**University of Alberta**

North American ginseng and the
stress response during acute exercise

By

Jennifer Diane Humphreys ©

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# ABSTRACT


**North American ginseng and the stress response during acute exercise**

Stress response measures including cortisol, growth hormone, insulin, and lactate were assessed in 10 moderately active males ($VO_{2max}$ $\leq$50ml/kg/min) to determine the effects of ginseng extract supplementation before, during, and after an acute 36-minute bout of exercise on a Monark 818E cycle ergometer (6 minute warm-up, 15 minutes at 80% ventilatory threshold, 15 minutes at ventilatory threshold). Subjects were randomly assigned to receive capsules of either placebo or 3g of ginseng per day for 35 days prior to testing. Average energy intake and macronutrient ratio, body composition, maximal oxygen consumption, reported physical activity, and resting energy expenditure did not differ between the two treatments. With respect to the stress response measures, cortisol, growth hormone, and lactate were not found to be significantly different, whereas insulin was found to be significantly different between ginseng and placebo, in that an attenuated insulin response was observed during an acute bout of exercise following ginseng treatment ($p=0.053$).

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| | |
|---|---|
| **CHO** | Carbohydrate |
| **CNS** | Central Nervous System |
| **GAS** | Ginseng Abuse Syndrome |
| **GH** | Growth Hormone |
| **g/day** | Grams per day |
| **g/kg/day** | Grams per kilogram per day |
| **g/kgFFM/day** | Grams per kilogram fat free mass per day |
| **HPA axis** | Hypothalamic-pituitary-adrenal axis |
| **Kcal/day** | Kilocalories per day |
| **Kcal/kg/day** | Kilocalories per kilogram per day |
| **Kcal/kgFFM/day** | Kilocalories per kilogram fat free mass per day |
| **PRO** | Protein |
| **REE** | Resting Energy Expenditure |
| **RER** | Respiratory Exchange Ratio |
| **RMR** | Resting Metabolic Rate |
| **rpm** | Revolutions per minute |
| **$VO_2$** | Ventilatory oxygen consumption |
| **$VO_{2max}$** | Maximal ventilatory oxygen consumption |
| **VT** | Ventilatory Threshold |

# CHAPTER 1

# INTRODUCTION

## 1. Purpose

Ginseng-users claim that regular use of the herb will reduce stress, strengthen metabolism, increase physical stamina, and stimulate the immune system (Bahrke & Morgan, 1994). Many of these claims have not been scientifically documented. In addition, there is little information on the North American variety of ginseng, *panax quinquefolius*. Thus, the overall purpose of this study was to evaluate the effect of daily consumption of an oral dose of North American ginseng (*panax quinquefolius*) on the stress response following an acute physiological challenge (an exercise protocol).

## 2. Significance of Study

Human studies investigating the use of ginseng are limited. Investigations of the use of North American ginseng (*panax quinquefolius*) are even more limited, yet a growing number of people are consuming ginseng with great expectations of its physiological properties. These properties have, in many cases, not been scientifically tested. Ginseng has been purported to improve the immune system and reduce stress (among a vast number of other claims) (Bahrke & Morgan, 1994). Positive results in the proposed study would verify work done in animal models and provide support for the role of regular use of ginseng to promote optimal immune health and modification of the stress response.

## 3. Hypotheses

**3.1** After an acute bout of exercise, there will be differences in indicators of the stress response of male volunteers receiving ginseng compared to those receiving a placebo. The stress response measures include: lactate, cortisol, growth hormone, and insulin, and it is hypothesized that responses to acute exercise will result in these measures being blunted due to ginseng acting as an adaptogen in order to decrease the effect of a physical challenge. Specifically, a blunted increase in lactate, cortisol, and growth hormone, and an attenuated decrease in insulin are hypothesized.

**3.2** Ginseng-users claim that use of the herb has many positive characteristics, including anti-stress and cooling effects (Court, 1975; Bahrke, 1994). It is thus hypothesized that following ingestion of ginseng for a one-month period, resting energy expenditure (REE) will decrease.

## 4. Delimitations

Volunteers considered for this study were required to be male and between the ages of 18 and 35 years. Delimitations included: no illness which would inhibit their ability to participate in the exercise protocol, free of diabetes, thyroid, renal, or autoimmune diseases, not taking any medications or herbal supplements, non-smokers, having a $VO_{2max}$ less than 50ml/kg/min, be willing to take ginseng, and having a Body Mass Index (BMI) between 20 and 27kg/m$^2$. The independent variables were the ginseng or placebo treatment of each subject and the dependent variables were cortisol, insulin, growth hormone, and lactate responses to each treatment.

## 5. Limitations

The nature of this research has several inherent limitations:

**5.1 Experimenter and equipment error:** It is recognized that errors in data collection and data analysis are potential limitations to this study. For example, hydrostatic weighing may have a two to three percent body fat range due to technical error as well as estimations regarding volumes of residual and gastro-intestinal air (Brozek et al, 1963).

**5.2 Dietary intake records and physical activity questionnaires:** Although the use of 3-day dietary records to record food intake and the Baecke activity score (Pols et al, 1995) for estimating physical activity have been chosen, it is recognized that there are limitations. Diet and exercise reports based on subject self-reporting can be unreliable. It has been shown that subjects may over-report energy output or physical activity (Lichtman et al, 1992) and under-report energy intake or restrict food intake during the period of data collection (Romieu et al, 1988).

**5.3 Resting energy expenditure (REE):** Oxygen consumption at rest (REE) is recognized as an estimation of energy expenditure. Subject compliance to fasting for 12 hours and abstaining from intense physical activity for 24 hours prior to the test, as well as ensuring optimal relaxation from moment of waking to the time of test are noted as potential limitations to the accuracy of the estimation of REE (McArdle et al, 1991).

**5.4 Small sample size:** The sample size calculation required that 10 subjects be used in this study for statistical power, and it is recognized that a larger sample may yield increased statistical power.

**5.5 Exercise mode used for testing:** Since more people have ridden a bicycle than have run on a treadmill, a cycle ergometer was selected as the mode of exercise used during testing. This should decrease a possible learning curve and inter-subject variability, as well as anxiety over using unfamiliar equipment. Still, it is possible that some individuals have never been on a cycle ergometer, which may be considered a limitation.

**5.6 Blood samples:** An indwelling cathelon for withdrawing blood samples was in place during the exercise stress protocol tests. This may cause anxiety in some subjects who are uncomfortable with this procedure, which may result in elevated heart rate and/or oxygen consumption. By familiarizing the subjects with the cathelon before the exercise test begins, and allowing for relaxation and adjustment before exercise, anxiety may be reduced.

**5.7 Dosage of ginseng:** Daily doses as low as 0.5g are reported to be therapeutically effective and 2 to 3g are recommended to achieve stimulation (Siegel, 1979). Subjects were given a normal-high dose to promote a ginseng response with minimal negative side effects such as insomnia, depression, confusion and nervous disorder as seen in large doses of up to 50g per day (Bruce et al, 1985; Seigel, 1979; Dubick, 1986). It is recognized that there is some uncertainty whether 3g daily, prescribed in three capsules of 1g doses throughout the day, is sufficient to elicit an optimal response.

**5.8 Duration of treatment:** Subjects were given ginseng for a period of 30-35 days. It has been shown in rats that one dose of ginseng can elicit a response (Hiai et al, 1979b) but while studies with animals show that ginseng may prolong survival to physical or chemical stressors, there have only been a few controlled studies examining the ability of ginseng to have an effect in humans (Bahrke & Morgan, 2000). Gribaudo and colleagues (1990) found a significant increase in muscular strength and decreased fatigue in young males receiving ginseng for 15 days, while in another study by Gribaudo and colleagues (1991), well trained, amateur cyclists had significant increases in anaerobic threshold, maximum work, RER, and $VO_{2max}$ after 30 days of ginseng ingestion. McNaughton (1989) found significant improvements in $VO_{2max}$, recovery heart rates, and strength in marathon runners receiving ginseng for 6 weeks. The shortest duration of ginseng ingestion to result in significant results was found in a study by Asana and colleagues (1986), who found a significant increase in total work, and an increase in time to exhaustion in young males after only 8 days of ginseng ingestion. It is therefore recognized that there is no well-established dose-response relationship available in the literature and that this is a possible limitation.

**5.9 Markers of Stress:** There are other hormonal markers of stress in addition to the ones being measured, such as norepinephrine as an indicator of catecholamine excretion. Since not all hormonal stress measures are being considered in this study, this is noted as a limitation.

## 6. Definitions

**6.1 Body Mass Index (BMI):** BMI is the ratio of body weight to stature and is used as a standard to estimate obesity. It is determined by dividing body weight in kilograms by the square of height in metres. BMI is highly correlated with relative body fat and probably provides a better estimate of obesity than does relative weight.

**6.2 Diet Composition:** the absolute amount of calories consumed per day as well as the relative ratio of macronutrients ingested (fat, protein, and carbohydrate).

**6.3 Maximal Oxygen Consumption ($VO_{2max}$):** the maximal rate of oxygen consumption by the body during maximal exertion. A $VO_2$ peak or plateau

(<100ml/min) during exercise with increasing power output is used to determine $VO_{2max}$. If a $VO_2$ peak or plateau is difficult to determine, secondary criteria includes one or more of the following: respiratory exchange ratio >1.1, age-predicted maximal heart rate attained or exceeded, and/or volitional fatigue.

**6.4 Resting Energy Expenditure (REE):** the body's metabolic rate early in the morning following a 12-hour fast and eight hours of sleep. This value represents the minimum amount of energy expenditure needed to support basic physiological processes and accounts for 60 to 75 percent of the total daily energy expenditure.

**6.5 Ventilatory Threshold (VT):** the point at which ventilation increases disproportionately compared to oxygen consumption during exercise of increasing intensity. VT reflects the respiratory response to increased carbon dioxide levels and ventilation increases dramatically beyond this point (Bhambhani & Singh, 1985)

**6.6 Physical Stress:** an acute bout of exercise of sufficient intensity to elicit oxygen consumption values equivalent to 80 percent VT for 15 minutes, followed by exercise at VT for 15 minutes.

# CHAPTER 2

# REVIEW OF LITERATURE

## I. Introduction

Two types of stressors can be classified: those that are relatively long-term, such as chronic exercise, and those stressors that are shorter term, such as a discrete event, as in acute exercise. This review of literature concentrates on the latter and describes the effects of acute exercise on cortisol, growth hormone, insulin, and lactate. Ginseng will then be introduced and its properties will be described. Finally, the stress response to an acute bout of exercise while consuming ginseng will be examined.

## 2. Measures of Stress

### 2.1 Cortisol

Cortisol is the major glucocorticoid produced by the cells of the zona fasciculata in the adrenal glands. It is regulated by pituitary adrenocorticoptropic hormone (ACTH), and the release of ACTH is in turn regulated by a hypothalamic corticotropin-releasing hormone (hCRH). There is a negative feedback mechanism mediated at the level of the pituitary, hypothalamus, and higher brain centres (Hadley, 1996). Cortisol is responsible for a number of metabolic functions including changes in carbohydrate, protein, and lipid metabolism (Pollard, 1995). The principle functions of cortisol outlined by Tharp (1975) may be summarized as follows: 1) stimulate gluconeogenesis, increasing liver conversion of amino acids into glucose, thereby increasing glycogen and blood glucose, 2) mobilize amino acids from tissues and increase liver amino acids, resulting in a protein catabolic effect in muscle and negative nitrogen balance, and 3) mobilization of fatty acids from adipose tissue to increase free fatty acids in blood. It can be hypothesized that these metabolic changes would be beneficial to exercising individuals because cortisol would provide greater blood supplies of substrates used for energy and synthesis of needed cellular compounds (Tharp, 1975).

During acute exercise, changes in plasma cortisol concentrations are dependent upon the relative intensity of exercise (Cumming, 1981) as well as the duration of exercise (Brandenberger and Follenius, 1975) and fitness of the individual. With prolonged exercise, circulating cortisol levels increase in proportion to the workload and this increase occurs despite a decrease in the half-life of cortisol and increased tissue uptake (Cumming, 1981). The critical value or threshold of exercise intensity, which results in an increase in circulating cortisol, is 60 to 70 percent of maximal oxygen consumption and this response continues to increase with greater exercise intensity (Howlett, 1987; Galbo, 1981). In a study by Luger and colleagues (1987), it was found that exercise at 50 percent of maximal oxygen consumption caused no elevation in plasma ACTH or cortisol in sedentary individuals, moderately trained runners, or highly trained runners. However, exercise intensities of 70 and 90 percent of maximal oxygen consumption were associated with a proportional activation of the hypothalamic-pituitary-adrenal (HPA) axis in all three groups. This study concluded that there is a threshold variation at which the HPA axis is activated and that generally at higher intensities (i.e., 70 percent of maximal oxygen consumption), cortisol levels may increase, and this response increases with greater exercise intensities. It was also concluded that during absolute workloads, the activation of the HPA axis is inversely proportional to the level of physical training. The cortisol response during high intensity exercise is blunted in trained individuals due to reduced activation of the HPA axis as compared with untrained individuals at matched absolute workloads. Luger and colleagues (1987) attributed this to an adaptation to regular aerobic exercise, and thus moderately fit individuals often exhibit an increased relative cortisol response compared to highly trained individuals.

The report that physically active individuals demonstrate attenuated cortisol responses to acute exercise compared to inactive individuals was also demonstrated by Rudolph and McAuley (1998). They compared cortisol, perceived exertion, and affective responses to acute exercise consisting of a 30-minute treadmill run at 60 percent $VO_{2max}$ in cross-country runners and non-runners. It was found that the ratings of perceived exertion were positively related to post-exercise cortisol levels.

Circadian rhythm of cortisol confounds its response to exercise (Thuma et al, 1995) and this has implications when reviewing the literature. Studies do not always control or report time of day for cortisol measurement, and it has been shown that by measuring at different times of the day, serum and salivary cortisol may be underestimated by up to 93 percent in the morning and up to 37 percent in the evening (Thuma et al, 1995). This can have a confounding effect on study results, and therefore it is necessary to standardize cortisol measurements.

### 2.2 Growth Hormone

Growth hormone (GH), in addition to being important for human growth, has a number of functions. The pivotal role of pituitary GH, also known as somatotropin (STH), in the control of growth has been firmly established (Hadley, 1996; Goodman, 1988). Although the anterior pituitary gland produces at least six hormones, GH is the most abundant of all the anterior pituitary hormones by accounting for almost 10 percent of the dry weight of the gland (Goodman, 1988). GH is released in a pulsatile manner, and secretion is regulated by stimulating (somatocrine) and inhibiting (somatostatin) factors from the hypothalamus (Hadley, 1996). The release of GH is stimulated by growth hormone releasing hormone (GHRH), which is synthesized in the median arcuate nucleus of the hypothalamus while somatostatin, in the paraventricular nucleus, causes inhibition of growth hormone secretion (Cumming, 1981).

