CPE: Modulating Chronic Pain: The Role of Nutrition and Botanicals
Sheila Sedig, MS RD

Frustratingly difficult to treat, chronic pain is not uncommon. The Chronic Pain Association estimates that 50 million Americans live with, or more aptly endure, chronic pain daily. Management of chronic pain generally falls into five domains: mechanical, pharmacological, cognitive/behavioral, nutritional, and complementary/alternative therapies. Mechanical therapies include physical therapy, massage, exercise, hydrotherapy, and biofeedback. Pharmacological treatments are prescriptive and over-the-counter (OTC) preparations. The cognitive/behavioral domain includes mind-body therapies and counseling. Nutritional recommendations involve diet modifications and dietary supplements. Complementary/alternative therapies include the use of herbs and botanicals. As the biochemical understanding of pain and inflammation has been further elucidated, the use of dietary modifications and herbal supplementation as pain modifiers has been explored.

The Inflammatory Process

To understand how diet and botanicals may influence the inflammatory process and accompanying pain response, it is first necessary to review that process and the biochemical elements involved. Acute inflammation caused by injury or infection is a normal physiological response that allows for healing and the ultimate return of normal tissue function. When inflammation is chronic, however, it can lead to chronic pain. Many factors contribute to this process.

The broad process of pain perception begins with nociceptors (pain receptors) that send messages of mechanical, thermal, electrical, or chemical irritation via the afferent nerves to the central nervous system, then the brain. Once such a message reaches the brain, it is interpreted based on the physical pain stimulus and also on psychological aspects. These psychological elements encompass cultural and personal attitudes regarding pain, the individual’s prior experience of pain, and previous pain expression. Psychological aspects of pain perception can be altered by mind-body therapies. The brain’s interpretation of the pain is then sent via efferent nerves back to the nociceptors, causing a reaction to the pain - increased or decreased sensitivity to the pain stimulus and release of chemical modulators that affect perception of pain as well as tissue response to pain, primarily via the inflammatory cascade. It is this part of the process that is affected by medications, diet, and botanical constituents.

When a pain stimulus arrives at the nociceptor site, surrounding cells begin...
Chair’s Corner:  
Susan Allen RD, CCN

I don’t know about your part of the world, but here in Chicago we’re having our first taste of fall. After a long hot summer, it’s very refreshing to have a breath of crisp, cool air. Though it won’t be long before nature starts it’s slow shut down for the winter, it is also a time for new beginnings: the start of school, sports seasons, perhaps even a new fall wardrobe!

This is also the time of year NCC plans for it’s new beginning – the slate of officers for the 06-07 year. Now is the time to get involved! Leadership can be rewarding, especially when you know you’re contributing to making a difference for the future of the dietitian’s role in CAM. It’s through likeminded leadership that we can continue the momentum we’ve begun. Who will join us???

Currently NCC is searching for a treasurer. If you have direct financial experience – great, however, please know that this position requires more ability to learn and become involved than it does as a financial wizard. Specific training and mentorship from ADA and our current treasurer will be available and as a board member, you will also have involvement in all NCC activities. If you are interested in running for treasurer or other available positions, please contact Natalie Ledesma, our Nominating Committee Chair or me directly for more details.

Speaking of new beginnings, NCC leadership is committed to the needs of its members. Shortly after FNCE, a random sampling of our members will receive a survey. It is very important that we have 100% involvement in this survey. With the information of who our members are and what they need most from their membership, we can ensure that NCC effectively meets members’ needs and continues on its path of growth and expansion. The information will help us attract sponsorship dollars that are critical to fund programming necessary to continue to position NCC as a leading DPG of ADA.

As we go to print, many of us are looking forward to attending this year’s FNCE in St Louis. NCC is very excited to have such a presence this year and we hope all attending will be able to take full advantage of all NCC has to offer.

Remember, my e-mail box is always open - I’d love to hear from anyone at any time about any topic. Let’s all continue to support the success of this fine group!

Editor’s Notes:  
Sarah Harding Laidlaw, MS RD MPA

It is September so it must be time for FNCE! Another year has passed by quickly and the NCC leadership, like the other DPG group’s leadership, is putting finishing touches on plans for exciting events and presentations at this year’s meeting in St. Louis. We hope to see many of you there and ask that you stop by, say hello, and if you are so inclined, volunteer for one of the many opportunities that NCC has to offer. Don’t miss us at the DPG Showcase and Product Marketplace and plan to attend the informational breakfast Sunday morning at 7AM and the reception that evening. For more information on the breakfast, reception, and NCC sponsored presentations, see page 36.

As newsletter editor I am always interested in what you, our members, want to know more about. In addi-
tion I am always looking for those of you who are aspir- ing or established authors to provide articles of interest for the newsletter. Among the topics that we would like to include are updates from members on what you are doing to integrate complementary nutrition into your practice; functional foods — new or updated information; therapies such as yoga, meditation, and acupuncture; nutrigenomics; and functional approaches to nutrition therapy, just to name a few. Any and all ideas and volunteers to help write, recruit authors or to edit are welcome. Please email me at peaknut@cascadeaccess.com with your ideas or to volunteer. Better yet, introduce yourself at FNCE so we both can put a face and voice with a name.

If you have not checked out the NCC Web site at recently, or at all, I encourage you to do so. It is updated on a regular basis by the Web Editor, Susan Moyer, PhD, MPH/LDN and Webmaster Corey Gransee. On there you will find up to date and cutting edge information on complementary nutrition as well as links to the NCC leadership, current events, and the awesome resource and member benefit — Natural Medicines Comprehensive Database.

Until next issue…. Or you meet me in St. Louis – Sarah.

