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The effects of super-fruits including Montmorency tart cherries and pomegranate on the human body: A literature review

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THE EFFECTS OF SUPER-FRUITS INCLUDING MONTMORENCY TART CHERRIES AND POMEGRANATE ON THE HUMAN BODY: A LITERATURE REVIEW

By

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Abstract

This literature review explores several published articles that report results related to health benefits of super-fruits including Montmorency tart cherries and pomegranate. Research suggests that Montmorency tart cherry supplementation may have the ability to relieve pain by decreasing inflammation, prevent gout flare ups by reducing uric acid levels in the bloodstream, relieve insomnia with natural exogenous melatonin, and lessen symptoms of muscle damage from physical exertion by decreasing oxidative stress. Studies have also shown that pomegranate supplementation may have the ability to help prevent obesity by helping to decrease body weight and fat production and improving insulin sensitivity as well as reducing the risk for heart disease by preventing low density lipoproteins from accumulating and causing atherosclerosis. Studies also claim that pomegranate can be beneficial in treating gastrointestinal ailments, cancer prevention, wound healing. The following literature review will delve deeper into the mechanisms by which Montmorency tart cherries and pomegranate affect the human body.

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The Effects of Super-fruits Including Montmorency Tart Cherries and Pomegranate on the Human Body: A Literature Review

Introduction

I grew up in a small town just north of Traverse City, Michigan, the Cherry Capital of the World. I worked in the cherry industry all through high school and most of college, where I constantly heard testimony as to the healing power of the Montmorency tart cherries. The company I worked for sold large quantities of Montmorency tart cherry juice concentrate, tart cherry capsules, and other cherry products and supplements. They proudly displayed posters and brochures with known health benefits of cherries, but were told that they could no longer make these claims because dietary supplements such as tart cherries, have not been studied enough to be approved by the United States Food and Drug Administration (FDA). Still, I continued to hear stories from people, who would come in to the office or call to order their supply of Montmorency tart cherry supplements, about how taking the tart cherry supplement helped to alleviate their joint pain related to arthritis, held off gout flares, aided in recovery after exercise, and several other benefits. Though cherries are full of antioxidants and are certainly nutritionally beneficial, based on these recurrent personal testimonies, I hypothesize that there is more to Montmorency tart cherries than the fact that they are a delicious, healthy snack. I started exploring research articles regarding health benefits of Montmorency tart cherries and found that many of the benefits of tart cherries were compared with the benefits of pomegranate.

The following, in-depth literature review, will discuss the health benefits of super-fruits focusing on Montmorency tart cherries and pomegranate. A few benefits that I have discovered through my research include the ability of Montmorency tart cherries to decrease inflammation, lower uric acid levels, promote sleep, and aid in the preparation for and recovery after physical

exertion. The following will delve deeper into the benefits by applying knowledge of pathophysiology of ailments, such as pain from inflammation, gout from increased uric acid levels, insomnia related to low melatonin, and muscle damage related to physical exertion due to the process of oxidative stress. I will delve deeper into the previously mentioned areas, and more, to explore what components of superfruits, such as Montmorency tart cherries and pomegranate, are beneficial to the human body.

Montmorency Tart Cherries

Montmorency tart cherries (*Prunus cerasus*) can be found in many forms: fresh, frozen, dried, canned, concentrate, capsule and more. The most well known of these are the Montmorency tart cherries used in cherry pie, however in recent years there has been a dramatic rise in the popularity of Montmorency tart cherries in the form of dietary supplements. Many people swear by the healing affects of these ruby-red fruits and studies have shown that the use of these supplements may be beneficial in promoting sleep regulation, relieving joint pain and inflammation, gout prophylaxis, recovery after strenuous exercise, and more. The following will discuss these health benefits in more detail.

Gout

Gout is characterized as an extremely painful and complex inflammatory arthritis caused by the crystallization of uric acid in the joints (Zhang, Neogi, Chen, Chaisson, Hunter, and Choi, 2012). Gout often presents with sudden, severe attacks of pain, redness, and tenderness in the joints and often manifests first at the base of the big toe (Mayo Clinic, 2016). This systemic disease results in pain and inflammation in joints and tissues where deposits of uric acid crystals are present (Ignatavicius & Workman, 2013). According to Ignatavicus and Workman (2013)

gout effects an estimated six million people in the United States. It can effect anyone, but is most common in men and postmenopausal women (Mayo Clinic, 2016).

There are two major types of gout: primary and secondary. Primary gout is often idiopathic and results from an inborn error of purine metabolism, in which the end product is uric acid (Ignatavicius and Workman, 2013). The human body produces uric acid when it breaks down purines, which are naturally occurring in the body, but can also be found in certain foods such as steak, organ meats, seafood, alcoholic beverages, and drinks sweetened with fructose (Mayo Clinic, 2016). Secondary gout involves hyperuricemia, which can be caused by multiple myeloma and certain carcinomas (Ignatavicius and Workman, 2013). Gout results when the production of uric acid exceeds the excretion capability of the kidneys and builds up in the joints and tissues leading to painful, joint inflammation and sometimes kidney stones (Ignatavicius and Workman, 2013). Normally, uric acid dissolves in the blood, is filtered through the kidneys, and is excreted in the urine, but sometimes the body produces too much uric acid or the kidneys are not able to excrete enough uric acid which can cause a build-up of urate crystals in the joints and tissues, eventually resulting in a gout flare-up (Mayo Clinic, 2016).

It is estimated that approximately 3.9% of adult Americans have gout. This percentage translates to approximately 8.3 million American adults. Gout develops more commonly in men between the ages of 30 and 50 and later effects women post menopause. This is due to the fact that men have naturally higher uric acid levels, but after menopause women's uric acid levels increase to levels similar to men (Mayo Clinic, 2016). The prevalence of gout appears to have risen considerably over the past 40 years.

There are many factors that can partially account for this increase in prevalence, including the overall rise in body mass index (BMI) of Americans and several related chronic

medical disorders (Gelber and Solomon, 2012). Individuals who are overweight produce more uric acid and their kidneys have to work harder to eliminate that uric acid build up, putting people who are overweight at a higher risk for developing gout (Mayo Clinic, 2016). The average American diet can be unhealthy and is often very high in sugar. Fructose, a sugar derived from fruit, is the main sweetener used in beverages such as juice, soda, sports drinks and more which are consumed in excess by the American population. According to the Centers for Disease Control and Prevention (CDC) approximately half of the United States population age two and older consumes sugary drinks, which include fruit drinks, sodas, energy drinks, sports drinks, and sweetened bottled water, on a given day. This number is lower for adult women, with 40% consuming sugary drinks daily, while 70% of boys age two to nineteen consume sugary drinks daily (Centers for Disease Control and Prevention, 2011). As previously mentioned, the consumption of fructose which is high in purines, leads to an increase in uric acid production in response to the purine metabolism and thus results in gout flare-ups. According to the National Institute on Alcohol Abuse and Alcoholism (2016) 87.6% of Americans age 18 and older report consumption of alcohol at some point in their life time; 71% report use of alcohol in the past year and 56.9% of people report drinking alcohol in the past month. Alcohol, especially beer, which is consumed by many Americans, is also high in purines and causes the same response to the purine metabolism as fructose. The American lifestyle often leads to obesity, which is associated with many co-morbid health conditions and puts a person at risk for a multitude of complications including, but not limited to, gout flare ups. Certain medical conditions left untreated such as hypertension and chronic conditions such as diabetes, metabolic syndrome, heart disease, and kidney disease can be related to obesity and can put a person at an increased risk of developing gout. Certain medications such as thiazide diuretics, which are used to treat hypertension, and

low-dose aspirin also cause in increase in purines in the body putting the person at risk (Mayo Clinic, 2016).