GH has many actions including a direct effect on adipose tissue, where it increases lipolysis (Sutton & Farrell, 1988). In addition, GH decreases glucose uptake in the liver, where it stimulates DNA and RNA synthesis, protein synthesis, gluconeogenesis and the production of somatomedins, and in muscle, where increases in amino acid uptake and protein synthesis occur (Sutton & Farrell, 1988, Woodhouse et al, 1999). With treatment for GH deficiency, there tends to be an increased reliance on oxidation of body fat to meet basal energy needs and to fuel increased protein synthesis (Goodman, 1988).

Stressful changes in the internal and external environment produce brief episodes of GH secretion (Goodman, 1988). Resting levels of GH are frequently low, but it is recognized that GH secretion is pulsatile in nature and that the two relatively reproducible physiological stimuli of GH secretion are exercise and sleep (Sutton & Farrell, 1988). The GH response to acute exercise has been studied extensively, with most investigators reporting that acute bouts of exercise increase the plasma concentration of GH (Chang et al, 1986; Chwalbinska-Moneta et al, 1996; Felsing et al, 1992; Ceresini et al, 1997; Elias et al, 1997; Luger et al, 1992).

Studies suggest that the factors that influence GH during acute exercise include the intensity and duration of activity, work output during exercise, muscle mass used during exercise, and fitness level (Pritzlaff et al, 1999; Chang et al, 1986; Chwalbinska-Moneta et al, 1996; Felsing et al, 1992). When assessing the GH response to acute exercise, single measurements need to be interpreted with caution due to its pulsatile release. However, based on a large number of studies, it is clear that GH levels rise in response to acute exercise (Jenkins, 1999).

The effect of training on the GH response to acute exercise is uncertain with different results reported (Jenkins, 1999). Bullen and colleagues (1984) found no change, while other studies have reported attenuated responses to both the same absolute and relative exercise intensity (Sutton et al, 1969; Sutton &

Lazarus, 1976; Bloom et al, 1976). Sutton and coworkers (1969) showed that when taken to exhaustion, unfit subjects continued to have a prolonged increase in GH secretion for several hours following exercise. When submaximal exercise was performed, the GH response was greater in the unfit subjects at the same absolute work level. Bloom and colleagues (1976) showed that when fit and unfit subjects exercised at the same absolute magnitude, which was therefore relatively more intense for the unfit subjects, a GH response was seen only in the unfit group.

Recently, Pritzlaff and coworkers (1999) investigated the effects of five different exercise intensities on GH release in recreationally active male subjects ($VO_{2peak}$ = 47.9$\pm$2.2ml/kg/min). Exercise consisted of 30 minutes of constant-load exercise at a predetermined velocity corresponding with one of the following five intensities [normalized to the lactate threshold (LT)]: 25 and 75 percent of the difference between LT and rest (0.25LT and 0.75LT, respectively), at LT, and at 25 and 75 percent of the difference between LT and peak $VO_2$ (1.25LT and 1.75LT, respectively). This study illustrated a linear increase in the amplitude of GH secreted per pulse and GH production rate, with no changes in GH pulse frequency or half-life of elimination. They concluded that GH secretory response to exercise is related to exercise intensity in a linear dose-response pattern in young men.

Luger et al (1992) found that in untrained, moderately trained, and highly trained individuals, a clear response of GH to exercise was registered at an intensity of 50 percent of $VO_{2max}$ with a maximal response at 70 percent $VO_{2max}$

and no further effect at 90 percent $VO_{2max}$. This is in contradiction to the previous study by Pritzlaff and coworkers (1999) who found a constant increase in GH with exercise intensity. It may be that the highest workload used by Pritzlaff and colleagues (75 percent of the difference between the $VO_2$ at LT and peak $VO_2$) was less than 90 percent $VO_{2max}$ and this may be the cause for discrepant results between the two studies.

Regardless of the GH pattern observed, it is evident from research that GH levels rise in response to acute exercise. Possible discrepancies between observed results and the mechanisms provided for these results are: (i) differences in exercise duration and intensity, (ii) individual nutritional and hormonal status, (iii) technical differences in assay protocols, and (iv) adaptation to training (Kraemer et al, 1995).

### 2.3 Insulin

Insulin is required for normal growth and development and directly lowers blood glucose levels (Hadley, 1996). In the normal individual, the concentration of glucose in blood is maintained at around 90mg/dl, and may even reach 1,000mg/dl on occasion (Goodman, 1988). Insulin deficiency results in unrestrained glucose production, lipolysis, ketogenesis, proteolysis, osmotic diuresis, metabolic acidosis, and ultimately, death (Hadley, 1996; Norman & Litwack, 1987). Conversely, excess insulin leads to an impairment of brain function, tremors, convulsions, and again, death (Hadley, 1996; Norman & Litwack, 1987).

Insulin is a peptide hormone produced by the β-cells of the pancreas, and is composed of two separate peptide chains consisting of 21 and 30 amino acid residues (Norman & Litwack, 1987). Proinsulin is a precursor of insulin and this conversion is thought to occur in both the Golgi complex and the β-granule (Norman & Litwack, 1987). Together with glucagon, the pancreatic cells function as a "fuel molecule" homeostat for the organism. The β-cell releases insulin in response to the L-amino acids, fatty acids, and ketones in the presence of glucose (Norman & Litwack, 1987).

Insulin interacts with stereospecific receptors present in the external membrane of a wide number of cell types. The highest concentration of insulin receptors is present in the cell membranes of liver, muscle, and adipose tissue (Norman & Litwack, 1987). Insulin stimulates the active transport of glucose and amino acids into muscle cells and enhances protein synthesis. Glycolysis and oxidative phosphorylation of glucose derivatives provide the energy required for such metabolic activity (Hadley, 1996).

Skeletal muscle glucose uptake and metabolism are major determinants of whole body glucose metabolism in response to exercise and insulin stimulation (Hargreaves, 1998). Regular exercise, by favourably influencing glucose uptake, enhances insulin action (Hargreaves, 1998). A single bout of exercise increases the rate of glucose uptake into the contracting skeletal muscles (Goodyear & Kahn, 1998; Bogardus et al, 1983; Mikines et al, 1988). Muscle contractions increase insulin sensitivity, but also stimulate muscle glucose uptake independent of insulin (Cortright & Dohm, 1997). In addition, acute exercise has been shown to decrease the insulin response to an oral glucose tolerance test (Young et al, 1989), suggesting that peripheral insulin sensitivity is increased.

As stated, exercise increases the rate of glucose uptake into the contracting skeletal muscles. The effect of exercise is similar to the action of insulin on glucose uptake, and the mechanism through which both stimuli increase skeletal muscle glucose uptake involves the translocation of GLUT-4 glucose transporters to the plasma membrane and transverse tubules (Hayashi et al, 1997). The period after exercise is also characterized by increased sensitivity of muscle glucose uptake to insulin (Hayashi et al, 1997). Work intensity affects the mechanisms by which glucose fluxes are regulated. The response to higher-intensity exercise takes on characteristics of the stress response. The response increases disproportionately for a given increment in work intensity, and glucose levels are no longer closely regulated, but increase (Wasserman, 1995). Once insulin levels increase, the general opinion seems to be that not exercise intensity, but rather the total amount of work performed is of prime importance (Borghouts & Keizer, 2000), with greater amounts of work resulting in increased levels of insulin.

### 2.4 Lactate

Lactate is a ubiquitous substance that is produced and removed from the body at all times, even at rest, both with and without the availability of oxygen (Myers & Ashley, 1997). It is now recognized that lactate accumulates in the blood for several reasons, not just in response to inadequate oxygen supply to the muscle (Myers & Ashley, 1997).

Lactate accumulates if pyruvate formation exceeds pyruvate oxidation. Pyruvate oxidation is enhanced by exercise-induced increases in pyruvate dehydrogenase activity and is relatively impaired by low oxygen availability and low mitochondrial capacity (Stallknecht et al, 1998). During exercise and recovery, lactate is eliminated in the liver, heart, and resting and working muscle.

Lactate plays a major role as a metabolic substrate during exercise. It is the preferred fuel for slow-twitch muscle fibres and is a precursor for liver gluconeogenesis (Myers & Ashley, 1997). The point at which lactate begins to accumulate in the blood is an indicator of metabolic acidosis, impaired muscle contraction, hyperventilation, and altered oxygen kinetics, all of which contribute to an impaired capacity to perform work (Myers & Ashley, 1997).

During light and moderate exercise, the energy demands of exercising muscle are met, and lactate does not accumulate but is rapidly oxidized. Lactate begins to accumulate in the blood and rise in an exponential fashion at about 55 percent of the healthy, untrained subject's maximal capacity for aerobic metabolism (Costill, 1973; Davis, 1979). This is usually explained as the release of hydrogen ions beginning to exceed its oxidation down the respiratory chain. Consequently, excess hydrogens are passed to pyruvic acid and lactic acid accumulates (Katz, 1988). This increase in lactic acid becomes greater as exercise becomes more intense and consequently, the muscle cells cannot meet the additional energy demands aerobically.

Thus, an acute bout of exercise may or may not produce lactate, but depends on the exercise intensity. Lactate accumulation is generally assumed to occur at or above 55 percent of maximal aerobic capacity.

## 3. Ginseng

### 3.1 Introduction

Ginseng has been used as a supplement for thousands of years in the Orient and has been attributed with properties such as the ability to prolong life and generally invigorate the body (Goldstein, 1975). In Chinese folklore, the roots are a source of health, strength, and happiness and, especially for older people, the drug is both a tonic and an aphrodisiac. Other qualities attributed to ginseng include the treatment of anemia, diabetes, insomnia, neurasthenia, gastritis, and sexual impotence (Court, 1975). The name ginseng means "man root" and stems from a belief that because this root is humanoid in appearance, it can benefit all aspects of the human body (O'Hara et al, 1998).

There are two major species of ginseng having almost the same physical characteristics and properties; the primary difference lies in their native geographic distribution (Goldstein, 1975). *Panax ginseng C.A. Meyer* is distributed in temperate eastern Asia (in China, with a concentration in Manchuria and Korea), while *Panax quinquefolium* is found in Southern Canada and in the United States.

Ginseng is perennial and takes about five years to reach earliest maturity. It grows primarily in mixed hardwood forests, prefers shade and well-drained soil, and is therefore found mainly secluded among tree roots (Goldstein, 1975). Because it is believed effective in restoring and maintaining the balance of *Yin* (negative) and *Yang* (positive) in the body, ginseng, although most commonly used by itself, is often used as a basic, non-specific herb in combination with other drugs (Goldstein, 1975). When there is a perfect balance of the complementary forces of *Yin* and *Yang*, physical and spiritual well being is achieved (Goldstein, 1975). *Panax quinquefolium* shows the efficacy of nourishing the *Yin* and eliminating the fever due to *Yin* deficiency (Liu & Xiao, 1992). Although the entire ginseng plant contains pharmacologically active properties, it is the root of the plant that is considered most valuable (Bahrke, 1994).

The discovery of ginseng in North America (*Panax quinquefolium)* is based on numerous versions of a story of the French Jesuit missionary, Father Jartoux (Goldstein, 1975). In 1709, Father Jartoux was in China developing a geographic survey and maps for the Emperor. During his travels he noticed hordes of people (10,000 by his count) scouring the region for ginseng. Father Jartoux wrote a letter describing his experiences with ginseng, which he used as an effective treatment for fatigue and sent this letter to Canada. He believed that if the plant grew anywhere outside China, it would be in Canada and the northern United States since these countries lie between the same latitudes, have a temperate climate, and forested mountains, as does China. Ginseng was in fact discovered to be growing in North America and was commonly used as an Iroquois medicinal herb. By 1718, the ginseng trade between China and North

America was established and by the 1720's ginseng was second only to fur as a Canadian item of trade (Goldstein, 1975). In 1840, ginseng was made an official drug in the *United States Pharmacopoeia*. However, many doctors disputed its effectiveness and by 1880 ginseng was no longer listed in the *Pharmacopoeia* due to pressure by physicians, but was still in common use among the pioneers and American Indians (Goldstein, 1975). Currently, the US Food and Drug Administration (FDA) regards ginseng as a food (Chong & Oberholzer, 1988). Nutritional analysis has shown that 100g of ginseng root contains 1414J (338kcal) of energy, 12.2g of protein, 70g of carbohydrates, and measurable amounts of vitamins [retinol (A), thiamine ($B_1$), riboflavin ($B_2$), cyanocobalamin ($B_{12}$), ascorbic acid (C), and tocopherol (E)], niacin, calcium, iron, and phosphorous, among other ingredients (Siegel, 1979).

With the rapidly increasing demand for ginseng, special efforts in cultivation have been carried out in China, including the development of culture varieties by selection, field cultivation, reutilization of the wasted ginseng plantation, ginseng cultivation under forestry, and prevention of ginseng diseases and pests. As a result, both the quality and quantity of ginseng have been significantly improved (Liu & Xiao, 1992). Today ginseng is one of the most popular and expensive herbs in the world (O'Hara et al, 1998). It is currently estimated that alternative or complementary medicine is used by 20 to 30 percent of the general North American population (Wong et al, 1998). At least 6 million Americans use the root of ginseng and the world market is said to be around one billion dollars per year (Beltz & Doering, 1993).

### 3.2 Ginseng Composition

The active components of ginseng are triterponoid glycosides or saponins, termed ginsenosides (Bahrke, 1994). The mechanism of action of ginsenosides is still unclear (Bruce et al, 1985). In addition to ginsenosides, polysaccharides, flavonoids, daucosterin, mucilaginous substances, amino acids, bitter substances, vitamins, choline, pectin, fatty oil and ethereal oil have been found in the different parts of the ginseng plant (Liu & Xiao, 1992). Quality control has been introduced in recent years to ensure that commercial ginseng products contain what they claim to. This is especially important when determining efficacy of ginseng in research. In a study of six commercial products sold in Sweden, the UK, and the USA claiming to contain ginseng, it was found that they did not contain ginsenosides in them, the component thought to be responsible for the beneficial effects (Walker, 1994). The ginsenosides are important markers for the analytical characterization of ginseng and their selective measurement provides information both botanically and for quality control when cultivating and marketing ginseng (Vigano & Ceppi, 1994). The chemical composition of commercial ginseng products is variable because of (a) the genetic nature of the plant source, (b) the cultivation methods, and (c) the drying and curing process (Bahrke, 1994).

