using aqueous extract, solvent extracts viz. ethanol and methanol of seed bars. The various extracts were screened for phytochemicals like tannins, terpenoids, phenols, flavonoids, saponins, quinones, glycosides and coumarins.

The aqueous extract of FPJ indicated a strong presence of the phytochemical terpenoids. Quinones and coumarins were present in aqueous extract of FPJ; while phenols and flavonoids were weakly present in aqueous

extract. In the aqueous extract tannins, saponins and glycosides were completely absent.

The ethanol extract of FPJ indicated the strong presence of terpenoids, and phenols. The phytochemicals such as coumarin and flavonoids were weakly present in the ethanol extract of FPJ. Tannins, saponins, quinones, and glycosides were absent in the ethanol extract of FPJ.

The methanol extract of FPJ indicated a strong presence of flavonoids. The methanol extract showed the presence of phytochemicals such as terpenoids, phenols, glycosides, coumarins. The phytochemicals such as tannins, saponis, and quinones were weakly present in methanol extract of FPJ.

TABLE X

PHYTOCHEMICALS IN SESAME SEED AND SUNFLOWER SEED BARS

Phytochemicals	SSJ		
	Aqueous Extract	**Ethanol Extract**	**Methanol Extract**
Tannins	++ +	++	+
Terpenoids	+	++	+
Phenols	+	+	++
Flavonoids	++	++	+
Saponins	-	++	+
Quinones	+	++	+
Glycosides	+++	+++	+++
Coumarins	+++	+	++

+++ Strongly present, ++ Present, + Weakly present, - Absent

The aqueous extract of SSJ showed a strong presence of phytochemical tannins, glycosides and coumarins; while flavonoids were present in aqueous extract. In the aqueous extract terpenoids, phenols and quinones were weakly present; the phytochemical saponins were completely absent.

The ethanol extract of SSJ indicated the strong presence of glycosides. The phytochemicals such as tannins, terpenoids, flavonoids, saponins and quinones were present in the ethanol extract of SSJ. Phenols and coumarins were weakly present in the ethanol extract of SSJ.

The methanol extract of SSJ indicated a strong presence of glycosides. The methanol extract showed the presence of phytochemicals such as phenols and coumarins. The phytochemicals such as tannins, terpenoids, flavonoids, saponis and quinones were weakly present in methanol extract of SSJ.

From the various extracts done in SSJ which were screened for phytochemicals glycosides were strongly present in all the three extracts viz. aqueous and solvents like ethanol and methanol extract. Out of the three extracts screened for the phytochemicals, the aqueous extract showed the maximum presence of all the phytochemicals thus exhibiting the potentials of phytochemicals in SSJ.

In sensory evaluation variation I scored the best for both the seed bars FPJ and SSJ. Nutrient content of the seed bar revealed that the moisture content in FPJ was 3.7% and in SSJ was 5.1%. The Ash content of FPJ was 11.5g and SSJ was 10.4g. The protein content is 12.7g in SSJ and 12.3g in FPJ. Fat content is 20.3g in FPJ and 8.1g in SSJ. The carbohydrate value for SSJ was 56.3g and FPJ was 41.5g. 0.015mg was the amount of selenium present in FPJ whereas 2.6mg is the amount present in SSJ. Zinc content is 2.77mg in FPJ and 1.38mg in SSJ. 541mg was the value of potassium in FPJ while 447mg was the value of potassium in SSJ. The iron content of FPJ was 4.84mg and the iron content of SSJ was 3.6mg. 234mg was the amount of phosphorous in FPJ and 162mg was the amount of phosphorous in SSJ. The total amount of magnesium present in FPJ was 328mg and in SSJ was 285mg per 100g of the seed bar.

Results of physicochemical properties indicated that SSJ has the highest TSS (9.7%).The colour values for FPJ and SSJ were 43.2*-1.02*12.61* and 63.4*3.7*18.27* respectively. In case of phytochemicals FPJ has terpenoids that are strongly present in aqueous and methanol extract where as phenols are strongly present only in ethanol extract and flavonoids are strongly present only in methanol extract. In the seed bar of variation SSJ the phytochemical tannin is strongly present in aqueous extract whereas glycoside is strongly present in all the three extracts such as aqueous, ethanol and methanol extract and coumarin is strongly present in aqueous extract.

SUMMARY AND CONCLUSION

V. SUMMARY AND CONCLUSION

The menstrual cycle is the monthly process in which female hormones stimulate ovary to release the egg, thicken the uterine lining to support pregnancy, and then cause the uterus to shed this lining if no pregnancy occurs. The average menstrual cycle lasts 28 days, but this varies from woman to woman and month to month. Periods should be regular unless the woman is pregnant, breastfeeding, postmenopausal, or have a medical condition that causes the periods to stop.