In addition to these, the frequency of gout has increased significantly in women, especially after menopause (Gelber and Solomon, 2012). I propose that since gout seems to occur in postmenopausal women, one reason for the increase in incidence is the increasing age of the American population. The average lifespan has increased, amplifying the frequency of postmenopausal women and thus increasing the frequency of gout occurrences in the American population.

Traditional drug therapy for gout includes colchicine, allopurinol, or probenecid in combination with nonsteroidal anti-inflammatory drugs (NSAIDs) as well as corticosteroids and adrenocorticotropic hormone (Gelber and Solomon). Many NSAIDs including ibuprofen (Advil, Motrin IB) and naproxen sodium (Aleve) are available over the counter and more powerful prescription NSAIDs such as indomethacin (Indocin) and celecoxib (Celebrex) are sometimes prescribed to treat an acute gout attack. NSAIDs work to decrease inflammation and therefore pain related to gout, but do carry the risk of stomach pain, bleeding, and ulcers (Mayo Clinic, 2016). In addition to the previously mentioned side effects, NSAIDs carry the risk for moderate to severe noncardiogenic pulmonary edema, dyspepsia, heartburn, epigastric distress, nausea, vomiting, anorexia, abdominal pain, gastrointestinal bleeding, mucosal lesions, altered hemostasis through effects of platelet function, acute reversible hepatotoxicity, reduction in creatinine clearance, acute tubular necrosis with renal failure, skin eruption, sensitivity reactions, tinnitus, and hearing loss (Lilley, Collins, and Snyder, 2014).

Colchicine (Colcrys, Mitigare) is considered a second-line therapy after NSAIDs (Lilley et al., 2014) and is often used to treat pain related to gout during an acute attack and is

sometimes prescribed in the form of a low daily dose to prevent future gout attacks (Mayo Clinic, 2016). Though colchicine has proven effective in treating acute attacks of gout and gout prophylaxis it carries with it unpleasant side effects including nausea, vomiting, and diarrhea (Mayo Clinic, 2016) and can cause bleeding in the gastrointestinal and urinary tracts (Lilley et al., 2014). If a person cannot take NSAIDs or colchicine (Colcrys, Mitigare) then oral or injectable corticosteroids such as prednisone, may be prescribed to help control gout inflammation and related pain. Side effects of corticosteroids include changes in mood, increased blood sugar levels, and elevated blood pressure (Mayo Clinic, 2016). Long-term management of gout may include a prescription for a xanthine oxidase inhibitor such as allopurinol (Aloprim, Lopurin, Zyloprim) or febuxostat (Uloric). These xanthine oxidase inhibitors may help to lower the uric acid level in the blood and therefore reduce the incidence of gout attacks, but come with side effects including rash, low blood counts, nausea, and decreased liver function (Mayo Clinic, 2016). The significant side effects of allopurinol include agranulocytosis, aplastic anemia, and serious and potentially fatal skin conditions including exfoliative dermatitis, Stevens-Johnson syndrome, and toxic epidermal necrolysis (Lilley et al., 2014). Probenecid (Probalan) may also be prescribed to improve the kidney's ability to filter and remove uric acid from the bloodstream. Probenecid, however increases the concentration of uric acid in the urine and can cause kidney stones. Other side effects include rash and stomach pain (Mayo Clinic, 2016).

In recent years, the Montmorency tart cherries have gained considerable public attention as a potentially effective alternative method for treating gout. Experimental studies, using healthy human subjects as well as animals, have concluded that cherry consumption lowers uric acid levels (Zhang et al., 2012). Since the consumption of cherries has been shown to lower uric acid levels it only makes sense that these lower levels would decrease the incidence of gout since

gout is caused by an excess of uric acid. The exact method by which the tart cherries prevent gout attacks remains somewhat unclear, but a strong correlation between Montmorency tart cherry consumption and decreased gout attacks certainly exists. One suggestion for why this association exists is that cherries are known to contain anti-inflammatory properties, which may be useful in treating inflammation from an acute gout flare up and for prophylaxis of gout (Schlesinger, N., Schlesinger, M., and Jersalem, n.d.) and as previously stated, the decrease in uric acid associated with tart cherries may also play a role in gout prophylaxis.

An article by Zhang et al. (2012) sought to investigate the relationship between cherry intake and the risk of recurrent gout attacks among individuals with gout. Since there are no known studies that have actually assessed whether the consumption of cherries and cherry supplements truly lowers the risk of acute gout attacks and a lack of sufficient data regarding the disease-related benefits of cherry products, Zhang et al. (2012) sought to address this knowledge gap, by conducting a study specifically pertaining to gout. The study analyzed 633 people with gout who were recruited via the internet from all across the United States. Using a case-crossover design, the study sought to quantify the relative risk of a gout attack after cherry intake compared with those who had no cherry intake and the potential modification by allopurinol use and other major gout risk factors (Zhang et al., 2012). The 633 individuals were recruited by clicking on a study advertisement when they used Google to search for the term "gout". In order to be considered eligible for the study participants were required to report gout diagnosed by a physician, have had a gout attack within the past 12 months, be at least 18 years of age, reside in the United States, agree to release medical records pertaining to their gout diagnosis and treatment, and to provide electronic informed consent (Zhang et al., 2012). Medical records were obtained and analyzed to determine if the diagnosis of gout was made in accordance to the

features listed by the American College of Rheumatology. In order to assess other risk factors within the two day period leading up to the gout attack, participants were assessed for dietary factors, alcohol use, infections, immunizations, physical activity, geographic location, anti-gout medications, and use of alternative remedies such as cherry consumption (Zhang et al., 2012). In order to determine a potential dose-response relationship with the risk of gout attacks, Zhang et al. (2012) examined cherry intake over the two days prior to the gout attacks and grouped the individuals into five categories based on their intake of zero, one, two, three, or four or more servings of cherries per day. The individuals were also categorized based on subgroup effects of cherry or cherry extract intake according to sex, body mass index (<30kg/m2 versus ≥30kg/m2), purine intake (≤1.7 gm versus >1.7 gm), alcohol use, and treatment with diuretics, allopurinol, colchicine, and NSAIDs over the two days prior to the attack (Zhang et al., 2012). It may have been beneficial for the study to further break down the BMI measurement into underweight (less than 18.5), normal healthy weight (18.5-24.9), overweight (25-29.9), and obese (30 and above) rather than just examining whether the patient was obese or not since individuals who are overweight produce more uric acid and are at a higher risk for developing gout.

In the two days prior to the gout attacks (the hazard period) the study found that approximately 61% of the participants consumed alcohol, 29% used diuretics, 45% used allopurinol, 54% used NSAIDs, and 25% used colchicine (Zhang et al., 2012). Of the 633 individuals 224 (35%) reported consuming fresh cherry fruit only, 15 (2%) reported consuming cherry extract only, and 33 (5%) reported consuming both fresh cherry fruit and cherry extract during the hazard period. The cherry intake over the two day period was associated with a 35% decrease in recurrent gout attacks in comparison to individuals who did not have any cherry intake (Zhang et al., 2012). The risk of recurrent gout attacks was shown to decrease up to 45%

with increasing cherry consumption over the two days, but intake of more than four servings of cherries over the two day period did not show any additional risk reduction (Zhang et al., 2012). According to Zhang et al. (2012) there did not appear to be a correlation between NSAID use and recurrent gout attacks, but increases in alcohol consumption, purine intake, and use of diuretics were associated with a higher risk of recurrent gout attacks. As previously mentioned alcohol, organ meats, seafood, and anything sweetened with fructose is high in purines and the byproduct of purine metabolism is uric acid, which in excess, can lead to a gout flare up. Diuretics can also cause an increase in uric acid levels leading to an acute gout flare.