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Modulating Chronic Pain: The Role of Nutrition and Botanicals

...to react to this pain signal by initiating the inflammatory cascade. Tissue damage from free radicals, histamines, or an acidic pH can also trigger this cascade. In brief, small blood vessels in the area become dilated, simultaneously increasing blood flow to, and slowing flow in the area. Endothelial cells in the region become swollen; small plasma proteins, primarily fibrinogen, leak into the area; and various immune cells, mainly T-lymphocytes and macrophages, are attracted to this space. Immune cells then begin to secrete cytokines, signaling chemicals that activate, coordinate, and regulate cell growth, tissue repair, immunity, and inflammation. Examples of cytokines include tumor necrosis factor (TNF), the interleukins (IL), and the interferons (IFN). Cytokines signal surrounding cells to produce the cyclooxygenase (COX) and 5-lipoxygenase (5-lipox) classes of enzymes. These enzymes then metabolize fat in the surrounding cells’ membranes to form eicosanoids — prostaglandins, leukotrienes, and thromboxanes. Some eicosanoids are pro-inflammatory, escalating the whole inflammatory cascade and continuing the process, while other eicosanoids are anti-inflammatory, inhibiting the process. Inhibition of cytokine and eicosanoid production has become the mainstay of pharmacotherapy in chronic pain including the ill-fated cyclooxygenase (COX) inhibitors, rofecoxib and celecoxib, and the non-steroidal anti-inflammatory drugs (NSAIDS). Ultimately, the purpose of this cascade is for tissue to respond to pain, heal any damage, fight off infection, then stop the inflammatory cycle and return to normal function. When inflammation is chronic and this process is not halted, the inflammation continues, creating chronic pain. According to current research, this contributes to arthritis, atherosclerosis, diabetes, colitis, and many other prevalent chronic illnesses.

How do diet constituents and botanicals modulate this cascade? Diagram 1 illustrates the biochemical pathway of eicosanoid production indicating where these nutritional and herbal compounds play a role. Dietary factors that most influence this process include fats: essential polyunsaturated omega-6 and omega-3 fatty acids, trans fatty acids, and omega-9 fatty acids. Herbal compounds that most affect the cascade are those that promote or inhibit the eicosanoid production pathways.

Mind-body treatments also impact this process. Their impact occurs directly in the brain, because this cascade occurs with real physical pain and with imagined pain or stress. When the brain registers psychological pain messages are sent via effenter nerves to various tissues which initiate the inflammatory cascade. Cognitive/behavioral therapies help to decrease these stress messages. While these therapies will not be the focus of this article, nutrition professionals treating individuals with chronic pain should be aware of their efficacy.

The Role of Diet in the Inflammatory Process

**Omega-3, Omega-6, Trans Fatty Acids, and Oils**

Because eicosanoid production originates in the fatty acids found in the membranes of cells in the affected area, the specific fatty acids present in these cells becomes important. The predominant omega-6 fatty acids (n-6 FA) present in the diet tend to promote inflammation, while omega-3 fatty acids (n-3 FA) work to inhibit inflammation (diagram 1). Our ancestral diets had an n-6:n-3 ratio of approximately 1:1.6 but may have been as high as 3:1.7 This ratio allows the inflammatory cascade to proceed beneficially – damage is repaired and the tissue is returned to normal, healthy functioning. If this ratio is in favor of n-6 FA, however, the pro-inflammatory pathway dominates. The balance of the n-3 FA anti-inflammatory response is inadequate. Enzyme availability for the conversion of fatty acids to eicosanoids also impacts the process. The fatty acid composition of cell membranes is directly influenced over time by the dietary fatty acid composition ingested.
The fatty acid ratio in the typical Western diet is reportedly about 16:1:8. Omega-6 FA are found primarily in beef, pork, chicken, whole milk dairy products, egg yolks, vegetable and seed oils, and packaged convenience foods – all staples of the American diet. Omega-3 FA rich foods include cold water fatty fish (salmon, mackerel, halibut, tuna), flaxseed and flaxseed oil, canola oil, walnuts, and purslane, a green leafy vegetable. These are not as common in a Western diet.9 Some researchers call the typical Western diet a proinflammatory diet.9

The ratio of n-6:n-3 has been the subject of several studies. Simopoulos’ synopsis of this is interesting. A ratio of 4:1 decreased total mortality by 70% in the secondary prevention of cardiovascular disease. Rectal cell proliferation was reduced in patients with colorectal cancer when dietary n6:n-3 ratio was 2:5:1, but a 4:1 ratio had no effect when the absolute amount of n-3 remained constant. There is a breast cancer protective effect in women who have a low dietary n-6:n-3 ratio. A ratio of 2:3:1 in patients with rheumatoid arthritis suppressed inflammation. A ratio of 5:1 was beneficial in asthmatics, but a ratio of 10:1 increased respiratory distress. Thus, the optimal ratio of n-6:n-3 appears to be disease-specific.10

Supplementation with fish oils high in n-3 FA has also been studied in inflammatory disease states, notably heart disease and arthritis.11,12 Studies have shown that fish oil supplements improve clinical markers for heart disease by reducing triglycerides and by decreasing blood pressure, arrhythmias, thrombosis, atherosclerotic plaques and risk of sudden death.13 In arthritis, studies have shown decreases in joint stiffness and pain rating, delay in onset of fatigue, and improvement in overall mobility.14 The mechanism of action is related to the dose of n-3 FA, specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) involved in the eicosanoid series 3 pathway. A high intake of EPA and DHA has been shown to lower several biomarkers of inflammation: C-reactive protein (CRP), interleukin-6 (IL-6), soluble tumor-necrosis factor (TNF), E-selectin, soluble intracellular adhesion molecule (SICAM), and soluble vascular adhesion molecule (SVCAM).15 CRP is a small protein synthesized by the liver and present in small concentrations, but increases dramatically in response to acute inflammation. CRP production is stimulated by interleukin-1. Interleukin-6 and TNF are pro-inflammatory cytokines. E-selectin, SICAM, and SVCAM are adhesion molecules produced by endothelial cells after cytokine activation, which mediate further inflammatory response.

Excessive intake of trans-fatty acids (TFA), abundant in the convenience, processed foods of the American diet, has also been shown to increase two markers of inflammation: IL-6 and CRP.16,17 TFA block fatty acid metabolism by inhibiting the delta-6-desaturase enzyme (diagram 1).18,19 It is well-established that these fats contribute to heart disease.20,21

Olive oil, a monounsaturated fat, has been promoted as heart healthy. It does contain omega-9 fatty acids (n-9 FA) which are involved in the inflammatory cascade and the production of eicosanoids (diagram 1). Omega-9 FA may enhance anti-inflammatory prostaglandin production by promoting the eicosanoid series 1 and 3 pathways from n-6 and n-3 FA respectively. Other n-9 FA sources include olives, avocados, pecans, almonds, peanuts, cashews, sesame oil, pistachio nuts, and macadamia nuts.22

It appears, however, that canola oil may be better than olive oil for cardiovascular protection. The Lyon Diet Heart Study showed a reduction in cardiovascular events when substituting n-3-rich canola oil for olive oil.23 Vogel, et al also reported a post-prandial reduction in brachial artery flow–mediated vasodilation after consumption of an olive oil-containing meal, but not in an n-3 enhanced canola oil-containing meal.24 This vessel constriction could lead to inflammatory sequelae.