Periods that are irregular, painful, or heavy could indicate a serious health problem. Irregular periods can also make it more difficult to conceive. Most women produce enough hormones to maintain a healthy cycle. However, hormonal imbalances can be caused by certain health conditions such as PCOS and hypothyroidism, as well as over-exercising and being under or overweight. Menstruation can be affected by both lack of body fat and an excess of body fat. Maintaining a healthy weight can lower insulin levels in those with PCOs who have a higher body weight.

Seed cycling is a natural remedy that claims to balance hormones by regulating oestrogen during the first half of menstrual cycle and progesterone during the second half. Seed cycling is diet supplementation with four different seeds namely pumpkin, flax, sesame, and sunflower. The seeds are eaten every day, raw and ground. It is said to help regulate periods, reduce acne, treat polycystic ovarian syndrome (PCOS), endometriosis, and infertility, and alleviate menopause symptoms like hot flashes, night sweats, fatigue, and mood swings. Whole seeds won't break down completely in gut, so grinding them enables the body to extract more nutrients from the seeds. They can be eaten alone or added to other foods like smoothies and salads.

The present study entitled "**Formulation of Seed Bar with Menstrual Health Potentials"** was aimed at evaluation of proximate principles, physicochemical properties, phytochemicals and developing menstrual friendly bars with seeds. The analysis of proximate principles of seed bars was carried out that included moisture, protein, ash, fat, carbohydrate, selenium, zinc, potassium, iron, phosphorus and magnesium. Qualitative analysis of phytochemical present in seed bars such as tannins, terpenoids,

phenols, flavonoids, saponins, quinones, glycosides and coumarins was conducted in aqueous and solvent extracts viz. ethanol and methanol.

The developed seed bars were subjected to sensory evaluation by 30 semi-trained panel members along with standard and three different variations (Variation I, II and III) with the help of score card (9 point hedonic scale). The evaluation was done in terms of the attributes like appearance, colour, flavour, texture, taste and overall acceptability of the recipes by rating from like extremely to dislike extremely in the 9 point hedonic scale rating.

The study protocol was approved by the institutional Ethical Committee of Avinashilingam Institute for Home Science and Higher Education for Women and the approval number was AUW/ IHEC/ FSN -21-22/XPD-20. The sensory evaluation of the seed bars were statistically analyzed and standard deviation to find the best acceptable one.

Only a very few Indian studies are available with the seeds in developing menstrual friendly products and keeping this in mind, an attempt was made in the present study titled **"Formulation of Seed Bar with Menstrual Health Potentials"** and was undertaken with the following objectives to:

- develop and standardize menstrual friendly seed bars
- evaluate the acceptability of the seed bars using sensory evaluation
- estimate the proximate principles present in seed bars
- analyze the physicochemical properties and phytochemicals of the seed bars

The **salient findings** of the study are summarized below:

- Sensory evaluation of **flaxseed-pumpkin seed bar** revealed that that the mean values for appearance for standard was 8.83, followed by FPJ, 8.5, FPB, 7.63 and FPP 7.63. The mean values obtained for colour was 8.90 for standard, 8.36 for FPJ, 7.66 for FPB and 7.73 for FPP. The mean scores obtained for the flavour in flaxseed and pumpkin seed bar ranged from 7.73 to 8.73, the maximum score obtained for standard with the mean value of 8.73, followed by FPJ with 8.70, FPB with 7.66 and FPP

with 7.73. With regard to texture standard showed the best result with a mean value of 8.66 followed by FPJ with 8.55, FPB with 7.53 and FPP with 7.76. The taste of the standard scored maximum mean value of 8.86 followed by 8.63, 7.60 and 7.56 for FPJ, FPB and FPP respectively. The overall acceptability of flaxseed and pumpkin seed bar revealed that FPJ had a maximum mean score of 8.66 and was comparable with the standard of 8.93. This was followed by FPB and FPP with the mean scores 7.80 and 7.83 respectively.