Zhang et al. (2012) also found that the positive effects of cherry consumption on recurrent gout attacks tended to be stronger when cherries were consumed during periods of higher purine intake and when diuretics, alcohol, and NSAIDs were not used. Ray Pleva of Pleva's meats patented his Plevalean burger in 1995 that combines Montmorency tart cherries with 91% lean ground beef (Pleva's Meats, n.d.). Is it possible that substituting a Plevalean burger, which contains Montmorency tart cherries, for a regular burger could be a small dietary change that could potentially help people who have had a previous gout flare or have risk factors for developing gout decrease their risk for a recurrent gout attack? As previously mentioned, Zhang et al. (2012) found a correlation between consumption of Montmorency tart cherries during periods of high purine intake, from foods such as red meat, and a decreased incidence of recurrent gout attacks. If this is true then wouldn't consuming tart cherries when consuming meat have a chance at decreasing a person's risk for a gout flare related to the purine component in the meat? Consuming a Plevalean burger in place of a typical hamburger may not only be a tasty alternative, but it is lower in fat, calories, sodium, and cholesterol making it a healthier option for people who are overweight. Recall that obesity plays a role in gout as well because a person who

is overweight produces more uric acid in their body and their kidneys have to work harder to eliminate the uric acid, placing a person who is overweight at an increased risk for a gout flare.

One very significant finding by Zhang et al. (2012) was the correlation between cherry intake combined with allopurinol use; recurrent gout attacks were reduced by 75%. Allopurinol, a xanthine oxidase inhibitor helps to lower the uric acid level in the blood and therefore reduce the incidence of gout attacks (Mayo Clinic, 2015). Studies also suggest that the consumption of Montmorency tart cherries also contributes to lowering uric acid levels in the body. This suggests that combination therapy with allopurinol and cherry supplements could be highly effective in reducing the risk for recurrent gout attacks.

Research suggests that Montmorency tart cherry supplementation may be beneficial in treating inflammation related to gout as well as lowering uric acid levels in order to prevent future gout flare-ups. As discussed above, there are several drugs available to treat the symptoms of gout and to help prevent future flares, but most medications come with several potential side effects. Though consuming Montmorency tart cherry supplements can lead to some gastric upset and/or diarrhea related to the rich fruit ingestion, the known side effects are much more mild in this natural supplement than a prescription medication. Montmorency tart cherry supplements have the greatest effect when they are paired with other antigout medications, such as allopurinol. Though there are known, effective gout treatments, prevention is always preferred to subsequent treatment, therefore supplementing Montmorency tart cherry products may be a preferred method for gout prophylaxis. In nursing, and healthcare in general, the least invasive and lower risk method is preferred. This includes trying diet and lifestyle changes when applicable and possibly Montmorency tart cherry supplementation before moving on to higher risk methods of treatment, such as prescription gout medication.

Inflammation and Muscle Damage

Muscle damage, inflammation and oxidative stress typically occur after strenuous exercise, such as long-distance running (Howatson, G., McHugh, Hill, Brouner, Jewell, VanSomeren, Shave, and Howatson, S., 2010). It is not uncommon to hear a person refer to "feeling the burn" during intense exercise. The "burn" is caused by lactic acid build up in the muscle tissue (Potter, Perry, Stockert, and Hall, 2013a). This lactic acid is produced via an anaerobic process called glycolysis. During the process of glycolysis, one molecule of glucose is broken down in to two pyruvic acid molecules, releasing energy to produce two adenosine triphosphate (ATP) molecules. Normally the pyruvic acid molecules would combine with oxygen to produce many more ATP molecules using the aerobic pathway, but when muscles contract vigorously and contractile activity reaches nearly 70% of the maximum possible contraction, the bulging muscles compress the blood vessels and therefore inhibit oxygen flow, thus activating the anaerobic pathway (Marieb and Hoehn, 2013). Under anaerobic conditions, most of the pyruvic acid molecules are converted into lactic acid which diffuses out of the muscles and into the bloodstream (Marieb and Hoehn, 2013).

Often times when a person is not used to a particular type of exercise, or the exercise intensity, he/she may feel sore for a few days following the initial workout. This soreness is often related to inflammation caused by micro tears in the muscle tissue. The five cardinal signs of inflammation are redness, swelling, heat, pain, and sometimes loss of function (Potter et al., 2013a). Inflammation can occur for a number of reasons. It is a non-specific response to injury that serves to destroy, dilute, or contain a harmful agent or damaged tissue (LeMone, Burke, Bauldoff, and Gubrud, 2015b). Acute inflammation occurs in response to strenuous exercise. Regardless of the cause, location, or extent of the injury the acute inflammatory response occurs

in the sequence of vascular response, cellular and phagocytic response, and healing. Inflammatory mediators, such as histamine and prostaglandins, are released in response to tissue injury. Manifestations of inflammation include erythema, localized heat caused by increased blood flow to injured area, swelling due to accumulated fluid secondary to vasodilation, pain from the swelling and chemical irritation of the nerve endings from prostaglandins and kinins, and loss of function related to swelling and pain (LeMone et al., 2015b). The degree to which the previously mentioned symptoms are experienced depends upon the degree of the injury.

Research suggests that Montmorency tart cherry juice may be a viable aid in recovery, following strenuous exercise, by increasing total antioxidative capacity, reducing inflammation, lipid peroxidation, and recovery of muscle function (Howatson et al., 2010). An article by Howatson et al. (2010) investigated the influence of tart cherry juice on recovery following a marathon. Muscle damage, inflammation, and oxidative stress typically occur with long-distance running, such as marathons (Howatson et al., 2010).

There have been several studies about antioxidant containing dietary supplements and their effect on muscle damage, inflammation, and oxidative stress. It is the goal that the antioxidant supplementation will help boost the body's defenses against oxidative stress and inflammation, which can occur from heavy exercise (Howatson et al., 2010). The researchers hypothesized that tart cherry juice intake during the days leading up to the marathon and the 48 hours following the marathon would reduce muscle damage, inflammation, and oxidative stress (Howatson et al., 2010).

During the study, 20 marathon runners were assigned to either consume Montmorency tart cherry juice or a placebo for the five days before, the day of, and the 48 hours following the marathon (Howatson et al., 2010). Indicators of muscle damage (creatine kinase, lactate

dehydrgenase, muscle soreness, and isometric strength), inflammation (interleukin-6, C-reactive protein, and uric acid), total antioxidant status, and oxidative stress (thiobarbuturic acid reactive species and protein carbonyls) were collected and analyzed before and after the race.

Howatson et al. (2010) found that runners recovered isometric strength significantly faster with the intake of Montmorency tart cherry juice compared to those who did not have any tart cherry intake. There did not seem to be any significant difference between the two groups when it came to damage indices, however the athletes who consumed the Montmorency tart cherry juice seemed to recover faster from the damage than those who did not consume the Montmorency tart cherry juice. The study found that there was correlation between Montmorency tart cherry juice consumption and inflammation, total antioxidant status, and oxidative stress. Inflammation was reduced in the group of individuals consuming Montmorency tart cherry juice (Howatson et al., 2010). Total antioxidant status was approximately 10% greater in the group consuming Montmorency tart cherry juice (Howatson et al, 2010). In terms of oxidative stress, protein carbonyls did not change in relation to cherry consumption, but thiobarbituric acid reactive substances (TBARS) were lower in the tart cherry juice group than the placebo group, indicating a decrease in lipid peroxidation (Howatson et al., 2010).

With these findings one can conclude that tart cherry juice consumption appears to provide viable means to aid in recovery following strenuous exercise by increasing total antioxidative capacity, reducing inflammation and lipid peroxidation, and aiding in the recovery of muscle function (Howatson et al., 2010).