Antioxidants and Flavonoids

It is well established that antioxidants, including vitamins and phytonutrients, play a role in reducing free radical damage to tissue, preventing initiation of the inflammatory cascade. Vitamin C and carotenoids, found in fruits and vegetables, have proven antioxidant ability. An article in 1993 by Ames, Shigenaga, and Hagen supported the recommendation of encouraging Americans to eat at least five servings of fruits and vegetables per day because of this antioxidant activity.25 Ames, Gold, and Willett confirm the antioxidant properties of vitamin C and carotenoids, particularly in relation to protecting DNA from oxidative damage. They also report that one of folate’s roles is maintaining DNA stability and that fiber decreases the risk of colon cancer.26 Folate and fiber are constituents of fruits and vegetables. Meydani reinforces that n-3 and n-9 FA, as well as vitamin E and other antioxidants found in fruits, vegetables, and nuts, play a role in reducing the expression of cytokines, thus inhibiting the inflammatory cascade.27 Studies with apples reveal they contain strong antioxidant phytochemicals: catechin, quercetin, phloridzin, and chlorogenic acid. These agents can lower serum cholesterol, inhibit lipid oxidation, and decrease cancer cell proliferation.28 In an excellent review, Donaldson lists not only the antioxidant qualities of fruits and vegetables, but also the protective vitamins,
**DIAGRAM 1. METABOLISM OF ESSENTIAL FATTY ACIDS**

**OMEGA-6**
- Linoleic Acid (LA)
  - Sources: Safflower, sunflower, sesame and corn oils
- Gamma-Linoleic Acid (GLA)
  - Sources: Evening primrose oil, black currant oil, borage oil
- Dihomo-gamma-linoleic Acid (DGLA)
- Eicosanoid Series 1: anti-inflammatory
  - Converted by cyclooxygenase-2 enzyme (cox-2 enzyme)
  - Inhibited by aspirin, Boswellia Complex, Cramplex, Saligesic, ginger, garlic, onions, feverfew
- Arachidonic Acid
  - Inhibited by steriods, licorice, feverfew
- Eicosanoid Series 2: Promotes pain
  - Promotes inflammation
  - Vasoconstricts
  - Increases blood clotting
  - Increases platelet stickiness
  - Increases blood pressure
  - Thromboxanes (inflammatory)
  - Leukotrienes (inflammatory)

**OMEGA-3**
- Alpha-Linoleic Acid (ALA)
  - Converted by Delta-6-desaturase enzyme.
  - Requires Be, Mg, Zn.
  - Inhibited by trans-fats, alcohol.
- Steardonic Acid (SDA)
  - Source: Black currant oil
- DHA (Important Brain EFA)
- Eicosapentaenoic Acid (EPA)
  - Sources: Fish oil (coldwater fish, including sardines, salmon and mackerel)

**PREFERRED PATHWAY**
- Inhibited by aspirin, Boswellia Complex, Cramplex, Saligesic, ginger, garlic, onions, feverfew
- Eicosanoid Series 3: Decreases pain
  - Anti-inflammatory
  - Vasodilates
  - Decreases blood clotting
  - Decreases platelet stickiness
  - Decreases blood pressure

**NOTE:** Eicosanoids are also called Prostaglandins.

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minerals, phytochemicals and fiber constituents of these foods. He concludes with an outline for an anticancer diet, part of which recommends 10 servings of vegetables per day (including cruciferous and allium vegetables) and four or more servings of fruits a day.29

More recently flavonoids, which include flavones and isoflavones (the latter are polyphenol plant chemicals with a structure similar to mammalian estrogen), have received attention. These food components are found in abundance in soy products, highly pigmented fruits, and teas. The isoflavones genistein and daidzein, found in soybeans, are active antioxidants.30 Flavonoids have been shown to have the following effects: anti-inflammatory;31 eicosanoid synthesis inhibition and protection of collagen;32 and the reduction of capillary permeability and fragility,33 which impacts the inflammatory cascade at its inception, reducing the influx of the various chemicals and cells that are involved in escalating the inflammatory response. Flavones have also been shown to inhibit the formation of free radicals from oxidation in an injured area, particularly by regulating nitric oxide production. When released from activated macrophages, nitric oxide can destroy tumor cells, intracellular bacteria, and parasites. In high concentrations, however, it can destroy healthy endothelial tissue and contribute to inflammation.34 In a small study with dogs, monkeys, and humans, Folts showed this nitric oxide regulation from flavonoids in grape products and also revealed the anti-platelet aggregation role of these chemicals.35 Arts and Hollman report that the polyphenol subclasses, flavones, catechins, and lignans, exert beneficial effects in cardiovascular disease and lung cancer.36 To further elucidate the exact mechanisms of these protective agents they recommend prospective studies using these different polyphenol subclasses.

Although animal products contain some antioxidants, the vast majority of antioxidants and flavonoids are found in fruits, vegetables, nuts, and soybean products. The American Dietetic Association, the American Heart Association, the American Cancer Society, and several other agencies have urged Americans to increase their intake of fruits and vegetables. The American Heart Association also recommends increasing n-3 FA intake. Table 1: Dietary Recommendations to Decrease Inflammation summarizes a few recommendations nutrition professionals can provide to clients.

Dietary Supplements: Glucosamine and Chondroitin

Glucosamine sulfate belongs to the family of cartilage proteoglycans and is isolated from oyster and crab shells.37 Proteoglycans are protein-carbohydrate molecules which have many physiological functions. It has been shown in joint cartilage to stimulate the synthesis of the proteoglycan matrix and the shock-absorbing glycosaminoglycans (GAG), long unbranched polysaccharides. High doses of glucosamine have mild anti-inflammatory effects by decreasing cytokine stimulated synthesis of COX-2 enzymes.38

Chondroitin sulfate is also a GAG and is derived from shark and cow cartilage. Chondroitin acts as the foundation of the proteoglycan matrix in joint cartilage.39 Chondroitin protects cartilage from damage in three ways. It interferes with leukocyte elastase, an enzyme that promotes the production of pro-inflammatory cytokines from white blood cells. Chondroitin decreases the migration of white blood cells (WBC) into the proteoglycan matrix. When activated these WBC release signaling chemicals which promote further inflammation. It also increases the production of proteoglycans and hyaluronic acid, another shock-absorbing GAG.40

Glucosamine and chondroitin are often used in combination for arthritis relief, however, there is a lack of evidence that this combination is any better than either compound used alone. Because more investigation of these dietary supplements is warranted, the National Center for Complementary and Alternative Medicine (NCCAM) is currently conducting the GAIT (Glucosamine/Chondroitin Arthritis Intervention Trial) study. This multicenter study will compare glucosamine alone, chondroitin alone, glucosamine and chondroitin together, celecoxib (a COX-2 inhibiting NSAID), and placebo. Results from this trial are expected to be published later this year.41

Recommended dosing of glucosamine is 500 mg three times/day and for chondroitin it is 400 mg three times/day.42 Combination tablets commonly contain 500 mg glucosamine and 400 mg chondroitin and the dosing recommends three or more tablets per day. There are combination tablets on the market with higher levels of each substance with the same ratio.