Ginseng saponins have been investigated and at least 13 saponins have been isolated. The saponins have been named ginsenoside $R_x$, where x is a, $b_1$, $b_2$, c, d, e, f, $g_1$, $g_2$, $g_3$, $h_1$, $h_2$, or o, according to their position on thin layer chromatograms (Bahrke, 1994). Among the various types of ginseng, *Panax* *ginseng C.A. Meyer* appears to be relatively rich in ginsenosides. Although *Panax quinquefolius* is similar in physical characteristics and properties, there is a difference. Both *Panax* species possess tonic and energizing effects as well as tranquilizing effects, but only two saponin glycosides are common to both kinds of ginseng, namely $R_{g2}$ and $R_o$ (Bahrke, 1994). *Panax quinquefolius* is purported to have an anti-stress, cooling effect while *Panax ginseng C.A. Meyer* stimulates a warming effect (Court, 1975).

### 3.3 Recommended Ginseng Doses

Daily doses as low as 0.5g are reported to be therapeutically effective, and 2 to 3g are recommended to achieve stimulation (Siegel, 1979). A wide variety of commercial ginseng preparations are available, including powders, extracts, teas, roots, capsules, tablets, cigarettes, chewing gum, and candies (Beltz & Doering, 1993). Ginseng is thought to be relatively safe. The $LD_{50}$ (lethal dose to 50% of the sample) of the whole root has been found to be 10 to 30g/kg body weight in mice and some researchers have reported that animals are affected by abdominal distension before toxic doses can be reached (Bahrke, 1994). In China, daily doses have been given up to 50g, and some large doses have resulted in insomnia, depression, and nervous disorder. Other side effects associated with large doses include nervousness, loose stools, high blood pressure, hypertension, confusion, and acne (Bruce et al, 1985; Siegel, 1979; Dubick, 1986).

The stimulating effects of ginseng, and the potential problems associated with long-term abuse of ginseng, has been described by Siegel (1979). The long-term effects of ginseng use, primarily central nervous system (CNS) excitation and arousal, have been labelled as 'Ginseng Abuse Syndrome' (GAS). GAS is defined as hypertension together with nervousness, sleeplessness, skin eruptions, edema, and morning diarrhea. The most common psychological finding among these individuals is altered mood, specifically euphoria, restlessness, agitation, and insomnia (Siegel, 1979). Many of the symptoms of ginseng toxicity have been found to mimic corticosteroid poisoning (Dubick, 1986).

According to Siegel (1979) and Kim and colleagues (1970), the effects are similar to organic brain syndromes associated with corticosteroids, and may be related to ginseng's interference with cortisone and corticotropin levels. Kim et al (1970) conducted experiments with an extract of ginseng on rats under heat and cold stress, and established that ginseng acts upon the peripheral site of the stress mechanism. This was done under the assumption that removal of the pituitary gland would abolish the effect of the drug on the stress mechanism if the drug acted chiefly upon the central site. It was found that even in the absence of the pituitary gland, ginseng facilitated both depletion and subsequent restoration of adrenal ascorbic acid content in response to ACTH.

## 4. Effects of Ginseng

### 4.1 Overview

As previously stated, ginseng is considered a tonic or adaptogen that enhances physical performance, promotes vitality, and increases resistance to stress and aging (O'Hara et al, 1998). Substances that cause a state of non-specific increased resistance (SNIR) are called 'adaptogens' (Bahrke, 1994). An adaptogen has been described as a substance which is (a) innocuous, causing minimal physiological disorder, (b) non-specific in action, increasing resistance to the adverse influences of a wide range of factors of physical, chemical, and biological nature, and (c) capable of a normalizing action irrespective of the direction of the pathological changes (Court, 1975). Ginseng has been classed as an adaptogen because studies suggest that it helps the body adapt to stress and corrects adrenal and thyroid dysfunction (Siegel, 1979) and in fact may be more or only effective in stressed, impaired or injured animals (Dubick, 1986). Ginseng is also used as a stimulant to increase metabolism and to regulate blood pressure and blood glucose (Siegel, 1979). Another feature of adaptogens is the lack of specificity of their action as defined by their capacity to increase the organism's resistance to various adverse factors of a physical, chemical and/or biological nature (Bahrke, 1994).

Although many claims are made that ginseng will enhance physical performance (O'Hara et al, 1998; Petkov et al, 1987; Wang & Lee, 1998), little substantiated evidence exists to show this. This is due to discrepancies between quality control of ginseng, methodological variations, and simply the lack of research performed in this area. The effects of ginseng reportedly vary, and may affect individuals in different ways. There may also be interactions with diet, lifestyle, exercise, and other drugs (Fulder, 1981). The effects of ginseng may also depend on the health of an individual (Bahrke, 1994).

Early studies revealed that ginseng possesses biomodulatory effects on the higher centres of the CNS, facilitating both physical and mental activities (Liu & Xiao, 1992). While in vitro and animal studies suggest that ginseng has beneficial effects on immune and endocrine functions, evidence of its effects in humans is limited and contradictory (O'Hara et al, 1998). The clinical and pharmacological activities of ginseng postulated are (a) anti-stress activity, (b) anti-circulatory shock effects and modulation of cardiovascular activities, (c) improvement or facilitation of learning and memory processes, (d) modulation of neuroendocrine system activities and hypothalamic-adrenal-gonadal system, (e) modulation of cellular metabolic processes on carbohydrate, fat and protein metabolism, and (f) modulation of immune functions (Liu & Xiao, 1992).

### 4.2 Hormonal and Related Effects with Physical Activity

The literature involving the effects of ginseng on hormonal secretion is limited. Pharmacological studies with animals (mainly mice) show that ginseng prolongs survival to physical or chemical stress (Brekhman & Dardymov, 1969). Ginseng has been purported to have a wide range of pharmacological properties including an increase in adrenal cortical capacity and output in response to stress (Fulder, 1981). Although several mechanisms of action have been postulated for ginseng's impact on circulating hormones, it may affect the HPA axis, resulting in elevated plasma corticotropin and corticosteroid levels (Avakia & Evonuk, 1979; Fulder, 1981; Wagner et al., 1994; Hiai et al, 1979a; Liu & Xiao, 1992). These results suggest that ginseng acts similar to a hormone by influencing the adrenals to release adrenalin (Bruce et al, 1985) and ginsenosides to induce a significant increase of serum corticosterone and decrease of liver glycogen (Liu & Xiao, 1992). When a ginseng saponin mixture (*Panax ginseng C.A. Meyer*) was administered to rats intraperitoneally, plasma ACTH and corticosterone increased significantly 30, 60, and 90 minutes after treatment (Hiai et al, 1979b). The ginseng-induced increase in plasma corticosterone was suppressed by pre-treatment with dexamethasone. Thus, the ginseng saponin was found to act on the hypothalamus and/or hypophysis primarily, and stimulated ACTH secretion, which resulted in increased synthesis of corticosterone in the adrenal cortex (Hiai et al, 1979b).

Ginseng has a reputation in folklore because of its claimed ability to increase human capacity for physical work and intellectual performance and to offset fatigue and weariness (Court, 1975). Ergogenic effects associated with ginseng use include increased fatty acid oxidation and glycogen sparing (Beltz & Doering, 1993). During exercise, there is apparently a more economical release of body energy and more efficient use of glycogen and high energy phosphates, thus preventing decreases in muscle ATP, glycogen or creatine phosphate and increases in muscle lactic and pyruvic acids which normally occurs during vigorous exercise (Court, 1975). Reduced glycogen metabolism results in increased capacity for endurance during prolonged exercise (Bruce et al, 1985).

Some stimulant effects of ginseng, such as the anti-fatigue action and enhanced performance reported by users, may be associated with ginseng-induced alteration of carbohydrate metabolism and increased synthesis of glycogen and phosphorous compounds (Bahrke, 1994). Brekhman and Dardymov (1969) reported that *Panax ginseng C.A. Meyer* intensified the inner inhibitory processes in the cortex, contributing to more sparing of carbohydrate use, and enhanced resynthesis of glycogen and high-energy phosphorous compounds. This action appeared to exist particularly under conditions of physical stress. Pieralisi et al (1991) studied 50 healthy male sports teachers receiving ginseng for six weeks. The total workload on a treadmill and maximal oxygen consumption during exercise were significantly greater following ginseng preparation than after placebo treatment. At the same work load, oxygen consumption, plasma lactate levels, ventilation, carbon dioxide production, and heart rate during exercise were significantly lower after the ginseng preparation than after the placebo. The effects of ginseng were more pronounced in the subjects with maximal oxygen consumptions below 60ml/kg/min during exercise than in the subjects with levels at or above 60ml/kg/min. This supports the theory that ginseng acts as an adaptogen in that its effects are more notable in less fit subjects who experience a greater exercise stress compared to more fit subjects.

In view of the experimental evidence supporting ginseng's ability to alter energy metabolism as well as other reported anti-stress effects, Avakian and Evonuk (1979) investigated a possible physiological basis for ginseng's claimed ergogenic actions. The acute effect of *Panax ginseng C.A. Meyer* root extract on the rate of glycogenolysis in white muscle and livers of rats during prolonged exercise of three hours was investigated. It was found that ginseng inhibited adrenal cholesterol by 21 percent after three hours of swimming. Ginseng had no effect on hepatic glycogen, but had pronounced effects on endogenous glycogen utilization in white skeletal muscle during exercise. These findings indicated that ginseng had a carbohydrate-sparing action during prolonged exercise. In other words, ginseng changed homeostasis during physical exercise, perhaps by increasing the biochemical capacity of the skeletal muscles for oxidizing free fatty acids in preference to glucose (Bahrke, 1994).

### 4.2.1 Cortisol and Ginseng

The role of the HPA axis in body adaptation abilities was studied in rats by Filaterov and colleagues (1988). The adaptation abilities were tested by a body working capacity (the running time on a treadmill until fatigue). A single administration of ginseng resulted in an increased working capacity of up to 132 percent, with a seven-day administration of up to 179 percent. The administration of ginseng was accompanied by an increase in the basal level of ACTH and cortisol.

Fulder (1981) reported that the hypothalamic model allows us to understand ginseng's effects. It is now known that both corticosteroids and ACTH peptides bind directly to brain cells where they cause behavioural changes (Fulder, 1981). Corticosteroids improve selectivity and discrimination, while ACTH improves motivation, performance, and arousal. Fulder also stated that the changes following administration of ginseng were more marked in debilitated and fatigued animals. Hiai and colleagues (1979) administered a ginseng saponin mixture to rats and found that it significantly increased plasma ACTH after 10, 30, and 60 minutes, and then began to decrease after 90 minutes, while it increased plasma corticosterone in a parallel kinetic pattern. This verified that the ginseng-induced increase in plasma corticosterone was due to the stimulation of corticosterone synthesis in the adrenals, and not due to the reduction in metabolism of corticoid. They concluded from their research that ginseng was found to act on the hypothalamus and/or hypophysis primarily, and stimulated ACTH secretion, which resulted in increased synthesis of corticosterone in the adrenal cortex.

There is evidence that *Panax* ginseng normalizes physiological dysfunctions caused by stress exposure (Buffi et al, 1993). It has also been reported that ginseng acts on the hypothalamus and consequently facilitates the release of ACTH, which enhances the capacity of adrenocortical cells (Buffi et al, 1993).

Building from the limited body of research involving cortisol and ginseng, it may be hypothesized that due to ginseng being an adaptogen, that the cortisol response to exercise may be attenuated.

### 4.2.2 Growth Hormone and Ginseng

Growth hormone is released in response to a number of stimuli, including exercise, stress, and pharmacologic agents (Wagner, 1989). There is no research available in the literature to explore the effects of ginseng on growth hormone, whether at rest or during activity.

### 4.2.3 Insulin and Ginseng

The literature involving insulin and ginseng is limited and study results are variable. In a review by Ng and Yeung (1985), it was found that ginseng contained insulinomimetic principles. One substance found in ginseng was demonstrated to provoke insulin secretion in diabetic and glucose-loaded normal mice, while having no effect in normal mice. Martinez and Staba (1984) administered ginseng to exercising rats and found that ginseng did not affect plasma lactic acid, glucagon, insulin, or liver glycogen levels and did not prolong their swimming time. Another study by Waki and colleagues (1982) showed that a long term treatment of DPG-3-2, a component of ginseng, which lowers the blood glucose level and stimulates insulin release in diabetic animals, stimulated insulin biosynthesis in pancreatic islets of hyperglycemic animals.

Hiai et al (1979) showed that ginseng saponin administered intraperitoneally to rats induced a significant rise in plasma corticocosterone, while it tended to increase plasma glucose and to decrease plasma insulin. In contradiction to this study, research by Kimura et al (1981) found that 10-50mg/kg body weight dosages of ginseng produced an increase in blood insulin in both diabetic and normal mice. These results indicated that ginseng fractions stimulated insulin release, especially glucose-induced insulin release from pancreatic islets and thereby lowered the blood glucose level.

It is apparent that more research needs to be performed studying the effects of ginseng on insulin levels, as the research presents differing results.

#### 4.2.4 Lactate and Ginseng

The literature researching the effects of ginseng on lactate accumulation during exercise is mainly focused on performance enhancement. In one such study by Allen and colleagues (1998), it was found that ginseng supplementation did not enhance healthy young adults' peak aerobic exercise performance, and no significant treatment effects were observed for peak plasma lactate levels.

Engels and Wirth (1997) were also unable to find an ergogenic effect of ginseng during graded maximal aerobic exercise. An eight-week supplementation with ginseng had no effect on blood lactate concentration after both submaximal and maximal aerobic exercises. In another study by Morris and colleagues (1996), subjects cycled after ingesting ginseng or placebo for seven days prior to testing. It was found that lactate did not differ between the ginseng and placebo groups, and thus no ergogenic effect was found.

Only one study was found that disputed the above results. This study (Avakian et al, 1984) was conducted in exercising rats that swam for either 30 or 60 minutes. At rest, there was no significant difference between ginseng-treated rats and saline-treated rats. During exercise though, it was found that ginseng-treated animals had markedly lower concentrations of circulating lactate at both 30 minutes and 60 minutes. The researchers accounted for the lower circulating levels of lactate by two possibilities: 1) decreased skeletal muscle lactate production resulting from a reduced rate of anaerobic glycolysis, and/or 2) increased clearance of circulating lactate by gluconeogenic tissues such as the liver and kidney cortex. The results of this study and the former ones are contradictory and the major difference is that this study was performed on animals whereas the former studies used human participants. Also, it is impossible to compare the intensity of exercise between humans and animals from the information provided in available research.

The majority of results and all available studies involving human subjects state that lactate does not significantly increase with the administration of ginseng, but further research is warranted.