A study by Connolly, McHugh, and Padilla-Zakour (2006) sought to determine the efficacy of tart cherry juice consumption in reducing symptoms of muscle damage. Considering the antioxidant and anti-inflammatory properties of tart cherries, Connolly et al. (2006)

hypothesized that consumption of tart cherries prior to eccentric exercise would have a protective effect. This particular trial followed a randomized crossover design and consisted of 16 men ranging in age from 18 to 26 years, who volunteered to participate. Four days before the eccentric exercise activity, participants engaged in baseline testing which included assessment of pain, muscle tenderness, relaxed elbow angle, and isometric elbow flexion and strength. After the baseline data collection, participants were given 12 ounce bottles of either the tart cherry juice or the placebo and were instructed to drink one bottle in the morning and one bottle in the evening for the next eight days. On the fourth day, participants performed a bout of eccentric elbow flexion contractions. The exercise regimen was used to induce delayed onset muscle soreness and consisted of 40 maximal eccentric contractions of the elbow flexors using a modified preacher curl apparatus (Connolly et al., 2006).

Over the following four days pain, muscle tenderness, relaxed elbow angle, and strength were assessed. Pain was measured by asking participants to verbally rate their overall pain during active elbow flexion and extension with everyday activities using a scale of zero to ten (zero indicating no pain and ten indicating extreme pain). Muscle tenderness scores were assessed through the use of a standard manual muscle myometer. Force was applied proximal to the distal tendon of the biceps brachii via the myometer probe until the participant indicated pain. In order to assess elbow range of motion, a standard plastic goniometer was used while the subject was standing. Two trials were conducted at 130 degrees, 90 degrees, and 30 degrees to measure isometric elbow flexion strength (Connolly et al., 2006).

Connolly et al. (2006) found that isometric elbow flexion strength loss was significantly greater in the group of men who consumed the placebo than those who consumed the tart cherry concentrate. Strength loss over the four days after the trial was 22% for the group who consumed

the placebo and only 4% for those who consumed the tart cherry juice. Pain reports also tended to be much higher in the placebo group than the tart cherry juice group. Pain peaked at 24 hours for the tart cherry juice group and then declined, but for the placebo group the pain continued to increase after 24 hours and peaked at 48 hours (Connolly et al., 2006). Connolly et al. (2006) suggests that though range of motion loss and muscle tenderness appeared to be unaffected by the tart cherry juice, consumption of tart cherry juice for three days before and for the four days after a bout of eccentric exercise can significantly decrease some of the symptoms of muscle damage, including pain and strength loss.

Though the study by Connolly et al. (2006) produced promising results, it is not possible to conclude that the tart cherry juice consumption really did prevent muscle damage because only two of the four markers of muscle damage were affected by the consumption of tart cherry juice. Though there is clearly a preservation of muscle function and a decrease in symptoms of muscle damage attributable to the consumption of tart cherry juice, the sample size was small and should be studied on a larger scale to produce stronger, more definitive results.

Using a crossover experimental design, a study by Bowtell, Sumners, Dyer, Fox, and Mileva (2011) sought to investigate whether consumption of Montmorency tart cherry juice concentrate would affect muscle function and damage from intensive unilateral leg exercise as well as oxidative damage. Participants included ten well-trained males, all of who competed in high-intensity intermittent sports such as football, rugby, and/or taekwondo (Bowtell et al., 2011). The participants completed two main trials which were separated by a two week washout period (Bowtell et al., 2011). Each of the participants consumed either 30 milliliters of Montmorency tart cherry juice concentrate or an isoenergetic fruit concentrate placebo (Bowtell et al., 2011). While consuming the Montmorency tart cherry juice concentrate or the placebo,

participants were instructed to continue with their normal training activities for the first five days of the cycle, but to refrain from participating in strenuous exercise for 48 hours before and after the intensive exercise test (Bowtell et al., 2011). On the day of the intensive exercise test, a blood sample of 10 milliliters was withdrawn and analyzed for creatine kinase, high sensitivity C-reactive protein, total nitrotyrosine, protein carbonyls, and total antioxidant capacity (Bowtell et al., 2011). After obtaining the blood sample, the participants were seated at a knee extension machine, which measured the maximum amount of weight they were able to lift as well as their pressure pain threshold over the vastus lateralis, rectus femoris, and vastus medialis muscles (Bowtell et al, 2011).

The main finding of the study was that knee extensor recovery and maximum isometric strength was enhanced with the consumption of Montmorency tart cherry juice concentrate for seven days prior to and two days after extensive resistance training (Bowtell et al, 2011). Protein carbonyls were also decreased with the Montmorency tart cherry juice consumption, indicating that oxidative damage was reduced (Bowtell et al, 2011). The study did not find any significant data to indicate that other markers of muscle damage, inflammation, muscle soreness, or pressure pain threshold were reduced with cherry consumption (Bowtell et al, 2011). Though the study by Bowtell et al. (2011) was fairly small and certainly needs further investigation on a larger scale to determine true statistical significance, it is a good pilot study to begin noticing trends related to consumption of Montmorency tart cherry concentrate and oxidative damage related to physical exertion. Perhaps a larger study of this nature would provide further insight as to the significance of consuming Montmorency tart cherry concentrate in order to decrease the degree of muscle damage, inflammation, or muscle soreness from physical exertion.

Long distance running causes acute muscle damage and subsequent pain, inflammation, and decreased force production (Kuehl, Perrier, Elliot, and Chesnutt, 2010). Many endurance athletes and long distance runners rely on NSAIDs to reduce pain and inflammation during intense periods of exercise, however NSAIDs carry side effects that can affect the gastrointestinal, renal, and cardiovascular systems. Tart cherries are considered a good source of phenolic compounds with high levels of antioxidant and anti-inflammatory activity (Kuehl et al., 2010). A study by Kuehl et al. (2010) suggests that since tart cherries contain natural antioxidants and anti-inflammatory properties, consumption of tart cherries before and during strenuous exercise may have a protective effect that will reduce muscle damage and subsequent pain. Consumption of approximately 45 tart cherries per day has been shown to reduce circulating concentrations of inflammatory markers in healthy men and women (Kuehl et al., 2010) and may be a viable alternative to the use of NSAIDs for endurance athletes.

Using a randomized, double-blind, placebo controlled trial, Kuehl et al. (2010) examined the effects of tart cherry juice consumption and the placebo on 54 healthy runners who were competing in the Oregon Hood to Coast relay race. The race consists of teams of 12 runners who each run three race segments totaling 22.5 to 31.4 kilometers individually and 315 kilometers collectively as a team. The race crosses two mountain ranges and the hilly terrain provides ample opportunity for eccentric muscle damage. The purpose of the study was to assess the effects of tart cherry juice in comparison to a placebo cherry drink on muscle pain among the Oregon Hood to Coast runners. In order for the athletes to be included in the study, they were required to abstain from the use of anti-inflammatory or pain relieving medications as well as refrain from seeking alternative treatments for symptoms of muscle damage until the study was completed (Kuehl et al., 2010).

Each study participant was given sixteen 355 milliliter bottles of tart cherry juice and instructions to consume two bottles daily for seven days before the race and two bottles during the race. To avoid cross contamination from teammates switching bottles accidentally or on purpose, subjects on the same team were given the same type of drink (either tart cherry juice or placebo). In order to establish a baseline, each subject was assessed by a physician seven days prior to the race, before starting to consume the tart cherry juice or placebo drink. Baseline assessment included using the Visual Analog Scale (VAS) to assess pain intensity. On the VAS pain scale a score of zero indicated no pain and a score of 100 indicated most severe pain (Kuehl et al., 2010). The VAS scale was completed again on the day of the race before beginning. After completion of the race participants completed the VAS again and also completed a questionnaire regarding their level of satisfaction with the drink and their willingness to use the drink again in the future (Kuehl et al., 2010).

Despite the fact that the participants were randomized into treatment groups, the group assigned to the tart cherry juice reported pain scores that were significantly higher than the placebo group on day one. At the race start however, there were no significant differences in the mean VAS score between the two treatment groups. Upon completion of the race, participants in both treatment groups reported increased pain, however the group that consumed the tart cherry juice reported that the increase in pain was significantly less than the placebo group. Participants who consumed the tart cherry juice reported higher satisfaction with the drink overall, higher satisfaction with the pain reduction that they attributed to the drink, and greater willingness to use the drink again (Kuehl et al., 2010).