There is some concern about glucosamine causing elevated blood sugar, but in studies this has not been shown to negatively impact glycosylated hemoglobin levels. Some preliminary evidence shows that chondroitin may increase the risk of prostate cancer, so until further studies are conducted men who have or are at risk for prostate cancer should not use chondroitin. There is also some concern that because chondroitin is sometimes made from bovine cartilage, there is a risk for bovine spongiform encephalopathy, mad cow disease. To date there have been no reported cases of BSE in those taking chondroitin.43

The Role of Botanicals in the Inflammatory Process
TABLE 1. Dietary Ways to Decrease Inflammation

Practical ways to change the fatty acid profile of the diet:
- Gradually decrease the amount of beef, pork, and poultry and increase the amount of cold water fish over time. For example: replace chicken or ground beef with broiled salmon or mackerel; replace a chicken salad sandwich with a tuna salad sandwich.
- Use canola or olive oil in place of other vegetable oils for salad dressings and in cooking.
- Add ground flaxseed, walnuts, or pumpkin seeds to salads, soups or cooked vegetables.
- Use omega-3 fortified eggs.

Practical ways to increase fruits and vegetables in the diet:
- Make fresh fruit and vegetables visible in the home; they are more likely to be eaten if they are seen.
- Add frozen or fresh cut vegetables to soups, salads, or pasta dishes.
- Add berries to muffins, waffles, or pancakes. Add other fresh or frozen fruits to cereals or yogurt.
- Buy, wash, cut up, and place fruits and vegetables in individual containers to use easily and quickly during busy times.
- Take dried fruit in the car, to the office, and visibly leave on the counter to snack on during the day.

Many botanicals have been used to reduce inflammation and ease pain, several of which are included in diagram 1. Information on a few of the most commonly used herbs for chronic inflammation follows. Some of the information for each product is taken from the Natural Medicines Comprehensive Database (NMCD), thus is not referenced each time. Many of these botanicals are also used for other conditions, but only their anti-inflammatory actions are discussed here.

**Evening Primrose Oil, Black Currant Oil, and Borage Oil**

These oils are sources of gamma linolenic acid (GLA). An omega-6 FA, GLA is a precursor to the anti-inflammatory eicosanoid series 1 pathway and preferentially reduces IL-1-beta, a pro-inflammatory cytokine. GLA is converted to dihomo-gamma-linolenic acid (DGLA), a precursor to the potent anti-inflammatory prostaglandin E1 (diagram 1). Borage oil also provides stearidonic acid (SDA), which is converted to EPA by delta-5-desaturase, competitively inhibiting arachidonic acid (AA) production and thus decreasing formation of the inflammatory leukotrienes via the eicosanoid series 2 pathway (diagram 1). Barham, et al showed that using EPA and GLA supplementation in combination decreased the synthesis of pro-inflammatory AA metabolites via delta-5-desaturase competitive inhibition.

Dosing: 540 mg to 2.8 g daily for evening primrose (Oenothera biennis) oil; best when used in combination with fish oils and vitamin E. There is no standard dosage for black currant (Ribes nigrum) oil. 1.1 to 1.4 g daily up to 24 weeks has been used for borage (Borago officinalis) oil.

**Licorice**

Licorice (Glycyrrhiza glabra) inhibits the conversion of DGLA to AA, ultimately decreasing the synthesis of prostaglandins E and F2 alpha. These are pro-inflammatory prostaglandins particularly active in gastric tissue and can contribute to ulcer formation.

Dosing: There is no standard dosing for anti-inflammatory effects, and it is usually used as the deglycyrrhizinated (DGL) extract.

**Feverfew**

A small plant with feathery leaves, feverfew (Tanacetum parthenium) has been used for its therapeutic effects for generations. Like licorice, feverfew inhibits the production of AA from DGLA, preventing pro-inflammatory prostaglandin synthesis. Parthenolide, an active ingredient of feverfew, selectively inhibits COX-252 and chrysantheryl acetate, an essential oil of feverfew that inhibits prostaglandin synthesis and may have analgesic affects.

Dosing: There is no standard dosing for anti-inflammatory effects, but 50 to 100 mg of feverfew extract standardized to 0.2% to 0.35% parthenolide/day has been used for migraine relief. No topical dosing is given.

**Garlic**

There is a plethora of research about garlic . Garlic is used as an antihypertensive, anti-cholesterolemic, antiviral agent, anticancer agent, GI protectant, and an aid in several other maladies. To maintain brevity in the current discussion, garlic biochemically inhibits the production of pro-inflammatory thromboxanes and leukotrienes from AA. It is an antioxidant as well as anti-inflammatory agent. It is proposed that allicin is the active ingredient in garlic.

Dosing: There is no standard dosing for garlic, but the more an individual consumes the more adverse affects they may experience such as breath odor or GI distress.