#### 4.2.5 Resting Energy Expenditure and Ginseng.

The effects of ginseng on REE have not been documented. It has been speculated that *Panax ginseng C.A. Meyer* may strengthen metabolism (Bahrke

& Morgan, 1994) and that this may result in an increased REE. This effect may be similar to that associated with chronic exercise, in which resting metabolic rate (RMR) has been found to increase (Poehlman, 1989). RMR represents the largest portion of total energy expenditure by sedentary humans and constitutes 60 to 75 percent of total energy expenditure in man (Danforth, 1979). It is influenced by such factors as age, gender, body size and composition, body temperature, thermogenic hormones, and prior exercise (Poehlman, 1988). *Panax ginseng C.A. Meyer* may influence one of more of the above factors to result in an enhanced metabolism, and a resultant increase in RMR and REE. While *Panax ginseng C.A. Meyer* stimulates a warming effect, North American ginseng or *Panax quinquefolius*, used in the current study, is purported to have an anti-stress, cooling effect. For this reason, *Panax quinquefolius* may have an opposite effect on REE, in that it may decrease it.

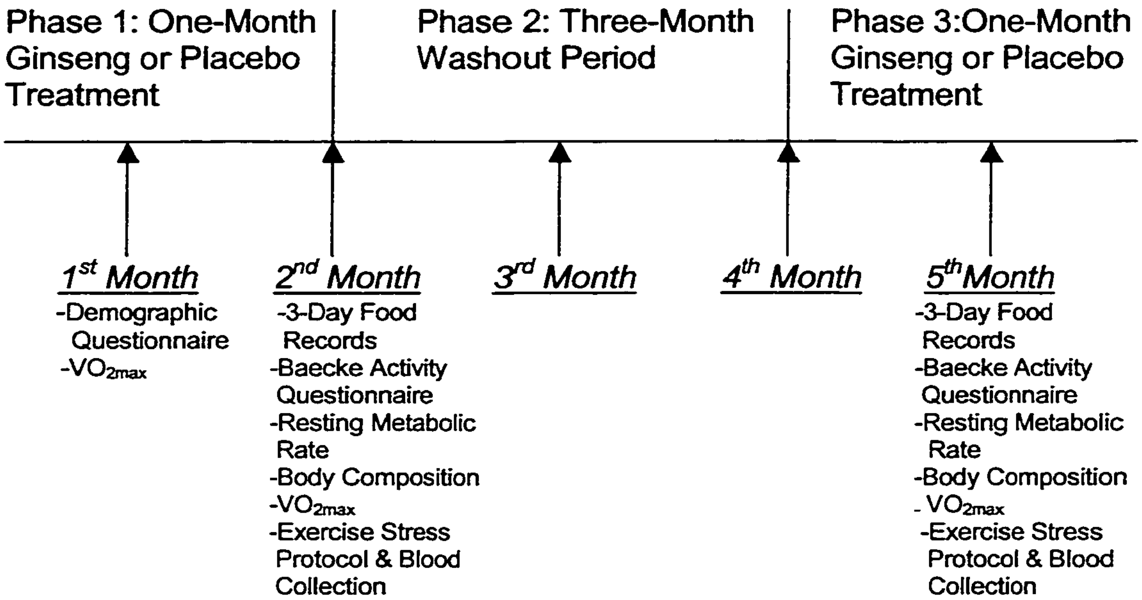
# CHAPTER 3

# METHODS AND PROCEDURES

## 1. Experimental Design

This study was a randomized, placebo-controlled, cross-over design. Following informed consent and prior to testing, all subjects were required to fill out a Physical Activity Readiness Questionnaire (PAR-Q; Appendix D) to screen for possible medical complications that would exclude the participant from the study. All participants completed identical measurements and questionnaires. Subjects were randomized by random-number assignment, half to receive placebo and half to receive ginseng for a one-month period. The exercise stress protocol and blood test were done at the end of each one-month trial. There was a three-month "washout" period and then subjects received the opposite treatment for one month, with the subsequent exercise stress protocol and blood test (Table 1). The washout period was three months since it has been shown to require at least 10 weeks before specific effects subside in individuals after cessation of treatment (Forgo & Schimert, 1985). This was also a double-blind study, with the assigned treatments being unblinded after all subjects had completed the study and data analysis had been performed.

***Table 1: Study Timeline***




## 2. Subject Information

Ethical approval was obtained from the Human Ethics Review Committee of the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta. Fourteen males were recruited for the study and ten (n=10) completed the project requirements. Four participants were excluded from the study for various reasons, one due to illness and three due to reported commitments outside of the study. Two participants withdrew from the study in the first phase and two others withdrew during the second phase.

All participants were recruited on a volunteer basis from posters, a newspaper article, and an on-line graduate student newsletter. Once the subject answered 'yes' to all the recruitment criteria listed below, and the study was explained in full detail to the satisfaction of the investigator and participant, a maximal oxygen consumption ($VO_{2max}$) test was performed (see below for protocol).

*Recruitment Criteria – the following eligibility criteria were met by each subject:*

- Male
- No illness which would inhibit their ability to participate in the exercise protocol
- Free of diabetes, thyroid, renal, or autoimmune diseases
- Aged 18-35 years
- Not taking any medications or herbal supplements
- Non-smoker
- $VO_{2max}$ less than 50 ml/kg/min
- Willing to take ginseng
- Body Mass Index of 20-27 kg/m$^2$

## 3. Measurement Protocols

### 3.1 Ginseng and Placebo Treatments

Ginseng and placebo capsules were provided by the Chai-Na-Ta Corporation (Langley, BC). Normal dosage for North American ginseng is 0.5-3g per day. For this study, subjects were provided with 3g per day (high normal value) in the form of single 1g capsules taken three times daily to increase the likelihood of a "ginseng effect". Subjects were instructed to take the capsules in regular intervals spread throughout the day for the entire treatment period (30-35 days depending on scheduling), and to avoid taking capsules close to bedtime due to a possible insomniac effect of the treatment. Ginseng treatment consisted of standardized 'North American Whole Root Ginseng Extract Powder' capsules. Placebo capsules contained 350mg of cornstarch. In Canada, ginseng is considered a food; there is no drug identification number for it. Safety and efficacy studies have shown that at 10 to 30 times the normal dose (10 to 30g/day) some people experience irritability, insomnia, dizziness and hypertension. Capsule consumption and symptoms were carefully monitored through weekly telephone calls and/or e-mails to the participants. Participants were asked to record any effects that they felt during the treatment phase (i.e., headache), and to record the day, time, and severity of effect, as well as if any treatment was used (i.e., acetaminophen) (Appendix I).

### 3.2 Resting Energy Expenditure

Subjects reported to the Metabolic Testing Unit in the Agriculture Forestry Building, Room 4-04, at the University of Alberta between the hours of 7:00am and 9:00am. Subjects were required to fast for 12 hours prior to testing and refrain from intense physical activity for 24 hours prior to arriving at the test site. Attempts were made to minimize energy expenditure whenever possible. For example, arrival to the testing site was by motor vehicle and subjects used the elevator to the fourth floor. Following an explanation of the test and measurement of height and weight, the subject rested for 30 minutes on a cot in the supine position while the lights were dimmed and relaxation music was played. A transparent ventilated hood was then placed over the subject's head and the test was started. Subjects were asked to remain awake but relaxed and to avoid voluntary skeletal muscle movement. The test, which measures exhaled oxygen and carbon dioxide, lasted approximately 30 minutes.

Oxygen consumption was measured by indirect calorimetry using a metabolic cart (Vmax 29N, Sensormedics, Yorba Linda, CA). The metabolic cart was calibrated against a reference gas mixture and relevant information including: height, weight, age, and gender were entered into the metabolic software. Steady state values were obtained for minute ventilation, $VO_2$, and respiratory exchange ratio (RER). The Weir equation (Weir, 1949) was programmed into the computer to calculate REE (kcals/day). The Weir equation is as follows:

$$REE\ (kcals/day) = 3.94[VO_2(ml/min)] + 1.06[VCO_2(ml/min)] \times 1.41$$

### 3.3 Body Composition

#### 3.3.1 Anthropometric Measurements

Height was measured without shoes after a full inspiration and recorded to the nearest 0.1cm using a measuring tape. Weight was measured while the subject was wearing a bathing suit and was recorded to the nearest 0.1kg on a pre-calibrated medical balance beam scale (Healthometer, Continental Scale Corporation, Bridgeview, IL).

### 3.3.2 Hydrostatic (Underwater) Weighing

Measurements were made after subjects completed the REE test, and were therefore in a fasted state and had refrained from intense physical activity in the past 24 hours. Hydrostatic weighing was performed on two occasions: the first being within two days before the first exercise stress protocol and the second test being within two days before the second exercise stress protocol (after having ingested either the ginseng or placebo capsules for approximately 35 days). Residual volume (RV) was measured during the first testing session and the same value was used for the second testing session. RV was measured with the helium dilution technique (Motley, 1957) on a SensorMedics 2450 Pulmonary Function Laboratory cart (Yorba Linda, CA). Vital capacity and expiratory reserve volume were measured and residual volume was calculated.

Underwater weight was measured with a computerized strain-gauge system and corrected for residual volume previously measured. Multiple trials were performed until the difference in body density for three trials was <0.005, upon which these three trials were averaged to obtain final values. Percentage body fat was estimated from body density using the equation of Siri (1956) and fat free mass and fat mass were also calculated. A swimsuit was worn and the water was pleasantly warm (34-37°C).

### 3.4 Aerobic Fitness Assessment

A maximal oxygen consumption ($VO_{2max}$) protocol was conducted as a measure of aerobic fitness and was performed three times throughout the study: as part of the recruitment criteria, and then on the day preceding the exercise stress protocol following each treatment. A graded exercise test to exhaustion was performed on a Monark 818E cycle ergometer (Varberg, Sweden). Respiratory gases were continuously collected and averaged every 15 seconds using an automated metabolic measurement system (D-Series Gas Exchange System, MedGraphics, CA). Subjects started pedaling at a resistance of 1.0 kiloponds (kp) and were instructed to maintain the frequency of pedaling between 60 and 70 revolutions per minute. Every 2 minutes, the resistance was increased by 0.5kp, until ventilatory threshold (VT) was reached, after which resistance was increased by 0.5kp every minute. VT was indicated by a decrease and plateau in $V_E/VCO_2$ prior to a systematic increase with increased power output as well as a respiratory exchange ratio (RER) greater than 1.05 (Bhambani & Singh, 1985). Heart rate was recorded every minute (Polar Electro Heart Rate Monitor, Polar USA Inc., Stanford, CN). The criteria used for defining attainment of $VO_{2max}$ was (a) a levelling or decrease in $VO_2$ with increasing workload, (b) a plateau in heart rate and/or attainment of age-predicted maximum heart rate, (c) RER > 1.1 and, (d) volitional fatigue (Thoden, 1991).

### 3.5 Assessment of Dietary Intake

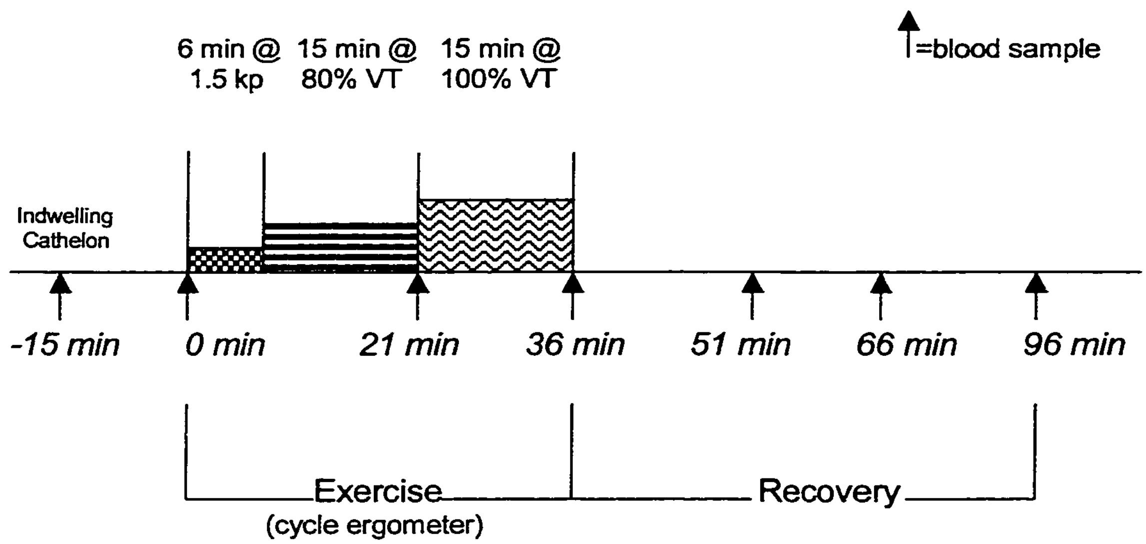
Dietary intake was assessed by the use of three-day food records during each of the two treatment phases as well as an initial baseline assessment, totalling three sets of diet records. The food records were completed by subjects over two weekdays and one weekend day. Each subject was instructed by a dietetic intern on how to record food intake, with particular detail in regards to serving size, amount, brand name and method of cooking. Subjects were instructed to maintain typical eating habits. Once completed, food records were reviewed and confirmed for accuracy with the participant by the dietetic intern. The records were analyzed by a computerized nutrient analysis software program, Food Processor II™ for Windows (ESHA Research, Oregon), measuring total caloric intake and relative macronutrient ratios (fat, carbohydrate, protein).

### 3.6 Self-Report Activity Records

On the day of testing, subjects were asked to complete the Modified Baecke Questionnaire on Physical Activity (Pols et al., 1995). The Baecke questionnaire is short and easy to complete (Appendix G), and provides an index of the amount of activity spent during work, sports, and leisure time.

### 3.7 Exercise Stress Protocol and Blood Collection

Participants were required to arrive at the Women's Health and Physical Activity Lab in the Faculty of Physical Education and Recreation, Room E-455, University of Alberta at either 2:00pm or 3:30pm. They were requested to refrain from physical activity the day of the exercise stress protocol and to refrain from eating for 2 hours prior to testing. Upon arrival at the lab, an intravenous cathelon was inserted by a registered nurse into the antecubital or cephalic vein prior to the start of the test and venous blood samples (7ml) were collected serially before exercise (-15, 0 min), during (21, 36 min), and after exercise (51, 66, 96 min) as illustrated in Figure 1 below.




***<u>Figure 1</u>: Exercise Stress Protocol and Blood Sample Collection***

Subjects performed 30 minutes of continuous exercise on a Monark cycle ergometer (Varberg, Sweden) comprised of 6 minutes of warm-up at 1.5kp, followed by 15 minutes at 80 percent ventilatory threshold (VT) and then 15 minutes at ventilatory threshold (determined from peak $VO_{2max}$), for a total exercise period of 36 minutes. A mouthpiece and hose system (Medgraphics, CA) was attached to the individual to monitor respiratory gases periodically during the exercise test to ensure that he was exercising at a workload that maintained the desired $VO_2$ depending on the exercise intensity. Subjects were given water on a frequent basis, but no food or other drink was permitted.