The pain that is associated with acute muscle injuries is most likely due to oxidative tissue damage which leads to an inflammatory response that causes further production of the free

radicals that cause muscle soreness (Kuehl et al., 2010). The significant findings that post race pain level was reduced with the consumption of tart cherry juice for seven days prior to and the day of strenuous exercise suggests that the tart cherry juice provided some type of protective benefit against the acute muscle pain that is caused by strenuous exercise such as long distance running. In previous studies consumption of approximately 45 tart cherries per day has been shown to reduce circulating markers of inflammation in healthy men and women. The 355 milliliter bottles of cherry juice, used for the study by Kuehl et al. (2010), contained approximately 90-100 tart cherries in each bottle, which should be more than enough to achieve a therapeutic effect. Though pain is very subjective, the VAS scale is a reliable method of assessing pain and is used frequently in the clinical setting. The study by Kuehl et al. (2010) suggests that consumption of tart cherry juice for seven days before and the day of strenuous exercise can reduce the symptoms of exercise induced, acute muscle pain.

Bell, Walshe, Davison, Stevenson, and Howatson (2014) sought to determine the effects of Montmorency tart cherry supplementation on oxidative stress and inflammatory responses to repeated days of high-intensity stochastic cycling. The study examined the impact of Montmorency tart cherry concentrate on the physiological indices of oxidative stress, inflammation, and muscle damage across a three day road cycle racing simulation. Bell et al. (2014) were the first researchers to investigate the impact of Montmorency tart cherry concentrate supplementation's effect on systemic inflammatory and oxidative stress induced by a series of metabolically challenging cycling exercises. Using a double-blind independent group design, Bell et al. (2014) divided the sixteen male cyclists, who denied a current smoking habit, food allergies, using other supplements, or a history of cardiovascular, renal, or gastrointestinal disease, into two groups. One group received the Montmorency tart cherry concentrate with

instructions to dilute the supplement in 100 milliliters of water and consume it twice a day at eight am and six pm. Each supplement of Montmorency tart cherry concentrate was the equivalent of approximately 90 whole Montmorency tart cherries. The second group received the placebo and was given the same instructions to dilute the solution in 100 milliliters of water before consuming it twice a day at 8am and 6pm. The supplements were consumed for a period of seven consecutive days, four days before the beginning of the exercise trial and on each of the three trial days (Bell et al., 2014).

Exercise trials took place on consecutive days and began at eight o'clock in the morning following a ten hour overnight fast. The road cycle racing trial was performed using a magnetically braked cycle ergometer and consisted of a prolonged, high-intensity, stochastic performance. Following a self-selected warm up, the trial began and ran for the duration of 109 minutes. During the trial participants' heart rates were monitored using wireless heart telemetry. Water was made available to all participants throughout the trial and they were given strong verbal encouragement (Bell et al., 2014).

Following the trial of intense exercise, venous blood samples were collected via venepuncture to a branch of the basilic vein in the anti-cubital fossa. The blood samples were then analyzed in order to determine level of oxidative stress, inflammatory response, and muscle damage. In order to assess oxidative stress, the blood sample was analyzed for aqueous phase lipid hydroperoxidies. Plasma tumor necrosis factor-alpha, interleukin-1-beta, interleukin-6, and interleukin-8 were analyzed in order to determine inflammatory indices and serum creatinine kinase was examined to determine muscle damage (Bell et al., 2014)

Bell et al. (2014) discovered that the lipid hydroperoxide responses were elevated in the placebo group and were decreased in the Montmorency tart cherry juice concentrate group,

indicating a decrease in oxidative stress for the group who consumed the Montmorency tart cherry concentrate. The pro-inflammatory marker, interleukin-6 was seen in lower values for the Montmorency tart cherry concentrate group compared to the placebo group, indicating a lesser degree of inflammation in the group receiving the tart cherry supplement. Muscle damage, measured by creatnine kinase, did not display a statistically significant difference between the two groups, indicating that the Montmorency tart cherry concentrate did not have a significant effect on preventing muscle damage. Heart rate analyses of the two groups also did not reveal any statistically significant differences between the two groups across the trial. Subjects who were in the Montmorency tart cherry concentrate group showed no increases in the thiobarbituric acid reactive substances (TBARS), whereas increases in the TBARS at 48 hours post exercise was seen in the placebo group, which indicates that lipid peroxidation occurred in the placebo group (Bell et al., 2014).

Data from the study by Bell et al. (2014) indicates that the supplementation of Montmorency tart cherry concentrate helps to decrease lipid peroxidation and therefore oxidative stress as well as lower the degree of inflammation experienced by cyclists who participate in cumulative bouts of metabolically challenging exercise. Bell et al. (2014) claims that the reduction in both primary and secondary inflammatory responses in the group who consumed Montmorency tart cherry juice concentrate may be related to the effects of reduced cell damage through oxidative stress during strenuous exercise. Bell et al. (2014) states that blunting responses such as oxidative stress and inflammation may positively influence functional performance since oxidative stress and inflammation are linked to damage to cellular structure and function. Since the anti-inflammatory effects of Montmorency tart cherry juice concentrate are so apparent, Bell et al. (2014) suggests that Montmorency tart cherry juice concentrate

supplementation may be beneficial for clinical populations, particularly those who suffer from low-grade chronic inflammation.

There has been growing attention in the area of antioxidant supplementation and its role in aiding the recovery of athletes following strenuous exercise due to the antioxidants' ability to reduce oxidative stress and inflammation that causes damage to the cells. Foods with a high concentration of the flavanoids, anthocyanins may be beneficial for use to aid in recovery after exercise due to their increased capacity for the inhibition of inflammatory cyclooxygenase enzymes and oxidative stress. The anthocyanins, found in Montmorency tart cherries, have been known to have similar anti-inflammatory properties to non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen and naproxen. Due to their high levels of anthocyanins, Montmorency tart cherries may be a good candidate for supplementation for use during recovery following intense exercise (Bell et al., 2014). Exercise that involves maximal exertion and muscle contraction, such as sprinting or weight lifting derives energy primarily through the anaerobic pathway causing a build-up of lactic acid and a higher degree of mechanical stress on the muscle tissue. Endurance exercise however, requires more prolonged energy turnover through the aerobic pathway of glycolysis (Bell et al., 2014). Physical activities, such as running a marathon, exert mechanical stress through eccentric contractions as well as through endurance and long distance running and requires a higher energy expenditure (Bell et al., 2014). A study by Howatson et al. (2010) demonstrated that participants who used the Montmorency tart cherry supplement displayed significantly lower oxidative stress, and significantly lower inflammatory responses following marathon running than the runners who consumed the placebo. Oxidative stress is a form of lipid peroxidation and is evaluated through the level of thiobarbituric acid reactive substances (TBARS) through a blood sample. A lower level of TBARS indicates a

lower level of oxidative stress and lipid peroxidation (Howatson et al., 2010). The inflammatory response is evaluated by examining the levels of interleukin-6 and high sensitivity C-reactive protein (Bell et al., 2014). Levels of interleukin-6 and high sensitivity C-reactive protein are elevated when inflammation is present. Signs of inflammation are redness, swelling, heat, pain, and sometimes loss of function (Potter, Perry, Stockert, and Hall, 2013a) and can be experienced by a person for a variety of reasons, including tissue injury and infection.

As previously discussed, runners and cyclists experienced positive effects related to consuming a Montmorency tart cherry juice supplement. I hypothesize that the positive effects experienced by the runners and cyclists can also be experienced by many other types of athletes, as many types of exercise puts strain on the body and the natural anti-inflammatory and antioxidative properties that exist within Montmorency tart cherries are potentially beneficial to all athletes.

