

Aroma 201: Advanced Aromatherapy Certification Program

Synergistic Effect of Essential Oils on Muscle Tissue

by

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I. Muscle tissue overview

Without more than 600 muscles in a human body, which make up nearly half of the body's mass, humans would not be able to do much of anything. Muscles are the "engines" that transform chemical potential energy into directed mechanical energy, thus allowing us to maintain bodily functions.

All muscles have four characteristics or abilities that allow them to perform their duties:

- Excitability (or responsiveness or irritability) - ability to receive and respond to a stimulus (any change in the environment inside or outside of the body);
- Contractivity: ability to shorten forcibly when adequately stimulated;
- Extensibility: the ability to be stretched or extended;
- Elasticity: the ability of a muscle to recoil and resume its resting length after being stretched.

Besides protecting internal organs by enclosing them, regulating the passage of substances through internal body openings, the four main functions for the body performed by muscles include the following:

- produce movement
- maintain posture and body position
- stabilize joints
- generate heat [1]

For the purposes of this research, I will focus on two out of three types of muscle tissue: skeletal and smooth, leaving cardiac muscle tissues out of the scope of this paper.

I.1. Skeletal muscle tissue

Skeletal muscle is under control of the somatic nervous system, which means that it is controlled voluntarily.

Each skeletal muscle fiber is supplied with a nerve ending that controls its activity and has rich blood supply which delivers oxygen and nutrients via arteries. In its turn muscle cells give off large amount of metabolic waste that must be removed through veins if contraction is to remain efficient.

Skeletal muscle also has many muscle capillaries, the smallest of the body's blood vessels, which straighten when the muscle is stretched and contort when the muscle contracts.

The individual muscle fibers are wrapped and held together by several different connective tissue sheaths. Connective tissues play an important role in skeletal muscle structure: they support each cell and reinforce the muscle as a whole, preventing the bulging muscles from bursting during exceptionally strong contractions.

In its relaxed state, a muscle is soft and unimpressive, not what one would expect from the prime mover of the body. However, within a few milliseconds, it can contract to become a hard elastic structure with dynamic characteristics that intrigue the entire scientific world.

The principal cytoplasmic proteins responsible for muscle contraction are *myosin* and *actin* (also known as "thick" and "thin" filaments, respectively) which are arranged in a repeating unit called a sarcomere. In addition to the actin and myosin skeletal muscle fibers also contain two other

important regulatory proteins, *troponin* and *tropomyosin*, that are necessary for muscle contraction to occur. These proteins are associated with actin and cooperate to prevent its interaction with myosin [2].

Skeletal muscle can do a short, single contraction, called a twitch, or a long, sustained contraction, called tetanus. The trigger for a muscle contraction is an electrical impulse. The electrical signal sets off a series of events that lead to crossbridge cycling between myosin and actin, which generates force. The series of events is slightly different between skeletal and smooth muscle.

The contraction process in the skeletal muscle can be described as follows:

1. During contraction, myosin molecule forms a chemical bond with an actin molecule on the thin filament. This chemical bond is the *crossbridge*.
2. Initially, the crossbridge is extended with adenosine diphosphate (ADP) and inorganic phosphate (Pi) attached to the myosin.
3. As soon as the crossbridge is formed, the myosin head bends, thereby creating force and sliding the actin filament past the myosin. This process is called the *power stroke*. During the power stroke, myosin releases the ADP and Pi.
4. Once ADP and Pi are released, a molecule of adenosine triphosphate (ATP) binds to myosin. When ATP binds, myosin releases the actin molecule.
5. When actin is released, the ATP molecule gets split into ADP and Pi by myosin. The energy from ATP resets the myosin head to its original position
6. The process is repeated. The action of myosin molecules are not synchronized -- at any given moment, some myosins are attaching to the actin filament, others are creating force and others are releasing the actin filament.

Muscle contraction is regulated by the level of calcium ions in the cytoplasm. In skeletal muscle, calcium ions work at the level of actin (actin-regulated contraction). They move the troponin-tropomyosin complex off the binding sites, allowing actin and myosin to interact.