**Turmeric**

Turmeric is a spice from the root of the plant...
Curcuma longa, a member of the ginger family. Its component curcumin has several actions in the inflammatory cascade. It inhibits COX-1, COX-2, and lipoxygenase enzymes, thus decreasing formation of the inflammatory prostaglandins - leukotrienes and thromboxane. Curcumin also inhibits the damaging action of nitric oxide and several enzymes: phospholipase, collagenase, elastase, and hyaluronidase. Curcumin inhibits the formation of monocyte chemoattractant protein-1 (MCP-1), interferon-inducible protein, tumor necrosis factor (TNF), and interleukin-12 (IL-12); all involved in inflammation or free radical damage which then promotes inflammation.56,57

Dosing: Curcumin has been found to be safe for humans at doses from 1125 to 2500 mg curcumin/day and as high as 8000 mg/day, this for three months.57

Ginger

Ginger (Zingiber officinale) has been used in rheumatoid arthritis (RA) and osteoarthritis (OA), providing some relief of pain. Using a standardized and highly concentrated extract of two different ginger species (Alpinia galangal and Zingiber officinale), Altman and Marcussen found a statistically significant decrease in the symptoms of OA in a group of 247 patients.58 The actual data from this study are interesting; subjectively, the percentage of responders with a reduction in knee pain was 63% in the ginger group versus 50% for controls (p=0.048) over the 6-week course of the study. When using a 100 mm visual analog scale to determine pain, it was found that subjects had a reduction in knee pain when standing (24.5 mm versus 16.4 mm; p=0.005) and a reduction in knee pain after walking 50 feet (15.1 mm versus 8.7 mm; p=0.016). There was also a decreased use of rescue medication in the ginger group versus the control group during the study. It is presumed that the anti-inflammatory effect of ginger comes from its inhibition of the COX and 5-lipox enzymes and decreased production of the cytokines TNF-alpha, prostaglandin-E2 and thromboxane B2.59,60,61

Dosing: A standard dosing of ginger extract for OA is 170 mg three times per day or 255 mg two times per day.

White Willow

White willow (Salix alba) comes from the bark of the Salix tree species and contains flavonoids and salicin, which is metabolized to salicylate upon absorption. Flavonoids are discussed above. Salicylates, like aspirin, decrease the production of pro-inflammatory prostaglandins, thus inhibiting inflammation. White willow bark has been found to be particularly helpful in those with low back pain.62

Dosing: Extracts with 120 mg to 240 mg of the salicin component have shown efficacy, but the higher end dose is recommended to achieve results.63 It also appears that one must use white willow for at least one week before some pain relief is experienced.

Indian Frankincense

Indian frankincense (Boswellia serrata) extract has been used for its anti-inflammatory, anti-arthritis, and analgesic effects. The resin of the plant contains boswellic acids that inhibit the synthesis of the 5-lipox enzymes and the formation of leukotrienes. These acids may also decrease GAG degradation and cartilage damage, which may explain their anti-arthritis qualities.64 Kimmatkar, Thawani, Hingorani, and Khiyani used the extract in 30 patients in a double-blind, cross-over, washout study for eight weeks and found that all patients receiving the herbal therapy reported decreased knee pain and swelling and increased knee flexion and walking distance.65

Dosing: 333 mg three times/day is standard dosing for osteoarthritis and 3600 mg/day for rheumatoid arthritis.

Devil’s Claw

An African plant, the root of Devil’s claw (Harpagophytum procumbens) contains several active ingredients, one of which is harpagoside. This chemical appears to have anti-inflammatory effects by inhibiting the inflammatory pathways of both COX-2 and lipoxygenase. It may also inhibit nitric oxide synthase, an enzyme that produces the free radical nitric oxide.66 While Devil’s claw has been used for centuries, there is some controversy regarding the quality of the research done with this compound (see dosing below).

Dosing: Chrubasik, Conradt, and Black recommend that more thorough research on Devil’s claw is needed, but they do state studies using at least 50 mg of harpagoside/day do seem to show effectiveness with pain relief.67

Bromelain

Bromelain (Ananas comosus), a crude extract from the stem and fruit of pineapple, contains various proteinases that have anti-edematous, anti-inflammatory, antithrombotic, and fibrinolytic activities.68 By decreasing immune cell migration to injured areas and decreasing activation of leukocytes already present in an injured area, bromelain inhibits the inflammatory cascade, primarily decreasing prostaglandin E2 and thromboxane A2. It also decreases plasma fibrinogen levels,
SUPPLEMENTS:
New Dietary Supplements for Management of Chronic Pain
Wendy Van Ausdal, BS, Stacey J. Bell, DSc, RD, Greg T. Grochoski, BS

All of us, rich or poor, young or old, have one thing in common: we experience pain. Pain is the signal that the body uses to notify the brain that something is wrong. In its less serious form, pain tells us that we need to rest and recover. At higher, more persistent levels, pain prompts us to take medicine or see a doctor.

There are two categories of pain: acute and chronic. Acute pain can appear as the result of disease, inflammation, or injury, and its onset is usually sudden. Acute pain generally ends when the original cause of the pain is treated and healing occurs. Chronic pain, on the other hand, tends to come on more gradually. It persists over a longer period of time, and is often resistant to medical treatments. Studies report that 12% to 58% of the population now experiences chronic pain. Factors such as sex, age, professional status, and environment (i.e. rural or urban) may account for this wide range.

Pharmaceutical Treatment Options for Chronic Pain

There are a number of ways that chronic pain sufferers can manage and lessen—even eradicate—in some cases—their discomfort. While popular natural treatments—from relaxation therapy to exercise, herbs to acupuncture—can certainly be beneficial, the most common method of conventional pain relief is analgesic administration (Table 1). Analgesics are a class of medications that include both over-the-counter (OTC) drugs and prescription medicines. One recent pain survey conducted at a veteran’s hospital studied 300 randomly chosen patient charts and found that 75% of the chronic pain patients (ages 30 to 90) were prescribed at least one analgesic and most (61%) received two or more. Of the analgesics prescribed, 67% were NSAIDs (non-steroidal anti-inflammatory drugs), 44% were opioids (strong prescription painkillers), and 29% were acetaminophen (a drug that reduces pain and fever but not inflammation).

NSAIDs can be very useful for treating mild to moderate pain and for reducing inflammation; however, they can also have a number of potentially problematic side effects. NSAIDs can irritate the lining of the stomach and gastrointestinal tract, leading to digestive upset, peptic ulcers, and bleeding in the digestive tract. Bleeding in areas other than the GI tract is also common because this class of drugs reduces platelet aggregation. In addition, using NSAIDs can increase the risk of cardiovascular (CVD) events. It was for this reason that two popular prescription NSAIDs (the COX-2 inhibitors rofecoxib and valdecoxib) were recently withdrawn from sale. All NSAID labels must now highlight the potential for increased risk of CVD events.

Opioids are potent prescription drugs that are chemically related to morphine and have many side effects, most notably that they slow the gastrointestinal tract and they are addictive. Over time, an individual’s opioid use often increases because the body adapts to the drug and thus responds less well to it—a condition called tolerance. People who take opioids over long periods of time usually become dependent on them.