Insomnia

Insomnia is defined as "a condition characterized by chronic inability to sleep or remain asleep through the night" (Potter, Perry, Stockert, and Hall, 2013b, p.225). One risk associated with insomnia is polypharmacy, as many older adults attempt to self-medicate using over the counter medications, with the intent to improve sleep quality and quantity. Polypharmacy occurs when a person takes two or more medications to treat the same illness, two or more medications from the same chemical class, two or more medications with the same or similar actions, or mixes nutritional supplements or herbal products with prescribed medications (Potter et al., 2013b). Sometimes polypharmacy is inevitable, but it should try to be avoided whenever possible. In an effort to evade polypharmacy, it would be beneficial for older adults if there was a safe and effective natural way to treat insomnia. Though there are few studies to date about the

effectiveness of Montmorency tart cherry juice on sleep promotion and regulation, tart cherries are thought to promote sleep due to their relatively high content of melatonin (Pigeon, Carr, Gorman, and Perlis, 2009).

I hypothesize that the consumption of Montmorency tart cherry products will decrease the incidence of recurrent gout attacks, improve and regulate sleep patterns, relieve pain and inflammation associated with gout, arthritis, and muscle damage, and enhance the recovery of individuals following strenuous exercise. The following articles will attempt to discuss and support my hypothesis. Throughout this essay, I will also attempt to expose the strength and limitations of the data. Since the therapeutic effects of Montmorency tart cherries have only begun to gain public attention in recent years, there is little research currently published regarding the effectiveness of the tart cherry supplementation, which calls for further studies.

This research article by Pigeon et al. (2009) investigated the connection between tart cherry juice intake and insomnia in older adults. The study was conducted as a randomized, double-blind, crossover investigation, in which each participant received both the palcebo and the tart cherry juice for two weeks each (Pigeon et al., 2009). The sample population consisted of 15 adults, age 65 and older, who had complained of insomnia, but were otherwise healthy, active, and mentally stable (Pigeon et al., 2009). In order to participate in the trial the participants were required to sign an informed consent agreement and undergo a physical assessment, 12-lead electrocardiogram, clinical laboratory evaluations, structured diagnostic interviews, and a self-report instrument battery (Pigeon et al., 2009). Participants were excused from the trial for any unstable medical or psychiatric illnesses, a positive screen for substance abuse, use of hypnotics or sedating medications, symptoms that suggested sleep disorders aside from insomnia, and any diagnosis of diabetes (Pigeon et al., 2009).

The elderly population was chosen as the main focus of the study based on the high prevalence of insomnia within their age group and the potential benefits of a non-pharmaceutical approach to treatment (Pigeon et al., 2009). Due to the high incidence of polypharmacy in the elderly, an effective non-drug remedy for insomnia may pose many benefits.

Following the screening process, the study was conducted over an eight week period. These eight weeks were broken down into two four week periods in order to allow each participant to receive both the tart cherry juice and the placebo. During week one baseline data was collected. During week two the participants were given either drink A or B, one contained tart cherry juice and the other contained the placebo. During the washout period (week three) no study beverages were given and during week four the participants were given either drink B or A (Pigeon et al., 2009). This process was repeated over the next four week period. Throughout the study the participants were asked to keep a sleep diary, in order to evaluate the perceived effectiveness of the drinks. When the data was analyzed, the study found that the Insomnia Severity Index and the time spent awake after sleep onset were both decreased, with the tart cherry juice consumption (Pigeon et al., 2009). This indicated that the tart cherry juice helped participants stay asleep and wake less frequently once they had fallen asleep. The study also concluded that there was no significant improvements with measures of sleep onset, total sleep time, sleep efficiency, fatigue, depression, or anxiety (Pigeon et al., 2009). Their findings indicated that tart cherry juice consumption helped the elderly participants stay asleep. However, the results did not produce strong evidence to support the idea that tart cherry juice consumption helped participants fall asleep faster than normal or sleep longer than normal. Given that each participant only consumed the tart cherry juice for a total of two weeks, it may be beneficial to further investigate the long term effects of cherry juice on sleep.

The previously mentioned study by Pigeon et al. (2009) indicates some promising subjective effects related to improved sleep quality with the supplementation of Montmorency tart cherry juice, however the study by Howatson, Bell, Tallent, Middleton, McHugh, and Ellis (2012) took the idea a step farther and collected both subjective data though questionnaires and objective data through the use of actigraphy, in order to produce more objective results. Using a randomized, double-blind, placebo-controlled, crossover design, Howatson et al. (2012) investigated the effects of Montmorency tart cherry consumption on sleep quality in 20 healthy volunteers. Participants in the study ranged in age from 18 to 40 years. Adults over the age of 40 were excluded from the study in order to avoid any age-related sleep disturbances that are seen in older people. Contraindications for participating in the study included prescription medications, sleep disturbances, special dietary habits, shift work or underlying medical pathology (Howatson et al., 2012).

Baseline data was collected from participants through urine samples collected over 48 hours in order to ensure that the full circadian rhythm was accounted for. During this baseline period, participants were also asked to complete an online sleep diary regarding their quality of sleep as well as complete a dietary journal in order to ensure that their diet was not influencing the results of the study. Participants were provided with a list of foods known to contain or influence melatonin and were asked to abstain from consuming them. Actigraphy was also initiated during the baseline period (Howatson et al., 2012).

Participants were divided into two groups, one group receiving the Montmorency tart cherry juice concentrate and the other group receiving a placebo drink that did not contain any anthocyanins or melatonin and only a trace of vitamin C. Participants were instructed to mix 30 milliliters of the supplement with approximately 200 milliliters of water and to consume two

servings of the supplement daily for seven days. Sequential urinary voids were collected for 48 hour segments, during each segment of the trial, in order to ensure that the entire circadian cycle was captured. Actigraphy was utilized via use of a band that participants wore on their non-dominant arm. Analysis was made via the actigraphy device on sleep efficiency, sleep onset latency, time in bed, fragmentation index, total sleep time, and sleep efficiency total. Though polysomnography offers the most accurate assessment of sleep, due to the nature of the study actigraphy, which has been shown to be reliable and to demonstrate agreement with results of polysomnography, was used. After awakening each day, participants completed online sleep diaries in order measure subjective sleep quality (Howatson et al., 2012).

Howatson et al. (2012) hypothesized that the consumption of Montmorency tart cherry juice concentrate by healthy adults would increase urinary melatonin and improve sleep quality. Baseline data collected before the initiation of supplement consumption showed no differences between the two groups in any of the dependant variable areas. Results after consumption of the Montmorency tart cherry juice concentrate or the placebo indicated that the placebo had no effect, as the data did not change from baseline in the placebo group. The urinary 6-sulphatoxymelatonin levels were significantly increased in the group of individuals who consumed the Montmorency tart cherry juice concentrate, indicating that a rise in urinary melatonin occurred in response to the tart cherry supplementation. Individuals in the Montmorency tart cherry juice concentrate group reported significantly less napping time and improved subjective quality of sleep; actigraphy showed an increase in sleep quality as well in the tart cherry group (Howatson et al, 2012).

Howatson et al. (2012) concluded that their hypothesis was correct and that supplementation of Montmorency tart cherry juice concentrate did increase levels of urinary

melatonin and improve sleep quality. However, an alternate hypothesis does exist and suggests that the anti-inflammatory properties of Montmorency tart cherries may have some influence on pro-inflammatory cytokines which are involved in sleep regulation (Howatson et al., 2012). Perhaps more detailed research into the exact method by which Montmorency tart cherry supplementation influences sleep, will reveal that both of these methods play a role in enhancing sleep regulation. Montmorency tart cherries are known to contain high levels of melatonin, which has a strong influence on the sleep-wake cycle. Physiologically, endogenous melatonin is secreted in response to light/dark cycle and influences body temperature and propensity for sleep (Howatson et al., 2012). Though shift workers were excluded from the study, I hypothesize that Montmorency tart cherry supplementation may be beneficial for individuals who work the night shift, as their sleep-wake cycle does not follow the typical light/dark cycle. Future studies should be conducted on the effectiveness of Montmorency tart cherry supplementation in night shift workers. Howatson et al. (2012) also suggested that Montmorency tart cherry supplementation may be beneficial for people who travel across time zones because of the circadian rhythm disturbance that occurs when traveling to different time zones. Overall, Howatson et al. (2012) concluded that Montmorency tart cherry juice concentrate did appear to improve sleep quality and therefore may present a suitable alternative intervention for individuals who suffered from disturbed sleep patterns.