All muscle activity requires energy. Muscles use energy in the form of ATP. The energy from ATP is used to reset the myosin crossbridge head and release the actin filament. To make ATP, the muscle does the following:

1. Breaks down creatine phosphate, adding the phosphate to ADP to create ATP
2. Carries out anaerobic respiration, where glucose is metabolized into lactic acid and ATP is formed
3. Carries out aerobic respiration, where glucose, glycogen, fats and amino acids are broken down in the presence of oxygen to produce ATP [3]

1.2. Smooth muscle tissue

Smooth muscle or "involuntary muscle" is found within the walls of organs and structures such as the esophagus, stomach, intestines, bronchi, uterus, urethra, bladder, blood vessels, and the arrector pili in the skin (that control erection of body hair). Unlike skeletal muscle, smooth muscle is not under conscious control.

Smooth muscle is divided into two subgroups: the single-unit (unitary) and multiunit smooth muscle. Within single-unit cells, the whole bundle or sheet contracts as a syncytium (i.e. a multinucleate mass of cytoplasm that is not separated into cells). Multiunit smooth muscle tissues innervate individual cells; as such, they allow for fine control and gradual responses.

Most smooth muscle is of the single-unit variety, that is, either the whole muscle contracts or the whole muscle relaxes, but there is multiunit smooth muscle in the trachea, the large elastic arteries, and the iris of the eye. Single unit smooth muscle, however, is most common and lines blood vessels (except large elastic arteries), the urinary tract, and the digestive tract.

Smooth muscle is fundamentally different from skeletal muscle and cardiac muscle in terms of structure, function, regulation of contraction, and excitation-contraction coupling. Smooth muscle containing tissue tend to demonstrate greater elasticity and function within a larger length-tension curve than striated muscle. This ability to stretch and still maintain contractility is important in organs like the intestines and urinary bladder.

A substantial portion of the volume of the cytoplasm of smooth muscle cells is taken up by the molecules myosin and actin, which together have the capability to contract, and, through a chain of tensile structures, make the entire smooth muscle tissue contract with them. Smooth muscle does not contain the protein troponin; instead calmodulin (which takes on the regulatory role in smooth muscle), caldesmon and calponin are proteins significantly expressed within smooth muscle. The number of calponin molecules may be equal to that of actin, and has been proposed to be a load-bearing protein. Caldesmon has been suggested to be involved in tethering actin, myosin and tropomyosin, and thereby enhance the ability of smooth muscle to maintain tension [4].

Tropomyosin is present in smooth muscle, spanning seven actin monomers and is laid out end to end over the entire length of the thin filaments. In striated muscle, tropomyosin serves to block actin–myosin interactions until calcium is present, but in smooth muscle, its function is unknown.

Smooth muscle cells have been observed to contract in a spiral corkscrew fashion, and contractile proteins have been observed to organize into zones of actin and myosin along the axis of the cell.

Smooth muscle contraction is caused by the sliding of myosin and actin filaments (a sliding filament mechanism) over each other via process called crossbridge cycling and is the same for all muscles. As smooth muscle does not contain the calcium-binding protein troponin, contraction is initiated by a calcium-regulated phosphorylation of myosin, rather than a calcium-activated troponin system. Crossbridge cycling causes contraction of myosin and actin complexes, in turn causing increased tension along the entire chains of tensile structures, ultimately resulting in contraction of the entire smooth muscle tissue [5].

Smooth muscle may contract phasically with rapid contraction and relaxation, or tonically with slow and sustained contraction. The reproductive, digestive, respiratory, and urinary tracts, skin, eye, and vasculature all contain this tonic muscle type.

1.3. Functional disruption

The function of both skeletal and smooth muscle can be disrupted in several ways. For the purposes of this research, we will focus on two main widespread functional disruptions of both skeletal and smooth muscle: muscle pain and cramps.

Abnormal muscle contraction may be caused by abnormal activity at any stage in the contraction process described in the section above. Certain mechanisms within the brain and

the rest of the central nervous system help regulate contraction. Interruption of these mechanisms can cause spasm. Motor neurons that are overly sensitive may fire below their normal thresholds. The muscle membrane itself may be over sensitive, causing contraction without stimulation. Calcium ions may not be recaptured quickly enough, causing prolonged contraction.

Muscle soreness

One of the main reasons for skeletal muscle pain is muscle soreness caused by strenuous exercise.

The working muscles generate energy anaerobically. This energy comes from glucose through a process called glycolysis, in which glucose is broken down or metabolized into a substance called pyruvate through a series of steps. When the body has plenty of oxygen, pyruvate is shuttled to an aerobic pathway to be further broken down for more energy. But when oxygen supply is limited, the body temporarily converts pyruvate into a substance called lactate, which allows glucose breakdown--and thus energy production--to continue. The working muscle cells can continue this type of anaerobic energy production at high rates for one to three minutes, during which time lactate can accumulate to high levels.