Acetaminophen also treats pain, though it has no anti-inflammatory actions. Although the exact site and mechanism of action are not clearly defined, acetaminophen appears to produce analgesia by raising the pain threshold, predominantly through a central rather than peripheral mechanism. It does not affect blood clotting and has almost no adverse effect on the stomach. High doses of acetaminophen drugs, however, can lead to irreversible liver damage.

Due to the risks of known—as well as potentially unknown—side effects of conventional drugs, people suffering from chronic pain are always searching for new, safer treatments. Many patients turn to dietary supplements. The purpose of this article is to review two dietary supplements for pain relief—krill oil and plant-based B-ring flavonoids and flavans (BRFF).

Krell Oil

There are nearly a hundred species of krill, small shrimp-like crustaceans that populate the oceans of the world. One useful form of krill oil is derived from Antarctic krill (Euphausia superba). This species feeds on nutrient-rich phytoplankton, which probably

cont. on page 30
accounts for the krill oil’s potent antioxidants, including vitamin A, vitamin E, and astaxanthin. Researchers specifically studied krill oil for pain relief because it is also rich in eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), both long-chain omega-3 polyunsaturated fatty acids (PUFAs). The two double-blind, prospective studies discussed below support a role for krill oil in pain relief for premenstrual syndrome and osteoarthritis.

Prenestational Syndrome (PMS)

Seventy women diagnosed with PMS were randomly assigned to receive two grams daily of krill oil or equivalent doses of fish oil during the first month of the study, and then the same doses cyclically (8 days prior to and day one and two of menstruation) during the second and third months. At baseline and on days 45 and 90, the scores of a self-assessment questionnaire for PMS, which is based on the diagnostic criteria for premenstrual syndrome of the American College of Obstetricians and Gynecologists, were assessed, as was the frequency of analgesic use for menstrual pain.

Both krill oil and fish oil significantly (p<0.001) decreased abdominal pain on days 45 and 90. Krill oil, but not fish oil, also significantly improved two other indices of pain: joint pain and breast tenderness (p<0.001). In addition, krill oil significantly improved physical score measurements (swelling, bloating, and weight gain) and psychological score measurements (stress, irritability, depression, and feeling overwhelmed) at both 45 (p<0.001) and 90 (p<0.001) days. The only other significant improvements in the fish oil group were reduced weight gain on days 45 (p<0.04) and 90 (p<0.01) and swelling on day 90 (p<0.001).

Although both these marine oils decreased the use of analgesics, krill oil was significantly more effective than fish oil (p<0.03), resulting in a 50% reduction in ibuprofen and acetaminophen use by day 90. In this study, krill oil appeared to reduce pain related to menstrual cramps within 45 days and improve other PMS symptoms, such as swelling, bloating, stress, and depression.6

Krill Oil for PMS Pain: Mechanism of Action

Pain associated with PMS was reduced due to the production of less potent prostaglandins (PGs) and thromboxanes (TXs) as well as a reduction in muscle contractions. Diets high in omega-6 fatty acids and low in omega-3s decrease endometrial blood flow which has been associated with pain (i.e: abnormal cramping). Compared to those with no pain, women with painful menstrual cramps have higher circulating levels of the metabolites PGE2 and PGF2a, which are derived from arachidonic acid (AA), an omega-6 fatty acid. In contrast, eicosanoids derived from omega-3 fatty acids like krill oil (e.g. PGE3) reduce the contraction of smooth muscle, including the uterine muscle, and produce less pain. Most NSAIDs also decrease the AA metabolites and also result in decreased pain.7 At this point the exact reason for krill oil’s efficacy at reducing pain is unknown, however through more research this should be determined.

Osteoarthritis

Ninety subjects diagnosed with cardiovascular disease, rheumatoid arthritis, or osteoarthritis, as well as increased levels of C-reactive protein (CRP), a marker of inflammation, were randomly assigned to receive a placebo or 300 mg of krill oil per day for 30 days. At baseline and on follow-up visits on day 7, 14, and 30, blood was drawn for serum CRP analysis, and patients completed the Western Ontario and McMaster (WOMAC) University Osteoarthritis Index questionnaire. Krill oil significantly lowered CRP compared to placebo (krill oil: 2.49 mg/dl at baseline and 1.75 mg/dl...
at day 14 versus placebo: 2.87 mg/dl at baseline and 3.79 mg/dl at day 14; p=0.004). The WOMAC pain (p=0.003), stiffness (p=0.056), and functional impairment (p=0.021) scores were also significantly improved by day 14 in those subjects taking krill oil, but not those in the placebo group. The use of acetaminophen was reduced by 31% with krill oil compared to a reduction of only 6% in the placebo group (p=0.012).6

Kril Oil for Osteoarthritis Pain: Mechanism of Action

Omega-3–rich krill oil modulates the function of eicosanoids by competing with omega-6 fatty acids. The eicosanoids (PGs, TXs) regulate vascular constriction, platelet aggregation, and inflammation.7 Potent forms of PGs and TXs are produced from AA, an omega-6 fatty acid, when it is liberated from cellular membranes and converted by enzymes called cyclooxygenase-1 (COX-1) and cyclooxygenase-2 (COX-2).8 For example PGE2, an immunosuppressive prostaglandin, is responsible for generating pain at the site of inflammation.9

The same COX enzymes, however, also preferentially produce less potent forms of PGs and TXs when the omega-3 fatty acid EPA is liberated from cellular membranes. Diets rich in long-chain omega-3 PUFAs, for instance, result in the production of more PGE3 than TX5 than diets devoid or low in omega-3 fatty acids. The incorporation of omega-3 and omega-6 fatty acids into cellular membranes is competitive. So when omega-3 fatty acids are sufficiently supplied in the diet, EPA preferentially replaces the omega-6 fatty acid AA in cell membranes,10 thereby reducing pain and inflammation.10

B-Ring Flavonoids and Flavans

Pain management has also been demonstrated by a newly developed, patent-pending, proprietary plant extract containing free B-ring flavonoids and flavans (BRFF). It is standardized to baicalin and catechin, which are derived from two herbs long used in traditional Chinese medicine – Chinese skullcap (Scutellaria baicalensis) and black catechu (Acacia catechu) from the bark of the acacia tree. Chinese skullcap has been used to treat inflammatory-related disorders in China and Japan for centuries. Historically, black catechu and more than 1000 other species of its genus have been utilized as astringents to treat gastrointestinal disorders, diarrhea, and indigestion and to stop bleeding. Chinese skullcap and black catechu were two of only a few organic plant extracts to show inhibition of COX-2 after initial screening. Subsequent in vitro and animal studies confirmed COX-2 inhibition and anti-inflammatory action. The following scientific study supports the efficacy of BRFF.