Montmorency Tart Cherry Conclusion

I hypothesized that the consumption of Montmorency tart cherry products would decrease the incidence of recurrent gout attacks, improve and regulate sleep patterns, relieve pain and inflammation associated with gout, arthritis, and muscle damage, and enhance the recovery of individuals following strenuous exercise. The previous articles attempted to test the validity of

my hypothesis. From the articles I concluded that consumption of Montmorency tart cherry juice, by itself, reduced the risk of recurrent gout, but that in combination with allopurinol, cherry intake further reduced the risk of recurrent gout attacks (Zhang et al., 2012). I also found that cherry intake influenced older adults with insomnia, by decreasing the amount of time that they spent awake after falling asleep (Pigeon et al., 2010), suggesting that cherry intake helped to older adults wake less frequently during the night. The study conducted by Howatson et al. (2012) also concluded that Montmorency tart cherry supplementation was beneficial in improving sleep quality in younger adults, by increasing the level of exogenous melatonin. In regards to recovery after strenuous exercise tart cherry juice consumption appeared to aid in recovery following strenuous exercise (Howatson et al., 2010) and decrease symptoms of muscle damage an inflammation (Connolly et al., 2006). Lastly, from the information above, it is indicated that cherry juice consumption does indeed aid in recovery and maximum isometric strength, when consumed both prior to and following resistance exercise (Bowtell et al, 2011).

Since the therapeutic use of cherry supplements has only become popular in recent years, there are only a handful of studies currently published regarding the potential health benefits of Montmorency tart cherry supplementation. Trends certainly suggest that Montmorency tart cherry supplementation is effective in gout prophylaxis, sleep regulation, reduction of inflammation and reduction in muscle damage and symptoms related to strenuous exercise. The specific anti-inflammatory mechanism by which Montmorency tart cherry juice supplementation exercise-induced muscle damage is not well understood (Kuehl et al., 2010) as well as the exact method by which tart cherries lower uric acid levels, and influence sleep. Due to the lack of studies to date, there is still a lot that is unknown about the mechanisms by which Montmorency tart cherry juice produces these therapeutic effects which calls for further investigation.

Pomegranate

As healthcare professionals we often try to prevent diseases such as obesity and heart disease through a healthy diet and lifestyle. When lifestyle measures fail to produce effective outcomes, we move on to pursuing drug therapy and other more invasive measures. Looking out for the best interest of the population, it is important to pursue the least invasive methods first, and move on to more invasive methods when necessary. This can be achieved by taking a more holistic approach to the health of an individual, through the use of dietary adjustments and even nutritional supplements. Studies have shown that the consumption of pomegranate can be beneficial to the human body and can be used in the prevention and treatment of certain diseases and ailments. Pomegranate juice has been found to contain antiatherosclerotic, antihypertensive, antioxidant, and anti-inflammatory effects on the human body (Al-Muammar and Khan, 2011). Pomegranate supplements can also be beneficial in cancer prevention and wound healing.

Obesity

Obesity is a growing issue in the United States. The Center for Disease Control and Prevention (CDC) reported that in the last 20 years there has been a dramatic increase in the rate of obesity and that currently more than 60% of the American population is overweight or obese (Al-Muammar and Khan, 2011). Though obesity is clearly an issue in the United States, it is also a prevalent issue in many other countries. The World Health Organization (WHO) has defined obesity as a global epidemic, because obesity has increased in prevalence in almost all countries in the world (Al-Muammar and Khan, 2011). With obesity comes the risk for many other health problems, such as type two diabetes, cardiovascular disease, hypertension, high cholesterol levels, depression, musculoskeletal problems, arthritis, infertility, back pain, and several cancers (Al-Muammar and Khan, 2011). As obesity becomes more severe, the risk for serious medical

complications, co-morbidities and mortality increase, hence the term morbid obesity (Al-Muammar and Khan, 2011).

In the case of obesity, prevention is key and the earlier the intervention the better. Al-Muammar and Khan (2011) claim that the third trimester of pregnancy marks a critical period, as fat cells start to increase within the fetus, a high fat diet by the mother can stimulate an overproduction of fat cells in the fetus, thus inducing permanent changes in the baby's appetite, neuroendocrine function, and energy metabolism. A dietary intervention at this stage could potentially lower the baby's chances of childhood obesity (Al-Muammar and Khan, 2011).

Traditionally, pomegranate components including roots, tree bark, fruit juice, leaves, and flowers, have been used to treat conditions such as, parasitic infections, diarrhea, dysentery, hemorrhage, acidosis, microbial infections, and respiratory pathologies, however recent studies have discovered positive effects of pomegranate on fat reduction (Al-Muammar and Khan, 2011). Recently, studies have found a link between pomegranate consumption and decreased body weight, improved insulin sensitivity, and improved fasting glucose and insulin concentrations (Al-Muammar and Khan, 2011). In one of the studies, pomegranate seed oil was given to a group of mice consuming a high fat diet, which resulted in decreased body weight, reflected by a decreased fat mass, when compared with the control group who did not receive the pomegranate seed oil supplement (Al-Muammar and Khan, 2011). The study also found that the pomegranate seed oil supplements improved insulin sensitivity in the mice (Al-Muammar and Khan, 2011). Pomegranate seeds are said to be high in catalpic acid, which is a conjugated linolenic acid (Al-Muammar and Khan, 2011). The study found that supplementation of catalpic acid resulted in improved fasting glucose and insulin concentrations, thus concluding that the use of pomegranate seeds as a supplement may be effective in protecting against obesity and insulin

resistance (Al-Muammar and Khan, 2011). Another study found that the use of pomegranate leaf extracts correlated with not only the decreased body weight of individuals, but also decreased total cholesterol and glucose levels (Al-Muammar and Khan, 2011). By decreasing the abdominal fat pad, pomegranate leaf extracts have proven to decrease dyslipidemia related to obesity and cardiovascular disease risk factors (Al-Muammar and Khan, 2011).

The concentration of antioxidants in pomegranate juice is known to be higher than the levels of antioxidants found in other natural juices (Al-Muammar and Khan, 2011). These antioxidants not only have antiaging effects, but they also have metabolic effects such as protecting against cholesterol oxidation (Al-Muammar and Khan, 2011). Dramatic increases in serum low-density lipoprotein (LDL), triaceylglycerols, and total cholesterol reflect symptoms of hyperlipidemia, which occurs with obesity (Al-Muammar and Khan, 2011). In fact, in a study discussed by Al-Muammar and Khan (2011) pomegranate juice was found to effect the cholesterol accumulation in macrophages, cellular oxidative stress, and cholesterol biosynthesis. Of the cells treated with pomegranate juice, 40% showed a decrease in the degradation of oxidized LDL and a decrease of 50% in the rate of macrophage synthesis, thus decreasing oxidative stress (Al-Muammar and Khan, 2011).

Studies show that the effects of pomegranate juice can help to reduce obesity and modify heart disease risk factors in hyperlipidemic patients. A study involving diabetic patients, found a significant decrease in total cholesterol and LDL cholesterol (Al-Muammar and Khan, 2011). The exact mechanism by which pomegranate effects obesity is not clear, but one study found that the antiobesity effects of pomegranate extract work by inhibiting lipase activity and suppressing energy intake (Al-Muammar and Khan, 2011).