A side effect of high lactate levels is an increase in the acidity of the muscle cells, along with disruptions of other metabolites. The same metabolic pathways that permit the breakdown of glucose to energy perform poorly in this acidic environment. Such acidic environment is a natural defense mechanism for the body: it prevents permanent damage during extreme exertion by slowing the key systems needed to maintain muscle contraction. Once the body slows down, oxygen becomes available and lactate reverts back to pyruvate, allowing continued aerobic metabolism and energy for the body's recovery from the strenuous event.

Contrary to popular opinion, lactate or, as it is often called, lactic acid buildup is not responsible for the muscle soreness felt in the days following strenuous exercise. Rather, the production of lactate and other metabolites during extreme exertion results in the burning sensation often felt in active muscles, though which exact metabolites are involved remains unclear. This often painful sensation also gets us to stop overworking the body, thus forcing a recovery period in which the body clears the lactate and other metabolites [6].

Though the precise cause of delayed-onset muscle soreness (DOMS) is still unknown, most research points to actual muscle cell damage and an elevated release of various metabolites into the tissue surrounding the muscle cells. These responses to extreme exercise result in an inflammatory-repair response, leading to swelling and soreness that peaks a day or two after the event and resolves a few days later, depending on the severity of the damage.

Cramps

A cramp is a sudden, severe, and involuntary muscle contraction or over-shortening. Onset is usually sudden, and it resolves on its own over a period of several seconds, minutes, or hours. Cramps may occur in skeletal muscle or smooth muscle.

Skeletal muscles work as antagonistic pairs. Contracting one skeletal muscle requires the relaxation of the opposing muscle in the pair. Curiously, relaxation of a muscle actually requires energy to be expended. The energy is used to recapture calcium and to unlink actin and

myosin. Cramps can occur when muscles are unable to relax properly due to myosin fibers not fully detaching from actin filaments.

Skeletal muscle cramps may be caused by any combination of muscle fatigue or a lack of electrolytes (e.g., low sodium, low potassium, or low magnesium). Electrolyte disturbance may cause cramping and muscle tetany, particularly hypokalaemia and hypocalcaemia. This disturbance arises as the body loses large amounts of water and salt through sweat due to which the calcium ions remain bound to the troponin, continuing the muscle contraction.

Skeletal muscle cramping is associated with strenuous physical activity. However, the cause of nocturnal leg cramps remains unclear. Potential contributing factors include dehydration, low levels of certain minerals (magnesium, potassium, calcium, and sodium), and reduced blood flow through muscles attendant in prolonged sitting or lying down [7].

A lactic acid buildup around muscles can trigger cramps; however, these happen during anaerobic respiration when a person is exercising or engaging in an activity where the heart beat speeds up.

Cramps of smooth muscle may be due to menstruation or gastroenteritis.

Smooth muscle contractions may be symptomatic of endometriosis or other health problems. Menstrual cramps may also occur both before and during a menstrual cycle.

During the menstrual period, the uterus contracts to help expel its lining. Hormone-like substances (prostaglandins) involved in pain and inflammation trigger the uterine muscle contractions. Higher levels of prostaglandins are associated with more severe menstrual cramps [8].

Other causes of menstrual cramps include endometriosis, uterine fibroids, adenomyosis, pelvic inflammatory disease, cervical stenosis. In this research paper only menstrual cramps caused by high levels of prostaglandins will be reviewed.

At research showed that women who suffer from severe dysmenorrhea have considerably higher amounts of prostaglandins in their menstrual discharge than do women who don't have painful cramps. The main agents for treating moderate menstrual cramps are the nonsteroidal antiinflammatory drugs (NSAIDs), which lower the production of prostaglandins and lessen their effect. Among the most popular NSAIDs are ibuprofen, naproxen sodium and ketoprofen.

II. Synergistic principles in aromatherapy

The word “synergy” is derived from the greek syn –together, ergon – work. An essential oil has a natural synergistic power where the combined action of disparate individual molecules within an essential oil has a total effect greater than the sum of their individual effects.