Osteoarthritis

In a double-blind study, 52 patients (ages 40 to 75) with mild to moderate osteoarthritis were given a placebo or the BRFF extract (125 mg) twice daily for 90 days. Patients underwent clinical and biochemical evaluations and completed the WOMAC University Osteoarthritis Index for assessment of pain, stiffness, and functional impairment at baseline and on days 30, 60, and 90. BRFF significantly decreased WOMAC pain scores compared to baseline at day 30 (3.17 and 2.65; p=0.058) and at day 90 (3.17 and 2.67; p=0.045). There was no reduction in pain with the placebo. BRFF significantly improved scores for stiffness (30 days: p=0.004; 60 days: p=0.002; 90 days: p=0.003) and functional impairment (30 days: p=0.006; 60 days: p=0.016; 90 days: p=0.018), while the placebo did not. This study supported a role for BRFF in reducing pain associated with osteoarthritis.11 Another study has been planned and is due to begin in late 2005.

BRFF for Joint Pain: Mechanism of Action

Traditional NSAIDs work by inhibiting both COX-1 and COX-2 enzymes, resulting in a reduction of both beneficial and pain-inducing forms of PGs and TXs. COX-1 inhibition causing a reduction of beneficial eicosanoids, which are linked to the production of PGs regulating normal physiological function, is thought to be related to many of the reported side effects associated with NSAIDs, such as gastric erosion. Newer NSAID forms (e.g. rofecoxib, valdecoxib, and celecoxib) were designed to inhibit, in a highly selective manner, only the COX-2 enzyme, and are thus sometimes referred to as COX-2 selective NSAIDs. Therefore, fewer NSAID-associated side effects occur with COX-2 selective NSAIDs, which do not inhibit the COX-1 enzyme. Use of the COX-2 selective NSAIDs rofecoxib and valdecoxib, however, produced an increased risk of CVD and have been banned from sale by the Food and Drug Administration.3 Some scientists have theorized that the lack of COX-1 inhibition by COX-2 selective NSAIDs may be responsible for the increase in CVD risks. They even recommend that using highly COX-2 selective NSAIDs without the use of COX-1 inhibitors should be avoided.14

BRFF plant extract inhibits both COX-1 and COX-2 enzymes. But unlike COX-2 selective NSAIDs, it is not a highly selective COX-2 inhibitor. In addition, BRFF
inhibits 5-lipoxygenase (5-LOX), an enzyme that can produce leukotrienes, biological compounds involved in inflammation. This combination of enzyme inhibition provided by BRFF appears to avoid the safety problems encountered by NSAIDs and COX-2 selective NSAIDs. No gastrointestinal ulcers were observed in microhistological slides of the stomach of either mice or rats, suggesting that the dual inhibition of COX and 5-LOX allows for greater gastrointestinal tolerance. During the 90-day human study, no CVD risk factors worsened (e.g., blood pressure, pulse rate, and plasma thrombin time levels). Long-term safety of BRFF has yet to be confirmed.

**Take Home Message**

The management of chronic pain is difficult because most drugs eventually lose their effectiveness or produce side effects. New effective products without side effects are welcomed. Although many pain-fighting medications (OTC and prescription) exist, many individuals seek safe, natural alternatives. Today, krill oil is offered in products from several different companies and BRFF has been available to the United States public since 2003. Krill oil and BRFF extracts have been shown to reduce chronic pain both effectively and safely.

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**References:**


thus interfering with the normal process of inflammation. Further, bromelain appears to modulate immune function, aiding the body in destroying tumor cells, removing burn debris, and healing wounds.

Dosing: 200 to 400 mg daily for 30 days has been used for acute knee pain. Two tablets of a combination of rutin (100 mg), trypsin (48 mg), and bromelain (90 mg) three times daily has been used for OA. Magnesium activates bromelain, while zinc supplements and potato and soybean protein can inhibit bromelain activity. Those with pineapple allergies may also have bromelain allergy.

Chili Peppers

Chili peppers of the capsicum species contain capsaicin. Capsaicin binds to nociceptors in the skin and causes release of substance P, a sensory neurotransmitter that mediates pain. Capsaicin first increases sensitivity in the area to which it is applied causing an itching, burning, or pricking feeling. However, after repeated topical application, desensitization and pain relief occur. This is thought to be due to the depletion of substance P over time. Capsaicin has been used topically for low back pain and diabetic neuropathy pain.

Dosing: Topical creams that contain 0.025% to 0.075% capsaicin concentrations have been used in research. These creams do take some time for full analgesic effect to occur, so clients must use them consistently 3 to 4 times a day for several days to obtain the desensitization that leads to pain relief. These creams should never be used on open wounds.

Green Tea

Green tea is not fermented, which distinguishes it from black (fermented) or oolong (partially fermented) tea. Like garlic, there are numerous studies involving green tea, but for purposes of this discussion, the important active chemicals are the flavonoids. These polyphenols act in ways similar to other compounds containing these constituents.

The flavonoids in green tea are primarily catechins. These chemicals have several actions. First, they inhibit the COX-1 enzyme system, but they may also inhibit the 5-lipox enzyme system and the production of pro-inflammatory leukotriene-B4. Second, they inhibit IL-1 beta induced COX-2 activity and the enzyme responsible for nitric oxide production. Third, they may also protect joint cartilage by decreasing the proteoglycan and collagen damage that occurs from oxidative and mechanical injury. There is also some evidence that green tea flavonoids might inhibit lipoprotein oxidation, thus decreasing the availability of cell membrane fatty acids. This can effectively blunt the pro-inflammatory side of the cascade in cells with a high n-6:n-3 FA ratio in their membranes.

Dosing: standard dosing is based on that typically consumed in Asian countries, about three cups/day; however, one to ten cups/day has been reported.

Any new oral compound can potentially cause adverse reactions so recommendations for the use of botanicals should be in conjunction with a review of medication, medical, and allergy history. These botanicals are generally safe when used in standard doses, but should not be recommended for pregnant or lactating women, as safety testing during these states is inadequate. In general, these botanicals should be monitored in those on anticoagulant or antiplatelet medications.