Blood samples (7ml) were obtained at each of the timepoints indicated in Figure 1. For lactate analysis, 0.5ml of the blood was pipetted into vacutainers containing 2ml of 4% perchloric acid in order to deproteinize the whole blood. This mixture was then vortexed briefly and set on ice for a minimum of five minutes before being centrifuged for 10 minutes at 4°C and 4000rpm. For hormonal analysis, the remaining 6.5ml of blood was allowed to clot at room temperature for approximately 45 minutes and then centrifuged at 4°C for 10 minutes at 4000rpm. Serum for both lactate and hormonal analysis was aliquotted and then stored at –80°C until analysis.

### 3.8 Analysis of Blood

#### 3.8.1 Lactate Analysis

A lactate standard solution of 0.40mg/ml (4.44mM) was diluted 5-fold to obtain the lactic acid working solution. Final concentration was 0.08g/ml. A lactate standard curve was prepared and 1.40ml of diluent was added to each sample tube, containing 0.10ml of serum. Each tube was vortexed briefly and incubated at 37°C for 45 minutes using a water bath. The spectrophotometer was initialized and the wavelength set at 340nm. The absorbance was measured for all tubes (samples were done in duplicate) and recorded. It was determined that the reaction had stopped when the absorbance stopped increasing, and this final number was deemed to be the absorbance value. To calculate the absorbance in mM, a regression equation was developed and applied to the sample values.

#### 3.8.2 Hormonal Analysis

All subject samples were analyzed in duplicate within the same assay. Serum was analysed for cortisol, insulin, and growth hormone. Serum samples were allowed to thaw one time and were then processed according to instructions provided by the manufacturers of the radioimmunoassay (RIA) reagent kits

(Diagnostic Products Corporation, CA). Controls with known concentrations were calculated in each assay to determine intra-assay variation. Precision of each assay was measured by a computer-generated coefficient of variability (CV). Acceptable intra-assay CV's were 6-15% (Chard, 1987).

### 3.9 Statistical Analysis

Data were analyzed statistically using Statistica 5.1 software program (Statsoft Inc., 1997, Tulso, OK). Paired, dependent t-tests were used to analyze and compare the ginseng and placebo groups for the following measures: REE, body composition, aerobic fitness, dietary intake, and physical activity. To analyze the hormone and lactate measures, two-way repeated measures ANOVAs (time x treatment) were used. An alpha level of 0.05 was used to establish significance. Post-hoc analysis, using Newman-Keuls, was conducted to determine differences between groups, when necessary.

# CHAPTER 4

# RESULTS

## 1. Demographics and Groupings

Ten males completed the requirements of this study. All subjects reported being in good health and free of any illness that would inhibit his ability to participate in the exercise protocol, including having no autoimmune and/or endocrine problems. No subjects reported taking medications or herbal supplements during the study.

Subjects were randomized to receive either ginseng or placebo for one month, followed by a three-month washout period, and then another month of treatment, ingesting the opposite treatment from the initial phase.

## 2. Subject Characteristics (Table 2)

There were no differences in body composition while participants were ingesting ginseng as compared to placebo. Weight, BMI, percent body fat, lean body mass, and fat mass did not significantly change.

***Table 2* - Body Composition Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]**

| Group | Weight (kg) | BMI ($kg/m^2$) | Percent Body Fat | Fat Free Mass (kg) | Fat Mass (kg) |
|---|---|---|---|---|---|
| Ginseng (n = 10) | 74.9±4.8 (68.4-82.5) | 22.9±1.3 (20.3-24.3) | 15.6±5.4 (10.1-26.0) | 63.2±5.7 (55.0-69.4) | 11.7±4.1 (7.4-19.4) |
| Placebo (n = 10) | 75.6±6.0 (66.6-84.6) | 23.1±1.6 (19.9-24.6) | 16.0±5.9 (10.0-26.7) | 63.5±6.4 (54.0-71.7) | 12.2±4.6 (7.4-19.7) |

**3. Resting Energy Expenditure** (Table 3)

REE was not significantly different between the ginseng and placebo treatments, when expressed in absolute terms, relative to body weight and/or relative to fat free mass.

***Table 3* – Resting Energy Expenditure Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]**

| Group | REE (kcal/day) | REE (kcal/kg body weight/day) | REE (kcal/kg FFM/day) |
|---|---|---|---|
| Ginseng (n = 10) | 1853.9 ± 306.4 (1302 – 2069) | 24.7 ± 3.4 (17.5 – 29.0) | 29.2 ± 2.8 (23.7 – 32.5) |
| Placebo (n = 10) | 1887.4 ± 274.5 (1292 – 2215) | 25.0 ± 3.4 (17.5 – 29.0) | 29.7 ± 2.6 (27.8 – 32.4) |

**4. Maximal Aerobic Consumption and Ventilatory Threshold** (Table 4)

Maximal aerobic consumption, expressed in litres per minute as well as relative to body weight, was not significantly different during ginseng versus placebo ingestion. Ventilatory threshold was identified for each subject and was not different across treatments. As well, maximum heart rate attained while cycling was also measured and not found to be significantly different between the treatments.

***Table 4* – Aerobic Fitness Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]**

| Group | $VO_{2max}$ (l/min) | $VO_{2max}$ (ml/kg/min) | VT (l/min) | VT (ml/kg/min) | VT: $\%VO_{2max}$ | Max HR(bpm) |
|---|---|---|---|---|---|---|
| Ginseng (n = 10) | 3.3±0.5 (2.4-3.9) | 43.9±5.8 (34.4-50.6) | 2.2+0.5 (1.6-3.1) | 29.8±5.6 (22.9-39.8) | 67.8± 7.3 (55.0-79.0) | 183 ± 11 (173-204) |
| Placebo (n = 10) | 3.4±0.4 (2.8-4.2) | 45.0±5.2 (38.0-51.3) | 2.2±0.2 (1.8-2.6) | 29.6±3.3 (21.7-33.2) | 66.0± 5.5 (56.0-73.0) | 182 ± 10 (170-199) |

**5. 3-Day Energy Intake** (Tables 5-8)

Absolute energy intake in kcal/day as well as relative to body weight and fat free mass was not significantly different between the ginseng and placebo treatments. Relative ratios of carbohydrate, fat, and protein were also not significantly different. Diet analysis was performed on eight rather than 10 subjects (n=8) due to the unavailability of 2 sets of diet records in the second phase of the study.

***Table 5* – Dietary Energy Intake Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]**

| Group | Energy Intake (kcal/day) | Energy Intake (kcal/kg/day) | Energy Intake (kcal/kg FFM/day) |
|---|---|---|---|
| Ginseng (n = 8) | 2513.9±290.8 (2137.0-2898.1) | 34.1±5.6 (27.7-42.4) | 41.0±7.0 (30.8-64.8) |
| Placebo (n = 8) | 2562.9±500.4 (1954.6-3498.9) | 34.5±8.4 (26.0-47.5) | 41.9±11.7 (30.6-64.8) |

***Table 6* – Carbohydrate (CHO) Intake Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]**

| Group | CHO Intake (g/day) | CHO Intake (g/kg/day) | CHO Intake (g/kg FFM/day) | Percent of Total Energy |
|---|---|---|---|---|
| Ginseng (n = 8) | 358.9±40.5 (284.0-408.6) | 4.8±0.6 (4.0-6.0) | 5.8±0.7 (4.8-6.8) | 56.7±7.3 (47.0-70.0) |
| Placebo (n = 8) | 377.1±93.5 (278.3-546.0) | 5.1±1.5 (3.5-7.4) | 6.2±2.0 (4.2-10.1) | 57.9±6.0 (46.0-63.0) |

***Table 7** – Fat Intake Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]*

| Group | Fat Intake (g/day) | Fat Intake (g/kg/day) | Fat Intake (g/kg FFM/day) | Percent of Total Energy |
|---|---|---|---|---|
| Ginseng (n = 8) | 78.4±23.5 (46.6-117.1) | 1.1±0.4 (0.6-1.7) | 1.3±0.5 (0.7-1.9) | 27.4±6.0 (19.0-36.0) |
| Placebo (n = 8) | 64.7±14.7 (51.1-89.5) | 0.9±0.2 (0.6-1.2) | 1.1±0.3 (0.8-1.7) | 22.5±3.4 (18.0-27.0) |

***Table 8** – Protein (PRO) Intake Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]*

| Group | PRO Intake (g/day) | PRO Intake (g/kg/day) | PRO Intake (g/kg FFM/day) | Percent of Total Energy |
|---|---|---|---|---|
| Ginseng (n = 8) | 95.6±18.2 (60.6-118.3) | 1.3±0.3 (0.8-1.5) | 1.6±0.3 (0.9-1.8) | 15.9±2.3 (11.0-18.0) |
| Placebo (n = 8) | 105.7±21.8 (83.0-143.7) | 1.4±0.3 (1.1-1.9) | 1.7±0.4 (1.2-2.4) | 19.6±4.0 (15.0-27.0) |

**6. Physical Activity Record** (Table 9)

Physical activity was assessed using the Baecke Physical Activity Questionnaire (Pols et al, 1995). No significant difference was found between ginseng and placebo ingestion.

***Table 9** - Baecke Physical Activity Questionnaire Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]*

| Group | Physical Activity Recall |
|---|---|
| Ginseng | 7.57 + 0.99 (6.30 – 9.10) |
| Placebo | 7.86 + 1.13 (7.05 – 10.10) |

**7. Hormonal and Lactate Concentrations** (Tables 10-19; Figures 2-5)

Exercise, regardless of treatment, had a significant effect on cortisol, growth hormone, insulin, and lactate, indicating that the exercise bout used in this study was of sufficient intensity to illicit a change over resting values in these measures for both placebo and ginseng treatments. These were anticipated responses to an acute bout of exercise (refer to Tables 10-13 for p-values reporting the main effect of time). Note that for cortisol (Figure 2), the 66min and 96min time points (post-exercise) were compared to exercise values instead of the -15min and 0min time points (pre-exercise). An anticipatory rise in cortisol due to stress of the cathelon and exercise obscured differences between rest and exercise concentrations (Mason et al, 1973). During recovery (66min, 96min), cortisol levels dropped significantly below exercise (21min, 36min) as expected.

When treatment was factored into the analysis, it was found that cortisol, growth hormone, and lactate were not significantly different during rest, exercise, or recovery after ingestion of either ginseng or a placebo, indicating that there was no treatment effect observed. It was found that insulin was not significantly different at rest or during recovery between ginseng and placebo treatment, but was significantly different for the two treatment groups during the acute exercise bout. The ginseng treatment group had higher levels of insulin compared to the placebo treatment, and this was significant at $\alpha = 0.05$. As indicated, the normal response of insulin with an acute bout of exercise is a decrease, and therefore the results indicated that there was significantly less of a decrease in insulin levels during exercise following ginseng treatment compared to placebo treatment. P-values for treatment are reported in Table 18.

***Table 10* – P-values for Cortisol Comparing Ginseng and Placebo Treatment With a Main Effect of Time**

| Time (min) | -15 | 0 | 21 | 36 | 51 | 66 | 96 |
|---|---|---|---|---|---|---|---|
| -15 | ———— | 0.104489 | 0.249941 | 0.492684 | 0.489489 | 0.109331 | 0.002883* |
| 0 | 0.104489 | ———— | 0.476777 | 0.239354 | 0.030090* | 0.000860* | 0.000138* |
| 21 | 0.249941 | 0.476777 | ———— | 0.361867 | 0.109178 | 0.000860* | 0.000162* |
| 36 | 0.492684 | 0.239354 | 0.361867 | ———— | 0.354821 | 0.005054* | 0.000617* |
| 51 | 0.489489 | 0.030090* | 0.109178 | 0.354821 | ———— | 0.039832* | 0.011169* |
| 66 | 0.109331 | 0.000860* | 0.005054* | 0.039832* | 0.180205 | ———— | 0.105659* |
| 96 | 0.002883* | 0.000138* | 0.000162* | 0.000617* | 0.011169* | 0.105659 | ———— |

*Denotes significance at α = 0.05

***Table 11* – P-values for Growth Hormone Comparing Ginseng and Placebo Treatment With a Main Effect of Time**

| Time (min) | -15 | 0 | 21 | 36 | 51 | 96 |
|---|---|---|---|---|---|---|
| -15 | ———— | 0.364699 | 0.000187* | 0.000143* | 0.000134* | 0.187316 |
| 0 | 0.364699 | ———— | 0.000406* | 0.000172* | 0.000144* | 0.975129 |
| 21 | 0.000187* | 0.000406* | ———— | 0.000917* | 0.236784 | 0.000887* |
| 36 | 0.000143* | 0.000172* | 0.000917* | ———— | 0.008853* | 0.000134* |
| 51 | 0.000134* | 0.000144* | 0.236784 | 0.008853* | ———— | 0.000197* |
| 96 | 0.187316 | 0.975129 | 0.000887* | 0.000134* | 0.000197* | ———— |

*Denotes significance at α = 0.05

***Table 12* – P-values for Lactate Comparing Ginseng and Placebo Treatment With a Main Effect of Time**

| Time (min) | -15 | 0 | 21 | 36 | 51 | 66 | 96 |
|---|---|---|---|---|---|---|---|
| -15 | ———— | 0.622719 | 0.000161* | 0.000132* | 0.014801* | 0.441597 | 0.365693 |
| 0 | 0.622719 | ———— | 0.000138* | 0.000136* | 0.003100* | 0.330004 | 0.984644 |
| 21 | 0.000161* | 0.000138* | ———— | 0.001956* | 0.001629* | 0.000123* | 0.000132* |
| 36 | 0.000132* | 0.000136* | 0.001956* | ———— | 0.000121* | 0.000161* | 0.000138* |
| 51 | 0.014801* | 0.003100* | 0.001629* | 0.000121* | ———— | 0.038416* | 0.002077* |
| 66 | 0.441597 | 0.330004 | 0.000123* | 0.000161* | 0.038416* | ———— | 0.219144 |
| 96 | 0.365693 | 0.984644 | 0.000132* | 0.000138* | 0.002077* | 0.219144 | ———— |