Thanks to advances in extraction process and technology, nowadays companies are able to extract isolates in order to research in more detail specific chemical components of the essential oils. Unfortunately, researching isolates has turned into a larger trend of using them in products in order to emphasize the effect of an essential oil blend. At the same time, complete essential oils have been found in practice to be more effective than their isolated principal constituents [9].

Essential oils are complex mixtures, some containing from a few dozen to several hundreds of different molecules which act in synergy to produce their healing effect. So it is not possible to ascribe the effects of the whole oil to one particular component, even a major one, because even chemical constituents present in very small amounts (ex furanocoumarins) are often found to be as active as or even more active than the principal constituent: “Minor components of essential oils can modify the activity of main components, reaffirming the importance of chemically characterizing essential oils in order to understand the overall bioactivity” Nunes et al (2010). At the same time, if the composition of an essential oil is altered, then the natural synergy of the remaining constituents is diminished or destroyed.

Despite an extensive research on specific essential oils and the benefit of their major chemical components, a truly holistic aromatherapy approach would incorporate a blend of at least three essential oils in order to achieve maximum effect in addressing a physiological, emotional or energetic issue.

II.2. Types of synergistic combinations of essential oils

The concept of synergy is crucial for aromatherapy as “Synergism implies that the therapeutic benefit of a mixture of essential oils will be greater than the arithmetical sum of the actions of the mixtures parts” (Jade’s website).

In her article “Synergism in essential oils and aromatherapy” Jade Schutes quotes Harris on ways synergy can occur in aromatherapy:

- Synergy within the essential oil itself;
- Synergy between essential oils in a blend;
- Synergy between essential oils and the base or carrier product [10]

II.2.a Synergistic effect within one essential oil

Many tests have been performed on the chemical components of an essential oil. As noted above, synergistic effect within one essential oil occurs not only between its major chemical components, but also between its minor constituents, which can impact the effect of the essential oil as a whole.

An example of how the synergy within one essential oil works can be found in analysis described by Low, Rawal & Griffin when tests carried out on individual components from *Eucalyptus citriodora* revealed that they were relatively inactive. However, a combination of the three isolated major components in the same ratio as found in the natural oil produced a fourfold increase in antimicrobial activity against *Staphylococcus aureus* [11]

II.2.b Synergistic effect between essential oils in a blend

This type of synergy is of a particular importance for aromatherapists as a powerful product emphasizing a specific feature or chemical component can be created by combining two or more essential oils together.

The two pathways that Jade mentions in her article quoted above are:

- synergy by therapeutic properties (e.g. an antispasmodic essential oil combined with another antispasmodic essential oil creates a highly antispasmodic product) or
- synergy by chemical components (e.g. an essential oil rich in thymol and an essential oil rich in eugenol will create a highly effective antimicrobial product)[12].

I would like to add to the synergy by chemical components a few subcategories selected during this research:

1. *Synergy between essential oils with the same chemical component.*

For example, it has been shown that citrus oils (*Citrus latifolia*, *Citrus reticulata*, *Citrus aurantium*) exhibit anxiolytic and sedative activity due to a synergistic action of the common chemical constituents present in these three species [13].

Analgesic effect would be more pronounced in a blend, if one blends together essential oils rich in monoterpene alpha-pinene such as Black Pepper, Rosemary ct. camphor or ct. 1,8 cineole and Scots pine.

The analgesic effect will be even more emphasized if one blends essential oils containing different chemical components which are similar in their therapeutic action. Therefore, the second subcategory would include:

2. *Essential oils with various chemical components, but same therapeutic action.*

An example of such synergy would include essential oils of Sweet orange, Lavender, Geranium. Sweet orange is rich in monoterpene limonene (anxiolytic activity); Lavender is rich in linalol (anxiolytic activity), Geranium is rich in citronellol (anxiolytic activity).

This synergistic blend can become even more powerful in its anxiolytic activity if another essential oil, such as Clary sage, which shares the chemical components of linalol and linalyl acetate with Lavender, would be added to the blend (combined synergistic effect of subcategory 1 and 2).

3. *The third subcategory would include essential oils with dual function, when the therapeutic effect of the essential oil in a blend fully depends on other essential oils used in a blend.*

A good example for the third subcategory would be Palmarosa, which can be either drying or moisturizing depending on other essential oils in a blend. Since Palmarosa contains monoterpenes which has a drying effect of the skin, blending it with such essential oils as Frankincense, Tea tree or Elemi would prompt Palmarosa to have drying effect on the skin due to monoterpene content. On the other hand, blending Palmarosa with such essential oils as Lavender and Neroli will enhance the action of esters, which are well tolerated by the skin and are soothing to dermal inflammation.