Mind-Body Therapies

Although this article addresses diet and herbal therapies that may be used to suppress inflammation and chronic pain, it must be mentioned that mind-body therapies have proven useful as well. As mentioned in the inflammatory process section, the inflammatory cascade can occur with real, physical pain as well as with imagined pain or stress. Thus modalities that address the psychological component of pain can be effective. These include aromatherapy massage; imagery, meditation, and cognitive-behavioral therapy; and therapeutic touch. Nutrition professionals should provide not only recommendations for orally consumed products, but also as many options for treatment as possible to a person enduring chronic pain. Referring clients with chronic pain to appropriate mind-body therapy practitioners is warranted.

Take Home Message

As research continues to reveal the fascinating biochemical basis for pain and inflammation, nutrition professionals can convert this scientific knowledge into practical advice for those suffering from chronic pain by making recommendations about dietary manipulations and botanical compounds that positively impact the body’s response to pain and inflammation. Helping clients modify the omega-6:omega-3 fatty acid profile of their diets, decreasing trans fatty acid intake, and increasing antioxidant and flavonoid ingestion may help clients restore some balance in their cellular response to inflammation. Reviewing with them the possible benefits of various dietary supplements and botanicals and recommending mind-body therapies that may enhance function should be a part of what nutrition professionals offer. With a basic understanding of these biochemical pathways and markers, new advances in the efficacy...
of diet and botanicals for managing chronic pain can be incorporated into the nutrition professional’s practice.

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References:


Membership Appreciation & Awards Breakfast, Sunday, October 23, 7am-8:30am, Renaissance Grand, Majestic D, Breakfast with Douglas A. Balentine, PhD. Flavonoids: Food & Beverage Sources and New Research Perspectives about their Unique Health Benefits Recognized by academics and government agencies as a global expert on tea chemistry and the health benefits of teas and dietary flavanoids, Dr. Balentine is currently leader of the Health and Wellness Technology Group and the Unilever Health Institute. Sponsored by Lipton.

NCC Member Networking Reception, Sunday, October 23, 6:30pm-8:30pm, Renaissance Grand, Crystal Ballroom. Join your NCC colleagues for an evening of light hors d’oeuvres and live jazz. Be sure to introduce yourself to your executive committee and become involved in the fastest growing DPG. In partnership with Dietitians in Business & Communications DPG. Sponsored by Prothera, Kyowa-Hakko, and Pharmavite.

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NCC SPONSORED PRESENTATIONS:

October 24 – Nutritional Neuroscience: Having a Positive Impact on ADHD and Autism Jeff Bradstreet, MD and Victoria Kobliner, MS, RD Identify specific genetic polymorphisms and resultant metabolic disorders related in children with ADD, ADHD, and Autism Spectrum Disorders. Recommend appropriate interventions based on nutritional deficiencies or malregulations that result from biochemical/psychological defects.

October 25 – Teas: Traditional Beverages or Functional Foods? Cynthia Thomson PhD, RD, FADA and Jeffrey Blumberg PhD, FACN Characterize the pattern of beverage consumption and associated nutrient intakes in the United States. Define and identify the principle phytochemical components of various teas and tisanes (herb teas). Suggest a role to reduce the risk for cancer and cardiovascular disease by explaining the research approaches.
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**Modulating Chronic Pain: The Role of Nutrition and Botanicals**

**CPE Questions:**

1. True/False: Individual pain perception is influenced by physiological and psychological factors.

2. Which eicosanoid series is anti-inflammatory?
   - A. Series 2 and Series 3  
   - B. Series 1
   - C. Series 1 and Series 2  
   - D. Series 1 and Series 3

3. Which dietary oil is an excellent source of alphalinolenic acid?
   - A. Olive oil  
   - B. Corn oil  
   - C. Black currant oil  
   - D. Flaxseed oil  
   - E. Fish oil

4. Which pathway describes the pain signaling process?
   - A. Pain stimuli→afferent nerves→brain→afferent nerves→nociceceptor

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**Congratulations to the following NCC Award Winners**

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**Rosalyn Franta Kulik, MS, RD**

**For Excellence in Practice Award**

**Dave Grotto, RD, LDN**

Thank you from all of us for your countless hours and dedication to making NCC the exemplary DPG that it is today.
B. Pain stimuli → nociceptor → afferent nerves → brain → efferent nerves → nociceptor → reaction to stimuli

C. Pain stimuli → nociceptor → afferent nerves → brain → afferent nerves → nociceptor → reaction to stimuli

5. Which foods are rich sources of omega-3 fatty acids?
   A. Corn oil, pork loin, chicken breast, cheese
   B. Apples, evening primrose oil, olive oil, garlic, onions
   C. Halibut, salmon, walnuts, flaxseed

6. A common concern in using botanicals to attenuate the inflammatory cascade/response is the potential interaction with OTC and prescriptive medications. Which drug class poses the greatest concern:
   A. Hormone replacement therapy
   B. Anti-neoplastics
   C. Anti-coagulants/anti-platelets
   D. Anti-psychotics

7. Which botanical preparations facilitate modulation of pain?
   A. Aspirin, NSAIDS, soybeans, fish
   B. Apples, pineapples, soy products, glucosamine chondroitin
   C. Licorice, feverfew, white willow, Indian frankincense

8. Other than dietary manipulation and the safe integration of herbs/botanicals what other non-pharmacological interventions might a clinician suggest?
   A. NSAIDS  B. Acupuncture  C. Aromatherapy
   D. Massage  E. Meditation  F. Mediterranean diet

Questions 9 and 10 are based on the following patient scenario:

A working mother of 3 teenagers presents to your clinic complaining of chronic pain. She states that she has no time to cook; and even if she did it would be a waste of time because her teenagers will not eat what she prepares. She tells you that her mornings are much too rushed to fix breakfast and if she eats at all it is from the kiosk vendor in the building lobby or fast food. In taking her food history her 24-hour recall includes the following: coffee with non-dairy powdered creamer, whole grain bagel, grilled chicken salad with cheese and ranch dressing, granola bar for a snack, and a fast food burger no bun and diet cola for dinner.

9. True/False: Her diet may be exacerbating the pain experience/response.

10. Which breakfast(s) will provide her with nutritional components to modulate pain while simultaneously meeting her “need” to “grab-n-go”?
   A. Single serve carton of milk, breakfast cereal bar
   B. Blueberry pancakes topped with fresh blueberries and hot green tea?
   C. Single serve carton of soymilk, apple, handful of walnuts.

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