*Denotes significance at α = 0.05

***Table 13* – P-values for Insulin Comparing Ginseng and Placebo Treatment With a Main Effect of Time**

| Time (min) | -15 | 0 | 21 | 36 | 51 | 66 | 96 |
|---|---|---|---|---|---|---|---|
| -15 | ———— | 0.184042 | 0.000152* | 0.000140* | 0.000392* | 0.000459* | 0.000308* |
| 0 | 0.184042 | ———— | 0.000138* | 0.000136* | 0.000127* | 0.000166* | 0.000134* |
| 21 | 0.000152* | 0.000138* | ———— | 0.569905 | 0.446378 | 0.436240 | 0.423962 |
| 36 | 0.000140* | 0.000136* | 0.569905 | ———— | 0.248513 | 0.279927 | 0.359643 |
| 51 | 0.000392* | 0.000127* | 0.446378 | 0.248513 | ———— | 0.796834 | 0.769729 |
| 66 | 0.000459* | 0.000166* | 0.436240 | 0.279927 | 0.796834 | ———— | 0.667375 |
| 96 | 0.000308* | 0.000134* | 0.423962 | 0.359643 | 0.769729 | 0.667375 | ———— |

*Denotes significance at $\alpha = 0.05$

***Table 14* – Cortisol Concentration (μg/dL) During Exercise Comparing Ginseng and Placebo Treatments [mean + SD, (range)]**

| Group | -15 min | 0 min | 21 min | 36 min | 51 min | 66 min | 96 min |
|---|---|---|---|---|---|---|---|
| Ginseng (n = 10) | 12.8±6.0 (5.9-27.5) | 14.9±5.0 (9.2-25.8) | 13.5±4.3 (8.4-21.1) | 12.2±3.5 (7.0-18.6) | 11.0±2.8 (7.5-15.7) | 9.7±2.4 (6.4-13.4) | 8.3±2.6 (5.7-13.8) |
| Placebo (n = 10) | 10.6±3.0 (6.8-17.1) | 12.5±5.5 (6.7-22.3) | 12.7±5.8 (7.1-25.0) | 12.4±5.7 (6.1-24.7) | 11.1±4.5 (4.3-17.9) | 10.0±4.7 (4.1-19.0) | 8.6±3.5 (4.0-14.6) |

***Table 15* – Growth Hormone Concentration (ng/ml) During Exercise Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]**

| Group | -15 min | 0 min | 21 min | 36 min | 51 min | 96 min |
|---|---|---|---|---|---|---|
| Ginseng (n = 10) | 1.1±2.0 (0.0-5.5) | 1.1±2.7 (0.0-8.7) | 5.1±6.7 (0.0-23.1) | 9.3±7.3 (0.7-25.5) | 7.0±6.4 (0.0-20.1) | 1.8±3.0 (0.1-9.5) |
| Placebo (n = 10) | 0.4±0.8 (0.0-2.3) | 3.5±6.1 (0.0-15.7) | 8.4±9.2 (0.0-24.9) | 13.2±6.8 (4.9-26.4) | 9.3±4.8 (4.2-21.5) | 2.7±1.8 (0.4-6.2) |

***Table 16* – Lactate Concentration (mM) During Exercise Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]**

| Group | -15 min | 0 min | 21 min | 36 min | 51 min | 66 min | 96 min |
|---|---|---|---|---|---|---|---|
| Ginseng (n = 10) | 1.3±0.2 (1.1-1.5) | 1.3±0.1 (1.1-1.5) | 2.2±0.8 (1.6-4.1) | 2.4±0.7 (1.6-3.6) | 1.7±0.2 (1.4-2.1) | 1.5±0.2 (1.2-1.8) | 1.3±0.1 (1.2-1.5) |
| Placebo (n = 10) | 1.4±0.3 (1.1-2.2) | 1.3±0.2 (1.0-1.9) | 2.1±0.6 (1.3-3.0) | 2.6±1.0 (1.4-4.3) | 1.8±0.5 (1.4-2.8) | 1.5±0.3 (1.2-2.1) | 1.2±0.2 (1.0+1.5) |

***Table 17*** ***– Insulin Concentration (μIU/ml) During Exercise Comparing Ginseng and Placebo Treatments [mean ± SD, (range)]***

| Group | -15 min | 0 min | 21 min | 36 min | 51 min | 66 min | 96 min |
|---|---|---|---|---|---|---|---|
| Ginseng (n = 10) | 18.6±11.2 (9.8-47.1) | 21.5±10.5 (8.2-40.1) | 8.0±3.0 (4.6-14.5) | 7.1±3.5 (3.7-15.1) | 12.8±8.4 (3.3-31.0) | 11.3±8.1 (4.0-31.3) | 8.9±4.1 (5.1-16.1) |
| Placebo (n = 10) | 14.6±9.9 (5.4-41.1) | 16.5±6.8 (7.6-27.1) | 6.2±2.0 (3.9-10.3) | 5.1±2.5 (2.5-11.4) | 6.8±3.1 (4.0-12.5) | 7.3±3.1 (4.6-12.5) | 8.2±3.7 (5.6-18.2) |

***Table 18*** ***– P-values of Hormone and Lactate Measures Comparing Ginseng and Placebo with a Main Effect of Treatment***

| Measure | p-value |
|---|---|
| Cortisol | 0.715 |
| Growth Hormone | 0.226 |
| Lactate | 0.803 |
| Insulin | 0.053* |

* Denotes significance at α = 0.05

***Table 19*** ***– Normal Resting Hormone and Lactate Values***

| Cortisol | Growth Hormone | Insulin | Lactate |
|---|---|---|---|
| 3-12μg/dl (p.m.) | <7ng/ml | 0-30μU/ml | 1-2mM |

(Diagnostics Products Corporation, CA)

**8. Reported Side Effects of Treatment**

Two subjects reported transient, mild insomnia and hot flashes at the onset of the ginseng treatment, lasting two to three days. No adverse effects were reported during either the ginseng or placebo treatment in any other participants.

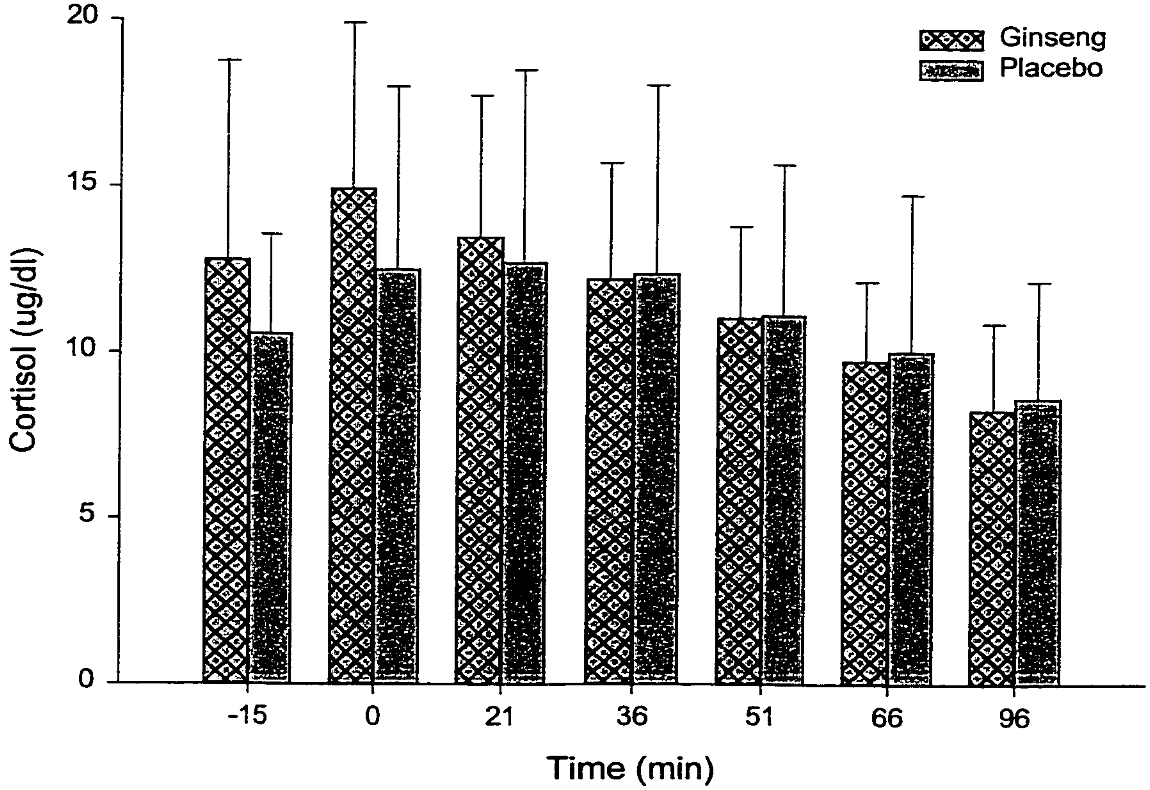



Figure 2: Cortisol Response to Exercise (mean±SD)

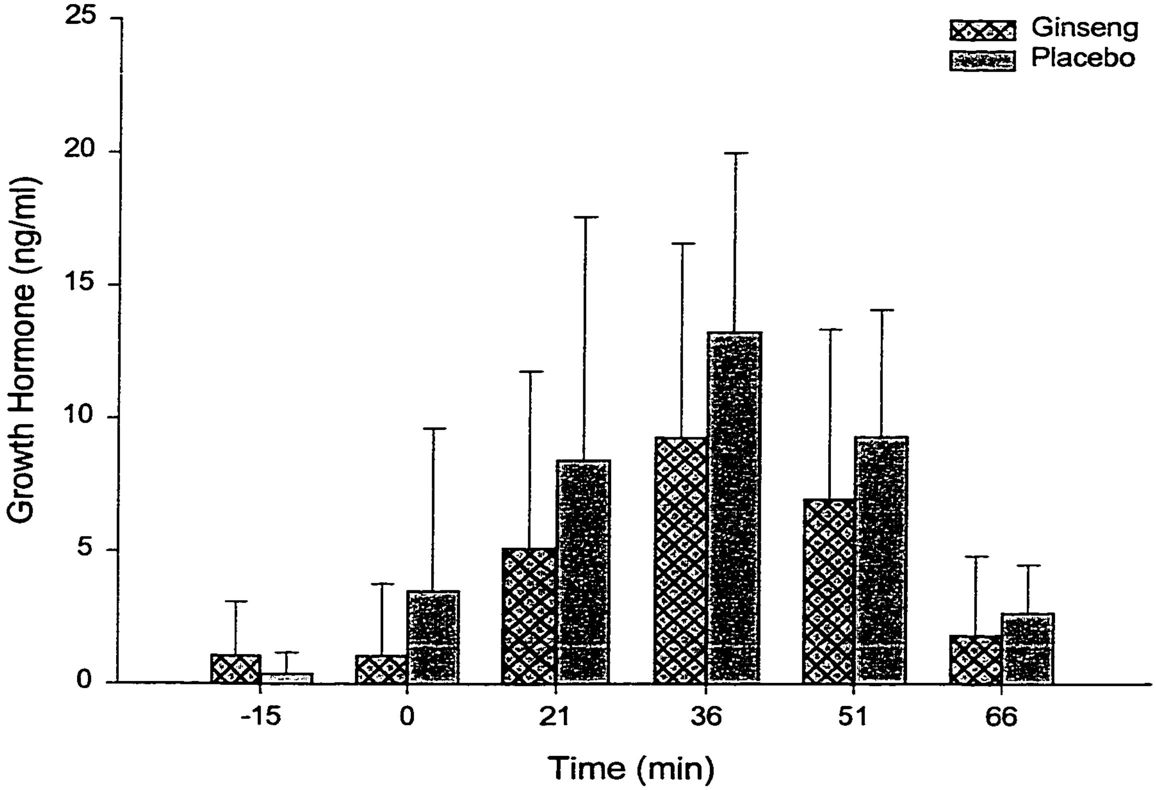



Figure 3: Growth Hormone Response to Exercise (mean±SD)

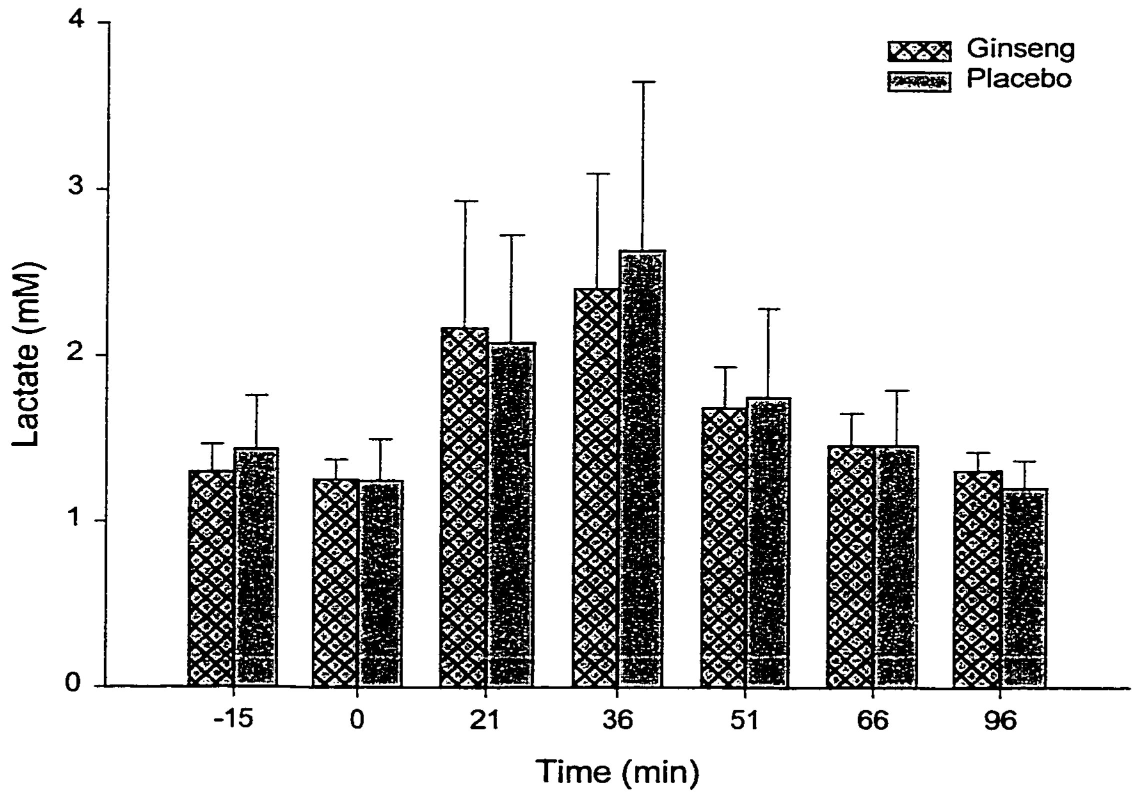



Figure 4: Lactate Response to Exercise (mean±SD)