While making aromatherapy products, one needs to take into account the base or carrier oils and butters. Not only do the essential oils interact with carrier oils, but the carrier oils themselves allow an aromatherapist to create a therapeutic base, which will enhance the effect of the essential oils.

For instance, carrot oil is indicated for burns, dry skin, itching etc. In order to better address these issues, carrot oil might be used as carrier oil for a serum containing German chamomile (chamazulene - anti-inflammatory action, wound healing), Lavender (linalol - antinociceptive), Roman chamomile (iso-butyl angelate - anti-inflammatory). Chemical components of these essential oils combined with chemical properties of the carrot oil would create a synergistic effect and would better relieve itchininess and dryness.

Another example of the importance of matching carrier oils with the purpose of the aromatherapeutic treatment is the use of arnica infused olive oil and such essential oils as Helichrysum, German chamomile and Roman chamomile. One of the main constituents of German chamomile, chamazulene is known to have a powerful anti-inflammatory and wound healing activity; Roman chamomile is rich in esters, which have been proven to soothe dermal inflammation. When combined with arnica infused carrier oil, the anti-inflammatory effect of these essential oils has a synergistic, more powerful effect. Thus, better results are achieved sooner.

III. Effects of synergistic blends on skeletal and smooth muscle tissue

In this section we would like to focus on synergistic blends for muscle pain related issues, such as muscle stiffness, muscle pain, cramps on one hand, and menstrual cramps on the other. Different synergies would be based on specific chemical components of essential oils that have a specific therapeutic action.

Several essential oils are known to help with muscle pain. This list includes the following essential oils: Basil ct. linalol, Birth, Black pepper, Black spruce, Cape chamomile, Cardamom, Cedarwood, Clove, Silver Fir, Juniper, Laurel, Listea cubeba, Sweet marjoram, Green myrtle, Palmarosa, Palo Santo, Ravensara, Spearmint, Yarrow, Eucalyptus Blue Gum, Lavender stoica, Lavandin, Clary sage, Rosemary ct camphor, Rosemary ct. cineole, Cinnamon leaf etc. All of the above essential oils are known to have anti-spasmodic and/or analgesic properties.

Most of the essential oils from the list above share the same chemical components and/or the same class of chemical components:

Chemical Component	Chemical Group	Effect	Essential oils containing this chemical component
Limonene	Monoterpenes	Analgesic	Black pepper; Litsea Cubeba
Alpha-pinene	Monoterpenes	Analgesic; anti-inflammatory	Black pepper; Black spruce; Juniper; Rosemary ct. cineole/camphor
Beta-pinene	Monoterpenes	Spasmolytic	Black pepper; Yarrow;
Beta-caryophyllene	Sesquiterpenes	Antispasmodic, anti-inflammatory, anaesthetic	Black pepper; Clove; Yarrow; Helichrysum
Linalol	Monoterpene alcohols	analgesic; antispasmodic; anti-inflammatory	Basil ct. linalol; Clary sage; Lavender; Lavandin;

Chemical Component	Chemical Group	Effect	Essential oils containing this chemical component
Terpinene-4-ol	Monoterpene alcohols	Anti-inflammatory	Sweet marjoram; Clary sage; Lavandin; Yarrow
Alpha-terpineol	Monoterpene alcohols	Analgesic; anti-inflammatory	Sweet marjoram; Clary sage
Menthol	Monoterpene alcohols	Analgesic; antispasmodic	Peppermint, Lavender stoechas
Linalyl acetate	Esters	analgesic; anti-inflammatory	Clary sage; Lavender; Lavandin; Basil ct. linalol; Sweet marjoram
Alpha-terpinyl acetate	Esters	antispasmodic	Cardamom; Laurel;
Eugenyl acetate	Esters	Analgesic	Clove; Cinnamon
Methyl salicylate	Esters	Analgesic	Birch
Eugenol	Phenylpropanoids	Analgesic; antispasmodic; anti-inflammatory	Basil; Cinnamon leaf; Clove
1,8 cineole	Oxides	Analgesic, muscle relaxant; anti-inflammatory	Cardamom, Bay Laurel, Rosemary ct.cineole, Spike Lavender, Eucalyptus ct. cineole
alpha-bisabolol oxide A/B	Oxides	Antispasmodic; anti-inflammatory	German chamomile
Camphor	Ketones	Analgesic	Rosemary ct. camphor

It can be clearly seen from the table above how a combination of Black pepper, Rosemary ct.cineole and Lavender can help relieve muscle pain: the synergistic effect of alpha-pinene found both in Black pepper and Rosemary ct.cineole on one hand, and linalol found in Lavender on the other, would create a powerful analgesic blend.