- The bar made from **sesame seeds and sunflower seeds** for standard, SSJ, SSB, and SSP, standard scored the best result with mean value of 8.5, SSP scoring a decreased score of 7.56. In terms of colour, standard and three variations got mean scores from 8.86 to 7.46. SSJ and SSB had a mean value of 8.53 and 7.56 respectively. The maximum mean score for colour was for standard with 8.86. The mean scores obtained for flavor ranged from 7.53 to 8.83, the minimum score 7.53 for SSP, 7.63 for SSB and 8.6 for SSJ and 8.83 for standard. Regarding texture, mean scores of standard showed a value of 8.86, SSJ and SSB with 8.63 and 7.63 and SSP with 7.53. Taste contributed mean scores from 7.46 to 8.83.The maximum mean value obtained for standard was 8.83 followed by SSJ with 8.63, SSB with 7.5 and SSP with 7.46.
- The **overall acceptability** of flaxseed and pumpkin seed bar showed that, standard scored a mean maximum value with 8.93, followed by FPJ with 8.66, FPB with 7.80 and FPP with 7.83. For sesame seed and sunflower seed bar, the maximum overall acceptability secured for standard with mean value of 8.83, SSJ with 8.73, SSB with 7.4 and SSP with 7.63. The overall results indicate that variation I i.e. FPJ and SSJ with jaggery had maximum overall acceptability when compared with FPB, FPP, SSB and SSP. Hence the seed bars can be made with jaggery instead of other sugars which may enhance the nutritional value of the bar consumed.
- **Nutrients** - Flaxseed has a moisture content of 6.09 per cent whereas pumpkin seed has a moisture content of 6.1 per cent. The mean value for the moisture content of FPJ was 3.7 per cent per 100g of bar. Ash value was 3.4g for flaxseed and 4.78g for pumpkin seed and the mean score for the ash content of FPJ was 11.5g. The protein content of FPJ was 12.3g

with the protein content of flax and pumpkin seed were 18.29g and 19g. In terms of fat, FPJ got the mean value of 20.3g while the fat content of flaxseed was 42.16g and the fat content of pumpkin seed was 19g. The carbohydrate content for flaxseed was 28.88g, pumpkin seed was 54gand FPJ was noted to be 41.5g. The micronutrients analyzed include selenium, zinc, potassium, iron, phosphorous, magnesium. The amount of selenium present in FPJ was 0.015mg, in flaxseed was 2.54mg and in pumpkin seed was 0.94mg. Zinc present in 100g of flaxseed was 4.34mg and in pumpkin seed was 4.34mg and in FPJ was 2.77mg. Potassium contributes the mean scores of 541mg in FPJ and the potassium content of flaxseed was 813mg and pumkin seed was 919mg. Iron content of flaxseed and pumpkin seed were 5.7mg and 3.3mg respectively. While the mean value for the iron content of FPJ was 4.84mg. The phosphorus content of FPJ was 234mg and for flaxseed the phosphorous content was 642mg and for pumpkin seed the phosphorous value was 1233mg. The magnesium content of flaxseed was 392mg and for pumpkin seed was 262mg. The mean score for magnesium content of FPJ was 328mg.

- Sesame seed has a moisture content of 7.40 per cent whereas sunflower seed has a moisture content of 3.1 per cent . The mean value for the moisture content of SSJ was 5.1 per cent per 100g of bar. Ash value was 4.2g for sesame seed and 4.49g for sunflower seed and the mean score for the ash content of SSJ was 10.4g. The protein content of SSJ was 12.7g with the protein content of sesame and sunflower seed were 18g and 19.69g. In terms of fat, SSJ got the mean value of 8.1g while the fat content of sesame seed was 50g and the fat content of sunflower seed was 53g. The carbohydrate content for ssame seed was 23g, sunflower seed was 18.72g and SSJ was noted to be 56.3g. The micronutrients analyzed include selenium, zinc, potassium, iron, phosphorous, magnesium. The amount of selenium present in SSJ was 2.6mg, in sesame seed was 3.44mg and in sunflower seed was 5.3mg. Zinc present in 100g of sesame seed was 7.8mg and in sunflower seed was 5.29mg and in SSJ was 1.38mg. Potassium contributes the mean scores of 447mg in SSJ and the potassium content of sesame seed was 468mg and sunflower seed was 850mg. Iron content of sesame seed and

sunflower seed were 15mg and 3.8mg respectively. While the mean value for the iron content of SSJ was 3.6mg. The phosphorus content of SSJ was 162mg and for sesame seed the phosphorous content was 629mg and for sunflower seed the phosphorous value was 1115mg. The magnesium content of sesame seed was 351mg and for sunflower seed was 129mg. The mean score for magnesium content of SSJ was 285mg.