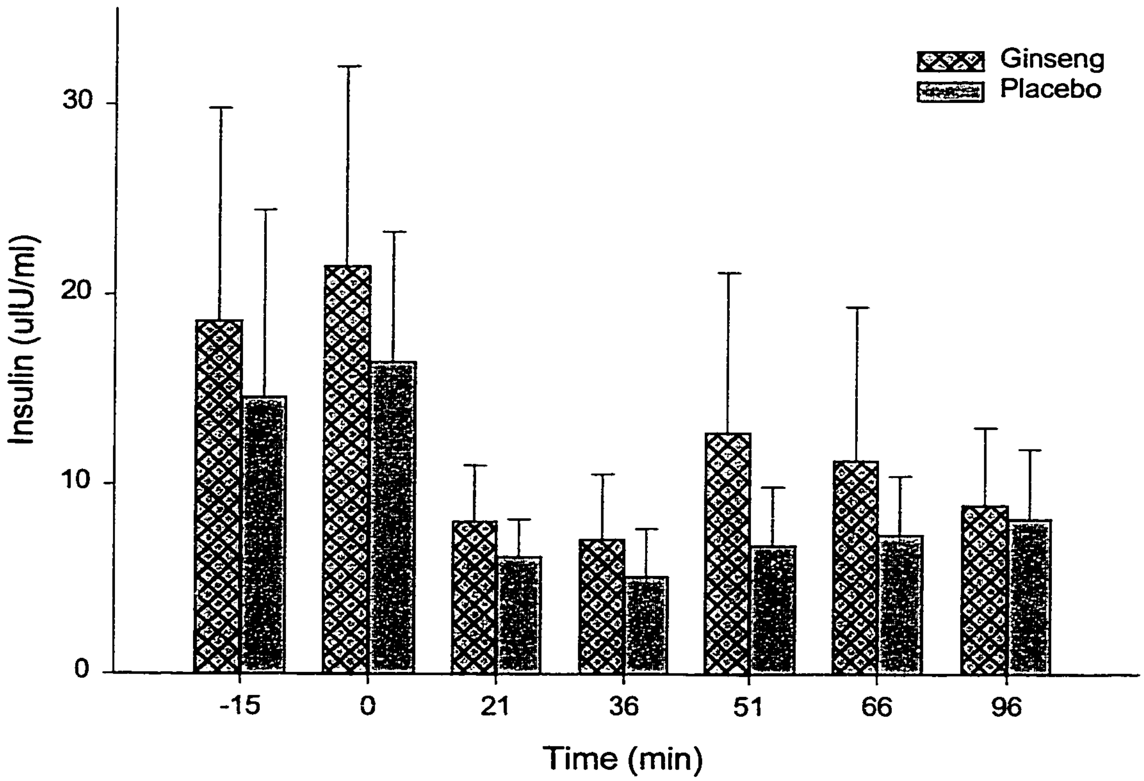



Figure 5: Insulin Response to Exercise (mean±SD)

*Effect of treatment was significant at p=0.053

# CHAPTER 5

# DISCUSSION

## 1. Introduction

Ginseng is one of the most popular and expensive herbs in the world (O'Hara et al, 1998). It is estimated that alternative or complementary medicine is used by 20 to 30 percent of the general North American population (Wong et al, 1998). At least 6 million Americans use the root of ginseng and the world market is said to be around one billion dollars per year (Beltz & Doering, 1993). Although ginseng-users claim that regular use of the herb will reduce stress, strengthen metabolism, increase physical stamina, and stimulate the immune system (Bahrke & Morgan, 1994), North American ginseng and its effects on humans have not been widely researched. However, research performed using rats has shown that ginseng may act as an adaptogen, decreasing the response to stress, for example, during an acute bout of physical exercise (Fulder, 1981; Hiai et al, 1979; Martinez & Staba, 1984; Ng & Yeung, 1985; Avakian et al, 1984).

The present study examined the effects of ginseng in moderately active males. Participants were assessed after one month of either ginseng or placebo ingestion and then again after one month of the opposite treatment, following a three month wash-out period. At the end of each one month treatment period, the following components were assessed: REE, body composition, physical activity level, dietary intake, and aerobic fitness, as well as the metabolic and hormonal response to an acute bout of exercise (cortisol, growth hormone, insulin, and lactate). A review of the hypotheses of the present study will follow and where literature exists regarding comparisons to the findings of this study, discussion will be included.

## 2. Subjects

Subjects were screened prior to the study through an aerobic fitness test to ensure that their $VO_{2max}$ values were below 50 ml/kg/min. A Baecke Physical Activity Questionnaire was also administered (Pols et al, 1995) to determine activity level. These two measures were valuable to the study, as the first treatment administration occurred following summer holidays, and several participants indicated that they tended to be more active in the summer rather than in the winter, when the second treatment was administered. No differences were found in reported activity level, $VO_{2max}$, or VT, between the ginseng and placebo groups, indicating that fitness level had not significantly altered and influenced results. Although many claims have been made that ginseng will enhance physical performance (O'Hara et al, 1998; Petkov et al, 1987; Wang & Lee, 1998), little substantiated evidence exists to show this, and this study did not support an ergogenic effect of ginseng on $VO_{2max}$ or VT. Differing results across studies may be due to discrepancies between quality control of ginseng, methodological variations, and simply the lack of research performed in this area. There may also be interactions with diet, lifestyle, exercise, and other drugs (Fulder, 1981). These factors were controlled for as best as possible, by standardizing time of last meal before testing, instructing participants not to exercise the day of testing, and by ensuring that participants were not ingesting any other medicines or herbal supplements throughout the study.

Body composition was also measured and it was found that there were no significant changes in weight, BMI, percent body fat, fat free mass, or fat mass with either ingestion of ginseng or placebo. The review of literature performed for this study did not uncover research involving the effect of ginseng on body composition and therefore comparisons of the results of this study to other studies cannot be made.

**3. Energy Intake**

Energy intake was measured using a 3-day prospective dietary format, recording food intake over two weekdays and one weekend day. The use of dietary records for assessing energy and macronutrient intake has limitations, mainly the tendency for subjects to under-report energy intake or to restrict food intake during the period of data collection (Romieu et al, 1988). No significant differences in total energy intake or ratio of macronutrients were found between the ginseng and placebo treatments, and thus consistency was maintained, regardless of the limitations of using dietary records.

**4. Resting Energy Expenditure**

It was hypothesized that resting energy expenditure may have decreased with ginseng ingestion. This was due to claims made by North American ginseng-users (*Panax quinquefolius*) that the herb has an anti-stress, cooling effect (Court, 1975, Bahrke, 1994), possibly resulting in decreased energy expenditure at rest. REE did not decrease with the ginseng treatment and therefore the claim that it affects metabolism was not supported in this study. A dose response curve has not yet been established to examine the efficacy of ginseng, but daily doses as low as 0.5g are reported to be therapeutically effective and 2 to 3g are recommended to achieve stimulation (Siegel, 1979). Subjects were given 3g daily but other studies have administered doses of up to 50g per day (Bruce et al, 1985; Seigel, 1979; Dubick, 1986) and therefore 3g may not have been a sufficient dose to elicit a response, specifically a decrease in REE.

## 5. Lactate and Hormone Concentrations

### 5.1 Lactate

Lactate levels are generally found to be steady at 1 to 2mM and then rise in an exponential fashion at approximately 55 to 60 percent $VO_{2max}$ in healthy, untrained individuals (Costill, 1973; Davis, 1979). Subjects exercised for 15 minutes at VT, which corresponded to a mean of $67.8 \pm 7.2\%$ $VO_{2max}$ for the ginseng treatment and $66.0 \pm 5.5\%$ $VO_{2max}$ for the placebo treatment, and it was found that lactate significantly increased at 21, 36, and 51 minutes over resting values for both the ginseng and placebo treatments.

Ginseng has been classed as an adaptogen because studies suggest that it helps the body adapt to stress (Siegel, 1979) and in fact may be more or only effective in stressed, impaired, or injured animals (Dubick, 1986). The exercise-induced increase in lactate was not different between treatments, therefore it is possible that a greater intensity of exercise may be required, as subjects reported that the exercise stress was only moderate. Using a rating of perceived exertion (RPE) scale, as an indicator of physical strain, may be a valid and simple method of determining exercise intensity in addition to VT, because the overall perception rating integrates many sources of information elicited from the peripheral working muscles and joints, central cardiovascular and respiratory functions, and central nervous system (Borg, 1973).

### 5.2 Cortisol

It was hypothesized that cortisol would increase with exercise, but that this increase would be reduced with ginseng ingestion. Research has shown that cortisol increases with activation of the HPA axis at approximately 60 to 70 percent maximal oxygen consumption (Howlett, 1987; Galbo, 1981; Luger et al, 1987). As reported above, subjects were exercising at $67.8 \pm 7.2\%$ $VO_{2max}$ for the ginseng treatment and $66.0 \pm 5.5\%$ $VO_{2max}$ for the placebo treatment. This intensity was sufficient to elicit a statistically significant rise in cortisol levels during exercise over resting values for both treatments, but a difference between ginseng and placebo was not detected. It may be speculated that the ginseng dose or duration was not sufficient, and this may be an explanation for the lack of distinction between the ginseng and placebo treatments, with respect to cortisol.

### 5.3 Growth Hormone

As with lactate and cortisol, growth hormone was not found to be significantly different between the ginseng and placebo trials. With successively increasing exercise intensities, there is a rise in GH production and secretion (Galbo, 1981; Galbo, 1983, Luger et al, 1992; Pritzlaff et al, 1999), and in a standard submaximal bout of exercise, the GH response is greater in unfit individuals compared to trained counterparts (Sutton et al, 1986). Because this absolute workload represents a greater demand on the less fit, it appears that the release of GH is in some way related to the relative strenuousness of effort (McArdle et al, 1991).

GH was found to significantly increase with exercise from resting levels of approximately 1.1$\pm$2.7ng/ml and 3.5$\pm$6.1ng/ml to immediately post-exercise values of 9.3$\pm$7.3ng/ml and 13.2$\pm$6.8ng/ml for the ginseng and placebo treatments, respectively. A statistically significant difference was not observed for the effect of ginseng on GH levels during the acute bout of exercise and this may be attributable to the dose or duration of ginseng treatment.

### 5.4 Insulin

During exercise of increasing intensity and duration, circulating levels of blood glucose and insulin progressively decrease (Björntrop, 1977; Galbo, 1977). Training increases sensitivity to insulin and thus the exercise-induced decrease in insulin is blunted in trained individuals (Farrell et al, 1988). Ginseng, acting as an adaptogen, is purported to have the same effect as training; they both decrease the response to a physical stress.

In this study, insulin decreased with exercise as expected in both the ginseng and placebo treatments, but this response was significantly reduced in the ginseng treatment, which experienced a statistically smaller reduction in insulin. As mentioned above, ginseng is considered to be an adaptogen and may have effects similar to that induced by training, in that in less stressed individuals a reduced response may be observed. As a consequence of training, the level of insulin is maintained closer to resting values in response to exercise (Farrell et al, 1988; Mikines et al, 1987). This attenuated response with training may be accomplished in one of several ways. It is possible that physical training increases an individual's sensitivity to insulin and consequently, less insulin would be required to regulate blood glucose after training than before (Dolkas, 1990; Farrell, 1988; Mikines, 1987). This improved insulin sensitivity may be related to the binding capacity of insulin to receptor sites of individual muscle cells (Devlin et al, 1987). Thus, during bouts of exercise, the trained person is able to spare carbohydrate and use fat as a fuel, resulting in a lowered insulin requirement (Devlin et al, 1987). As well, a smaller insulin output is required to clear any excess glucose from the circulation (Devlin et al, 1987).

Research regarding ginseng and its influence on insulin is not well documented and study results are variable. Hiai and colleagues (1979) administered ginseng intraperitoneally to rats and found that it induced a decrease in insulin, while Kimura (1981), found that ginseng produced an increase in blood insulin in both diabetic and normal mice. Ng and Yeung (1985) also found that ginseng had an effect in diabetic mice by producing an increase in insulin, but in contradiction to the former study, showed no effect in normal mice. Waki (1982) showed that a long-term treatment of a component of ginseng stimulated insulin biosynthesis in pancreatic islets of hyperglycaemic rats, while Martinez and Staba (1984) found that ginseng administered to rats, had no effect on insulin levels.

As is evident from the brief review above, the available literature provides conflicting evidence regarding the effect of ginseng on insulin, with studies stating that it increases, decreases, or has no effect on insulin. Quality control with regards to time of testing, prior food intake and/or exercise, and dose and duration of treatment may be a factor in these studies, and the lack of human research is a limitation. In a recent study by Vuksan and colleagues (2000a), it was found that with ingestion of an oral dose of 3g of ginseng taken in conjunction with an oral glucose challenge, no differences in glycemic level were found in individuals without diabetes, but when ginseng was ingested 40 minutes before the glucose challenge, significant reductions were observed. In subjects with type 2 diabetes mellitus, the same was true whether capsules were taken before or together with the glucose challenge.

In a follow-up study, Vuksan et al (2000b) randomly administered 0, 3, 6, or 9g of ginseng root 120, 80, 40, or 0 minutes before a 25g oral glucose challenge. Analysis demonstrated that treatment but not time of administration significantly reduced post-prandial glycemia, irrespective of dose. No more than 3g of ginseng were required at any time in relation to the challenge to achieve reductions, indicating that a maximal biological response may have occurred with this dose..

Although research to date provides contradictory evidence, the hypothesis that ginseng influences glucose in humans is reasonably supported (Vuksan et al, 2000a; Vuksan et al, 2000b), and this may be a factor in changes in insulin sensitivity with future implications for diabetes treatment.

## 6. General Discussion and Summary

The blunted exercise-induced decrease of insulin in those individuals ingesting ginseng may provide further insight into the herb's purported ergogenic effects. Although there were no differences in growth hormone, cortisol, or lactate, the data presented in this study is not sufficient to disprove a possible effect on these measures. The administered exercise stress significantly altered the level of hormones and lactate over resting values, and therefore it may be that the ginseng dose or duration of treatment was not sufficient.

A dose-response relationship has not been established for ginseng's influence on hormonal and metabolic measures used in this study. Vuksan and colleagues (2000a) found that 3g of ginseng, compared to 0, 6, and 9g was sufficient to elicit a glucose response in individuals with and without diabetes. A similar design has not been published outlining a dose-response relationship for cortisol, growth hormone, insulin or lactate, and the dosage of 3g per day in the current study may not have been adequate for a response to be observed for these measures. Two subjects reported insomnia for the first few nights when ingestion of ginseng began and the same two subjects reported hot flashes for a transient period while adjusting to the treatment (two to three days), but other than this, no adverse effects were reported. In future, a larger dosage may be administered which may provide different results. In China, daily doses have been given up to 50g, and some large doses have resulted in insomnia, depression, and nervous disorder. Other side effects associated with doses ranging from 3 to 15g/day include nervousness, loose stools, high blood pressure, hypertension, confusion, and acne (Siegel, 1979; Bruce et al, 1985; Dubick, 1986).