As previously mentioned in section I, muscle soreness after vigorous exercise is mostly due to the inflammation of the muscle cells. Most of the analgesic and/or antispasmodic chemical components from the table above exhibit anti-inflammatory activity as well. Thus, the blend of Black pepper, Rosemary ct.cineole and Lavender will not only help reduce muscle soreness, but also relieve cell inflammation, which will lead to a quicker recovery.

The anti-inflammatory activity of both linalol and alpha-pinene, two major components of Black pepper and Lavender, could be enhanced by beta-caryophyllene - a powerful anesthetic and

anti-inflammatory chemical component or 1,8 cineole, which is also known to be a muscle relaxant.

Skeletal muscle cramps differ in their nature from muscle soreness caused by vigorous exercise. Thus, the approach to treating skeletal muscle cramps should be different. It is worth noting that not all of the essential oils that help relieve muscle pain/muscle soreness would also help relieve skeletal muscle cramps. Skeletal muscle cramp is caused by a prolonged muscle contraction, thus, antispasmodic chemical components will come into play to relieve muscle cramps:

Chemical Component	Chemical Group	Effect	Essential oils containing this chemical component
Linalol	Monoterpene alcohols	antispasmodic	Basil ct. linalol; Clary sage; Lavender; Lavandin;
Beta-pinene	Monoterpenes	Spasmolytic	Black pepper; Yarrow;
Menthol	Monoterpene alcohols	Antispasmodic	Peppermint, Lavender stoechas
Beta-caryophyllene	Sesquiterpenes	Antispasmodic	Black pepper; Clove; Yarrow;
Alpha-terpinyl acetate	Esters	antispasmodic	Cardamom; Laurel;
1,8 cineole	Oxides	Analgesic, muscle relaxant	Cardamom, Bay Laurel, Rosemary ct.cineole, Spike Lavender, Eucalyptus ct. cineole
alpha-bisabolol oxide A/B	Oxides	Antispasmodic; anti-inflammatory	German chamomile
Eugenol	Phenylpropanoids	Analgesic, antispasmodic; anti-inflammatory	Basil; Cinnamon leaf; Clove

It has to be noted that even though Sweet marjoram's major chemical components are mostly known to have analgesic effect, it also includes such antispasmodic components as 1,8 cineole and beta-caryophyllene, which are known to be powerful antispasmodic agents. As noted in the previous section, essential oils should be considered as whole. And even though we do pay attention to the chemical components of a particular essential oil to make a blend in order to address a specific therapeutic issue, we should consider the minor chemical components as well, because they definitely impact the therapeutic properties of the essential oil. Having said that, a sample blend for skeletal muscle cramps would include Black pepper, Rosemary ct. cineole, Bay Laurel. The synergistic effect between beta-caryophyllene and beta-pinene found in Black pepper, 1,8 cineole found both in Rosemary ct. cineole and Bay Laurel would create a powerful antispasmodic blend.

As noted earlier, lactic acid build-up can be one of the reasons for skeletal muscle cramps. Thus, by adding Rosemary ct. cineole to this blend, we not only benefit from muscle relaxant activity of 1,8 cineole, but also helping the body get rid of the lactic acid: "Rosemary ct. cineole

has an analgesic effect on the muscles by means of its tonic effect on the circulation, which not only improves the nutrition of the muscle fibers but also helps eliminate lactic acid"[14].

The above mentioned sample antispasmodic blend could be complemented with German chamomile as it contains alpha-bisabolol oxides A and B known to have a powerful antispasmodic activity, and/or with Sweet Marjoram, which has a unique combination of analgesic and anti-spasmodic chemical components.

The mechanism of smooth muscle cramps is different from that of skeletal muscle cramps. The main reason for menstrual cramps, which are a good example of smooth muscle cramps, is the high level of hormone-like prostaglandins causing uterine muscle contraction, pain and inflammation. Thus, essential oils whose chemical components would act on prostaglandins on one hand, and have analgesic/antispasmodic therapeutic action on the other, would relieve menstrual cramps much more efficiently.