Orlistat (Alli, Xenical) is a clinically proven weight control agent, that acts by inhibiting pancreatic lipase, decreasing the absorption of dietary fat and increasing fat excretion (Vallerand and Sanoski, 2013). Al-Muammar and Khan (2011) report that the effects of pomegranate juice on energy intake is similar to that of orlistat, and that the active compounds present in the extract decrease hyperlipidemia by inhibiting pancreatic lipase activity and increasing fecal fat excretion. One side effect of orlistat is hepatotoxicity (Vallerand and Sanoski, 2013). Perhaps a substitute for orlistat in obese individuals who have impaired hepatic function may be a pomegranate extract supplement.

Gastrointestinal Ailments

Pomegranate has been used since ancient times in the Egyptian culture to treat ailments such as inflammation, diarrhea, intestinal worms, cough, and infertility (Ismail, Sestili, and Akhtar, 2012). Its antimicrobial, antihelminthic, and antioxidant potential suggests its use to prevent and treat gastro-mucosal injuries, cancer chemoprevention, ethanol and acetone induced ulceration, and diabetic oxidative damage (Ismail et al., 2012). The pomegranate peel is characterized by its outer shell and inner membranes. It is rich in phenolic compounds which include flavonoids (anthocyanins, catechins, and others) and hydrolyzable tannins (punicalin, pedunculagin, punicalagin, gallic and ellagic acid) which make up 92% of the antioxidant activity associated with the pomegranate (Ismail, Sestili, and Akhtar, 2012). Polyphenols, flavonoids, and tannins are extracted from fruits, vegetables, herbs, and spices, and have been suggested as potential agents for treating and preventing a vast amount of infections (Ismail et al., 2012). Pomegranates contain the highest concentration of punicalagin, which has antioxidant, antifungal, and antibacterial properties, when compared to other commonly consumed fruits (Ismail et al., 2012). Gallic acid, ellagic acid, and punicalagin express antibacterial effects

against intestinal flora and enteric pathogens such as *Escherichia coli, Salmonella, Shigella,* and *Vibrio cholerae* (Ismail et al., 2012) suggesting the use of pomegranate to prevent the flourishing of enteric pathogens.

In the Indian culture, pomegranate extract, dried pomegranate peel, plant bark, and flower infusions have been used to treat diarrhea, intestinal worms, bleeding noses, and ulcers (Ismail et al., 2012). Pomegranate peel extract can be obtained by boiling the peel for 10-40 minutes. The extract, in liquid form, can be gargled to relieve a sore throat or hoarse voice or can be applied topically, in the powder form, to aid in healing bleeding gums and dental plaque in patients with peridontitis (Ismail et al., 2012).

Cancer Prevention

Ismail et al. (2012) claim that fruits and vegetables are natural sources of antioxidants and that their pharmological potential should be explored. Studies have concluded that pomegranate peels have a high concentration of antioxidants (Ismail et al., 2012). In fact, pomegranate peel demonstrated a 2.8 fold higher antioxidant activity when compared to pomegranate seed and leaf extracts (Ismail et al., 2012) making the peel the preferable source for creating supplements for antioxidant purposes. Studies suggest that the antioxidants derived from the pomegranate play an inhibitory and protective role against oxidative damage and the progression of carcinogenesis (Ismail et al., 2012).

Studies suggest that the use of pomegranate may help to prevent various types of cancer including prostate, skin, colon, and breast cancer. Anticarcinogenic effects of the fruit ellagitannins have been shown to induce apoptosis in colon, breast, and prostate cancer cells (Ismail et al., 2012). Pomegranate peel extract has also been found to inhibit the proliferation of melanocytes and inhibit melanin synthesis by inhibiting tyrosinase activity. The pomegranate

peel extract, specifically the ellagitannins, have been shown to inhibit free radical generation in UVA and UVB irradiated human skin (Ismail et al., 2012). This inhibition of free radical generation protects the skin from DNA fragmentation, burns, and depigmentation (Ismail et al., 2012).

Heart Disease

According to the CDC (2016) heart disease is the leading cause of death in the United States. Atherosclerosis is the primary underlying cause of coronary heart disease and results from both modifiable and non-modifiable risk factors. Primary methods of prevention of heart disease include therapeutic lifestyle changes such as, smoking cessation, exercise, diet modification, and weight loss (LeMone, Burke, Bauldoff, and Gubrud, 2015a). Atherosclerosis is the leading cause of death in many developed countries (Ismail et al., 2012). Low density lipoproteins (LDL) accumulate within blood vessels and undergo oxidation. The inhibition of LDL oxidation is key to prevent the accumulation within the vessels, which leads to cholesterol deposits in the arteries (Ismail et al., 2012). Since pomegranate peel extract is high in antioxidants, studies suggest that it has the potential to inhibit the oxidation of LDL and slow the progression of atherosclerosis. One study supplemented pomegranate peel power in the diet for four weeks and found a significantly reduced serum total cholesterol, triglycerides, LDL, and lipid peroxidation levels in hypercholesterolemic rats (Ismail et al., 2012). This suggests that pomegranate peel extract, in addition to lifestyle modifications, may be effective in lowering cholesterol levels and reducing the incidence of atherosclerosis.

Wound Healing

It has been said that pomegranate peel extract may be aid in the healing of wounds. Studies have shown that topical administration of pomegranate peel extract can be beneficial for

use on dead tissue, incisional and excisional wounds (Ismail et al., 2012). It has been shown to improve healing by improving the epithelialization, breaking strength, and contraction of incised wounds as well as increase the breaking strength of granulated tissues (Ismail et al., 2012).

Pomegranate Conclusion

In recent years, healthcare has been focusing on the prevention of chronic diseases through healthy lifestyles. Lifestyle changes such as modifying one's diet, exercising, refraining from unhealthy behaviors, and even dietary supplements are believed to be able to decrease the prevalence of chronic diseases that are a large issue in our population. Studies suggest that a routine pomegranate supplement may prevent or even correct the effects of obesity, diabetes, and cardiovascular disease (Al-Muammar and Khan, 2011). Pomegranate supplementation has not been shown to be harmful and can be beneficial in the prevention of many of the leading causes of death, including heart disease, complications related to obesity, and cancer. In general, pomegranate supplements are safe with no adverse effects reported by human subjects (Al-Muammar and Khan, 2011) however further studies are needed to determine a to what extent the whole fruit and the extract can be consumed without risk to human health (Ismail et al., 2012) and how effective the supplement is in preventing certain diseases long term.

Conclusion

In conclusion, the studies previously discussed revealed that Montmorency tart cherry supplementation may have the ability to decrease inflammation, lower uric acid levels, promote sleep, and aid in the preparation for and recovery after physical exertion. Based on my knowledge of pathophysiology, I can conclude that ailments, such as pain from inflammation, gout from increased uric acid levels, insomnia related to low melatonin, and muscle damage related to physical exertion due to the process of oxidative stress, may be positively affected by

the use of Montmorency tart cherry supplementation. Studies have also shown that the consumption of pomegranate can be beneficial to the human body due to pomegranate's antiatherosclerotic, antihypertensive, antioxidant, and anti-inflammatory effects, and can be used in the prevention and treatment of certain diseases and ailments including heart disease, obesity, wound healing, cancer prevention and gastrointestinal ailments. As a healthcare professional, it is preferable to prevent a disease or ailment all together rather than to treat it. Often times lifestyle modifications and elimination of modifiable risk factors are effective in preventing disease. When lifestyle measures fail to produce effective outcomes, healthcare professionals move on to pursuing drug therapy and other more invasive measures. Looking out for the best interest of the patient population, it is important to pursue the least invasive methods first, and move on to more invasive methods when necessary. This can be achieved by taking a more holistic approach to the health of an individual, through the use of dietary adjustments and even nutritional supplements including Montmorency tart cherry supplements or pomegranate supplements.

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