- The **TSS** present in FPJ was measured as 7.2 per cent and in SSJ was measured as 9.7 per cent. The **colour** values for FPJ and SSJ were 43.2*-1.02*12.61* and 63.4*3.7*18.27* respectively. The **hardness** of the seed bars FPJ and SSJ were measured to be 19.6 and 13.3. The values 0.273 and 0.233 were the **adhesiveness** of seed bars FPJ and SSJ respectively.
- **Phytochemicals** - The aqueous extract of FPJ showed the strong presence of phytochemical terpenoids. Quinones and coumarins were present in aqueous extract of FPJ; while phenols and flavonoids were weakly present in aqueous extract. In the aqueous extract tannins, saponins and glycosides were completely absent. The ethanol extract of FPJ indicated the strong presence of terpenoids, and phenols. The phytochemicals such as coumarin and flavonoids were weakly present in the ethanol extract of FPJ. Tannins, saponins, quinones, and glycosides were absent in the ethanol extract of FPJ. The methanol extract of FPJ indicated a strong presence of flavonoids. The methanol extract showed the presence of phytochemicals such as terpenoids, phenols, glycosides, coumarins. The phytochemicals such as tannins, saponis, and quinones were weakly present in methanol extract of FPJ.
- The aqueous extract of SSJ showed a strong presence of phytochemical tannins, glycosides and coumarins; while flavonoids were present in aqueous extract. In the aqueous extract terpenoids, phenols and quinones were weakly present; the phytochemical saponins were completely absent. The ethanol extract of SSJ indicated the strong presence of glycosides. The phytochemicals such as tannins, terpenoids, flavonoids, saponins and quinones were present in the ethanol extract of SSJ. Phenols and coumarins were weakly present in the ethanol extract of SSJ. The methanol extract of SSJ indicated a strong presence of glycosides. The

methanol extract showed the presence of phytochemicals such as phenols and coumarins. The phytochemicals such as tannins, terpenoids, flavonoids, saponis and quinones were weakly present in methanol extract of SSJ.

It can be concluded from the present study that, menstrual friendly seed bars are rich in nutrients such as protein, carbohydrate, potassium, iron, phosphorus and magnesium. It is also rich in phytochemicals like terpenoids, glycosides, tannins, coumarins, flavonoids and phenols which possess various nutraceutical properties. Though many seed are highly nutritious and offer a number of health benefits, the seeds namely flax, pumpkin, sesame and sunflower are claimed to balance hormones particularly in women that plays role in menstrual cycle, boost fertility and ease the symptoms of menopause. Hence it can be concluded that the seed bars are safe and effective for consumption when compared to the tablets taken to regulate the menstrual cycle.

Recommendations for further research:

- ✓ Identification of other menstrual friendly seeds
- ✓ Development of menstrual friendly recipes with the substitution of seeds namely flax, pumpkin, sesame and sunflower in foods suitable to all age group
- ✓ Carrying out studies on food ingredients other than seeds with menstrual health benefits
- ✓ Utilization of underutilized or extinction seeds in food products to help menstruation
- ✓ Carry out clinical trials to validate the role of menstrual friendly seed bars in women with irregular menstrual cycle
- ✓ Expedite the role of seed bars in PCOD
- ✓ Compare the role of selected seeds and seed bars in menstrual health, menopause and PCOD

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APPENDICES

APPENDIX I

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam
Institute for Home Science and Higher Education for Women
(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956) Re-accredited with 'A++' Grade by NAAC.
Recognised by UGC Under Section 12 B
Coimbatore-641 043, Tamil Nadu, India

08th March 2022

To
Ms.Sangami.S.S
Department of Food Science and Nutrition
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Sangami.S.S,

Ref: Your proposal No. IHEC/21-22/FSN-20 entitled "Formulation of Seed Bar with Menstrual Health Potentials" resubmitted for approval to IHEC on 02.03.2021.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/21-22/ FSN-20 entitled "Formulation of Seed Bar with Menstrual Health Potentials" resubmitted by you. The Approval number for the same is AUW/IHEC/FSN-21-22/XPD-20.

We wish you all the best in your research endeavours.

Regards,

S. Uma Mageshwari
Dr.S.Uma Mageshwari
Member Secretary

APPENDIX II

SCORE CARD FOR SENSORY EVALUATION

Name :

Class :

Date :

Flaxseed-pumpkin seed bar

Code	Standard	FPJ	FPB	FPP
Appearance				
Colour				
Flavour				
Texture/mouthfeel				
Taste				
Overall Acceptabililty				

Sesame seed-sunflower seed bar

Code	Standard	SSJ	SSB	SSP
Appearance				
Colour				
Flavour				
Texture/mouthfeel				
Taste				
Overall Acceptabililty				

Hedonic Rating Scores:

9-Like Extremely, 8-Like very much, 7-Like moderately, 6-Like slightly, 5-Neither like nor dislike, 4-Dislike slightly, 3-Dislike moderately, 2-Dislike very much, 1-Dislike extremely

Signature