The following essential oils are known to help relieve menstrual cramps: Basil ct.linalol, Sweet marjoram, German chamomile, Lavender, Clary sage, Rose, Cinnamon leaf.

Anti-inflammatory therapeutic action of the essential oils via inhibition of hormone-like prostaglandins might be due to the synergistic effect of linalol, linalyl acetate, alpha-terpineol and geraniol found in Clary sage, Lavender, Sweet Marjoram, Rose and Geranium. This might be the reason why these five essential oils are typically used in the most known blends for menstrual cramps.

The anti-inflammatory action of the above essential oils might be enhanced by:

- Basil ct. linalol which contains both linalol and linalyl acetate, whose synergistic properties include strong anti-inflammatory activity, and
- German chamomile containing oxide alpha-bisabolol which has exhibited strong anti-inflammatory and antispasmodic activity.

The summary of chemical components with anti-inflammatory therapeutic action is presented in the table below:

Chemical Component	Chemical Group	Therapeutic action	Essential oils containing this chemical component
Gamma-terpinene	Monoterpenes	Anti-inflammatory	Sweet Marjoram
Linalol	Monoterpene alcohols	Anti-inflammatory; analgesic; antispasmodic	Basil ct. linalol; Clary sage; Lavender; Lavandin;
Geraniol	Monoterpene alcohols	Anti-inflammatory	Rose, Rose geranium, Geranium
Terpinene-4-ol	Monoterpene alcohols	Anti-inflammatory	Sweet marjoram; Clary sage; Lavandin; Yarrow
Alpha-terpineol	Monoterpene alcohols	Anti-inflammatory	Clary sage, Sweet marjoram

Chemical Component	Chemical Group	Therapeutic action	Essential oils containing this chemical component
Linalyl acetate	Esters	Anti-inflammatory; Analgesic	Clary sage; Lavender; Lavandin; Basil ct. linalol; Sweet marjoram
alpha-bisabolol oxide A/B	Oxides	Antispasmodic; anti-inflammatory	German chamomile
Eugenol	Phenylpropanoids	Analgesic, antispasmodic; anti-inflammatory	Basil; Cinnamon leaf; Clove

In order to make the blend more powerful, one could also take into account the base oils, as mentioned in the previous section. Thus, one could use such carrier oils as rosehip seed oil and borage oil in order to address the inflammatory effect of prostaglandins which build up in the body during the first part of the menstrual cycle and causing pain and inflammation known as menstrual cramps.

Both borage and rosehip seed oils have high levels of Gamma Linoleic Acid (GLA). The GLA – prostaglandin connection is important in the reduction of endometriosis and PMS symptoms, where the vasodilatory effect of borage oil increases the blood flow in the fine peripheral blood vessels, thus eliminating the congestion that causes pain and discomfort during menstruation. Thus, both borage and rosehip seed oil can be used as base oils to enhance the anti-inflammatory and antispasmodic effects of chemical components of the essential oils used in a blend.

Further Research

Further research of the following chemical components is needed: 1,8 cineole; limonene; alpha-pinene.

Recent research has shown inhibitory action of 1,8 cineole on prostaglandins. However, It hasn't been shown whether the essential oils rich in 1,8 cineole (such as Eucalyptus globulus, Bay Laurel, Rosemary ct. cineole etc) would relieve menstrual cramps, especially when used with essential oils containing linalol and/or linalyl acetate.

Both limonene and alpha-pinene, main chemical components of Bergamot essential oil, have been shown to have strong anti-inflammatory activity when used with linalol and linalyl acetate. At the same time, Bergamot hasn't been included in well-known synergies that help relieve menstrual cramps. There might be a few reasons for this, one of them would include interference of the chemical components resulting in the absence of the inhibitory effect on prostaglandins.

Conclusion

In our research paper we gave the overview of two types of the muscle tissues: skeletal and smooth addressing the differences in their functions, mechanisms and possible dysfunctions. We have also examined main principles of creating synergistic blends and have given sample

synergies addressing specific muscle related issues focusing on chemical components of the essential oils. Further research needs to be done on such chemical components as 1,8 cineole, limonene, alpha-pinene which have exhibited strong anti-inflammatory activity especially when used synergistically with linalol and linalyl acetate, however, essential oils containing these chemicals as their major components haven't been used as part of anti-menstrual cramps blends.

Notes:

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