In addition, capsules were standard-sized and therefore all participants received 3g per day, regardless of weight or fat free mass of individuals. Establishing a more precise measure of ginseng ingestion is also suggested, based on body weight and/or fat free mass. The range of ginseng ingested was between 0.036g/kg and 0.044g/kg of body weight (mean = 0.040$\pm$0.003g/kg) and 0.043g/kg and 0.055g/kg fat free mass (mean = 0.286$\pm$0.092g/kg FFM). The question has been raised as to whether the positive treatment results in studies with animals can be attributed to higher doses of ginseng. In a comparison of seven animal studies using rats, the dosage relative to body weight ranged from 0.005g/kg to 0.033g/kg. The ranges in these animal studies were either similar or lower than the dosages used in the current study, indicating that relative to body weight, ginseng results may be comparable between animal and human studies. One limitation in comparing results of animal studies to human studies, is that dosage relative to FFM has not been reported, and this may be a consideration for future research.

Adherence to this study was not monitored, in that investigators did not witness all consumption of capsules, and it is possible that subjects forgot to take pills throughout the day or took more than the required amount to make up for missed pills on other days. In order to limit the possibility of this, subjects were telephoned weekly to maintain contact and encourage compliance. Subjects were requested to refrain from physical activity on the day of testing, and cease eating at least two hours prior to testing. This was not supervised, and may not have been adhered to. Providing subjects with a standard meal and specific time to eat prior to testing is suggested for future research to increase standardization and decrease the possibility of non-compliance.

It has been purported that after only eight days of ginseng ingestion, individuals experience an ergogenic effect (Asana et al, 1986) and other studies report positive results after 15 days (Gribaudo et al, 1990), and 30 days (McNaughton, 1989), with as little as 1g ingested daily. Participants in this study ingested ginseng for a period of 30 to 35 days, but once again, a minimum threshold for ginseng administration has not been established in the literature.

These factors could all have influenced the lack of a statistically significant decrease in REE or altered hormonal and metabolic response to exercise (with the exception of insulin), as was hypothesized to occur due to a change in metabolism and stress response resulting from ginseng ingestion.

Previous ginseng research has focused mainly on animal models, and few studies exist which claim positive results with humans. Research involving the stress response to ginseng is very limited with few papers available regarding ginseng's influence on cortisol, growth hormone, insulin, and lactate, in addition to resting energy expenditure. Results from this study suggest that ginseng influences insulin levels during exercise, and further investigation is warranted to develop both a dose-response relationship for stress markers of ginseng with respect to dosage of ginseng, duration of treatment, and intensity and duration of exercise administered.

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# Appendix A

## Recruitment Poster

**University of Alberta**
Faculty of Agriculture, Forestry, and Home Economics
Faculty of Physical Education and Recreation

# Ginseng and Exercise Study

Volunteers are needed for a study on ginseng and exercise. If you volunteer and meet the study entry criteria, you will receive:

**Free Body Composition Assessment!**
**Free Aerobic Fitness Testing!**
**Free Dietary Assessment!**

Are you:

- In Good Health?
- Male?
- 18-35 Years Old?
- Low to Moderately Active?
- Willing to give Blood Samples?

**For More Information, Please Contact:**
Sarah Robbins @ 492-4267 (email: sarah@ualberta.ca)
Jen Humphreys @ 492-8739 (email: jdh6@ualberta.ca)

# Appendix B

## Study Information Sheet

**UNIVERSITY OF ALBERTA**
FACULTY OF AGRICULTURE, FORESTRY, AND HOME ECONOMICS
FACULTY OF PHYSICAL EDUCATION AND RECREATION

Effects of ginseng on stress response and immune response

**Investigators:** Linda McCargar, Catherine Field, Vicki Harber, Sarah Robbins, Jennifer Humphreys

## Study Information Sheet

## Purpose

Ginseng-users claim that regular use of the herb will reduce stress, strengthen metabolism, increase physical stamina, and stimulate the immune system. Many of these claims have not been scientifically documented. In addition, there is little information specifically on the North American variety of ginseng, *Panax quinquefolius.*

**The purpose of our study is to investigate the effects of daily consumption of an oral dose of *Panax quinquefolius* on stress response and immune response after acute physiological stress (an intense exercise protocol).**

## Study Protocol

### I. ENTRY CRITERIA

- good health (ie: free of diabetes, thyroid, autoimmune disease)
- male
- ages 18-35 years
- ability to perform strenuous activity
- not taking any medications or herbal supplements
- non-smokers
- $VO_{2max}$ less than 50ml/kg/min as determined by an aerobic fitness assessment: Maximal aerobic consumption ($VO_{2max}$) will be determined through progressive exercise to volitional fatigue on a cycle ergometer. Muscle discomfort/soreness, shortness of breath, and abnormal heart rate and blood pressure are possible side effects associated with maximal aerobic consumption ($VO_{2max}$), but are rare in healthy young individuals. (TIME = 1 HOUR)
- Body Mass Index (BMI) of 20-27: BMI will be obtained through the administration of a demographic questionnaire, at which time height and weight will also be taken.

### II. GINSENG AND PLACEBO TREATMENT

You will receive ginseng capsules for one month and placebo capsules for one month. Some side effects of the ginseng capsule that may be experienced include: irritability, insomnia, dizziness, hypertension, and diarrhea. If you experience any of these symptoms, please contact one of the investigators immediately. The investigators will contact you throughout the treatment periods to ensure that you are not experiencing side effects from the capsules.

**III. STUDY PROTOCOL** – These tests will be scheduled and conducted over several days for a total time commitment of approximately 8 hours. You will be required to complete these tests at the end of each of the two treatment periods.

**Study Timeline:**

| **Subject Recruitment** | **Phase 1: One-Month Ginseng or Placebo Treatment** | **Phase 2: Three-Month Wash-out Period** | **Phase 3: One-Month Ginseng or Placebo Treatment** |
|---|---|---|---|
| Demographic Questionnaire | Three-Day Food Records, $VO_{2max}$ testing | | Three-Day Food Records, $VO_{2max}$ testing |
| $VO_{2max}$ testing | Baecke Activity Questionnaire | | Baecke Activity Questionnaire |
| | Resting Energy Expenditure Measurement | | Resting Energy Expenditure Measurement |
| | Under Water Weighing | | Under Water Weighing |
| | Exercise Stress Protocol, Blood Collection | | Exercise Stress Protocol, Blood Collection |

1. **Assessment of Dietary Intake:** You will be instructed how to record your food intake for the duration of two week-days and one weekend day. You will return the completed food records to the investigators on the testing day. (TIME = 2 HOURS)

2. **Self-Report Activity Records:** On the day of testing, you will be asked to complete the Modified Baecke Questionnaire on Physical Activity. It is short and easy to complete and provides an index of the amount of activity spent during work, sports, and leisure. (TIME = 30 MINUTES)

3. **Resting Energy Expenditure (REE):** Resting metabolic rate will be taken in the metabolic testing laboratory in the Agriculture-Forestry Building. The measurements will be taken immediately upon your arrival at the University. You will be required to fast and refrain from exercise 12 hours prior to arriving at the test site by motor vehicle. After resting on a cot in the supine position for 30 minutes, a transparent hood will be placed over your head and the test started. The test, which will measure inhaled oxygen and exhaled carbon dioxide, will last approximately 30 minutes. (TIME = 1 HOUR)

4. **Underwater Weighing:** Residual lung volume will be measured by the helium dilution technique. You will be required to breathe a very small amount of helium and do some breathing exercises into a machine that measures the volume of air you inhale and exhale. Body density will be measured by underwater weighing at the University of Alberta. A swimsuit is worn and the water is pleasantly warm. Changing facilities are located adjacent to the test pool. You will be briefly submerged underwater approximately 6 times in order to get a constant measure of your body density. (TIME = 2 HOURS)

5. **Exercise Stress Protocol and Blood Collection:** You will perform 30 minutes of continuous exercise on a stationary bicycle. The first 15 minutes will be of moderate intensity, while the second 15 minutes will be more intense. An intravenous catheter will be inserted in your arm prior to the start of the test, so that blood samples can be taken before, during, and after the exercise. The total amount of blood taken will be equivalent to 70 ml. (Blood donations usually take 500ml). You will receive support and encouragement throughout the exercise protocol. (TIME = 2.5 HOURS)

[redacted]

**Confidentiality**

The confidentiality of all data and subjects' identities will be ensures. All data will be locked in a filing cabinet in a locked office to which only the principle investigators will have access.

[redacted]

**We strongly encourage questions for clarity and understanding of the above outlined study.**
**For further information, please feel free to contact:**
**Sarah Robbins @ 492-4267 (email: sarah@ualberta.ca) or**
**Jennifer Humphreys @ 492-8739 (email : jdh6@ualberta.ca)**

# Appendix C

## Subject Consent Form

**UNIVERSITY OF ALBERTA**
FACULTY OF AGRICULTURE, FORESTRY, AND HOME ECONOMICS
FACULTY OF PHYSICAL EDUCATION AND RECREATION

**Effect of [illegible] on the [illegible] response and immune response**

**Investigators:** Linda McCargar, Catherine Field, Vicki Harber, Sarah Robbins, Jen Humphreys

## SUBJECT CONSENT FORM

This study has been satisfactorily explained to me and I understand the necessity for the protocol outlined in the Study Information Sheet. I know that I may contact the persons designated on this form at any time if I have any further questions. I have been informed of the possible benefits of joining this research as well as the possible risks and discomforts. I have been assured that the information obtained from my participation in this study may be published in medical reports, but that my personal records will be kept confidential. I understand that I am free to withdraw from this study at any time without prejudice. I understand that I will be promptly informed of any findings which may develop during the research period that may affect my willingness to continue participating in the study. I understand that I will be given a copy of the Study Information Sheet and the signed Consent Form to keep.

| | | |
|---|---|---|
| ______________________ | ______________________ | ______________________ |
| Subject Name (print) | Subject Signature | Date |
| ______________________ | ______________________ | ______________________ |
| Witness Name (print) | Witness Signature | Date |
| ______________________ | ______________________ | ______________________ |
| Investigator Name (print) | Investigator Signature | Date |

**Questions or concerns may be directed to:**
**Sarah Robbins @ 492-4267 (email: sarah@ualberta.ca) or**
**Jen Humphreys @ 492-8739 (email: jdh6@ualberta.ca)**

# Appendix D

## Physical Activity Readiness Questionnaire (PAR-Q)

Physical Activity Readiness
Questionnaire - PAR-Q
(revised 1994)

# PAR - Q & YOU

**(A Questionnaire for People Aged 15 to 69)**

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

| YES | NO | | |
|---|---|---|---|
| ☐ | ☐ | 1. | Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor? |
| ☐ | ☐ | 2. | Do you feel pain in your chest when you do physical activity? |
| ☐ | ☐ | 3. | In the past month, have you had chest pain when you were not doing physical activity? |
| ☐ | ☐ | 4. | Do you lose your balance because of dizziness or do you ever lose consciousness? |
| ☐ | ☐ | 5. | Do you have a bone or joint problem that could be made worse by a change in your physical activity? |
| ☐ | ☐ | 6. | Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition? |
| ☐ | ☐ | 7. | Do you know of <u>any other reason</u> why you should not do physical activity? |

## If you answered

### YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

### NO to all questions

If you answered NO honestly to <u>all</u> PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.

**DELAY BECOMING MUCH MORE ACTIVE:**

- if you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- if you are or may be pregnant — talk to your doctor before you start becoming more active.

**Please note:** If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

<u>Informed Use of the PAR-Q</u>: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

**You are encouraged to copy the PAR-Q but only if you use the entire form**

*NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.*

I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction.

NAME ______________________________

SIGNATURE ______________________________ DATE ____________________

SIGNATURE OF PARENT ______________________________ WITNESS ____________________
or GUARDIAN (for participants under the age of majority)

continued on other side...

# Appendix E

## Demographic Questionnaire

# <u>DEMOGRAPHIC QUESTIONNAIRE</u>

Name:______________________________ Date:______________________________

Address:____________________________ Telephone (Home):__________________

____________________________________ (Work):__________________

____________________________________ E-mail:____________________________

Date of Birth:_________________________ Age:________________

[redacted]

**Please answer the following questions as accurately as possible. Please ask for clarification where needed.**

1. Have you experienced a weight loss or gain (+/- 3Kg or 6.6lbs or more) in the last 2 months?
   Yes_______ No_______
   If yes, specify the amount of weight lost (-) or gained (+)
   __________________

2. List any prescribed medication or over-the-counter medication you regularly take:
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

3. List any vitamin supplements, herbal supplements, or other dietary supplements that you take (please include herbal teas, cold remedies, weight gain/loss supplements):
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

4. Do you have a heart, liver, or renal disease? Yes_______ No_______

5. Do you have diabetes or a thyroid disorder? Yes_______ No_______

6. Do you have an autoimmune disease? Yes_______ No_______

7. Do you have any chronic or "nagging" musculoskeletal aches or pains (eg. Sore knees, weak back)?

Yes_______ No_______

If yes, indicate the location of your ache or pain and describe any related physical limitations:______________________________________________________________

______________________________________________________________

8. Are you allergic to any drugs, food or beverages? Yes_______ No_______

If yes, please list:______________________________________________________________

______________________________________________________________

9. Have you ever, or do you currently, take ginseng? Yes_______ No_______

If yes, please describe the type, amount, and duration that you have taken ginseng:

______________________________________________________________

______________________________________________________________

10. Do you smoke: Yes_______ No_______

11. Are you comfortable putting your head under water? Yes_______ No_______

12. Are you afraid of needles? Yes_______ No_______

## Physical Activity

1. Are you involved in a regular routine of physical activity? Yes_______ No_______

If "YES"...

(a) Does your routine include **4 or more sessions** a week? Yes_____ No_______
For how long have you been doing this routine? ____________________

(b) Does your routine **exceed 3 hours** a week? Yes_______ No_______
For how long have you been doing this routine? ____________________

2. Please list and describe ALL of the physical activities that you are involved in:

| ACTIVITY | DURATION (MIN/SESSION) | FREQUENCY (SESSIONS/WEEK) | INTENSITY* |
|---|---|---|---|
| Eg. Running | 20 | 4 | 1 2 3 4 5 |
| 1. | | | 1 2 3 4 5 |
| 2. | | | 1 2 3 4 5 |
| 3. | | | 1 2 3 4 5 |
| 4. | | | 1 2 3 4 5 |
| 5. | | | 1 2 3 4 5 |
| 6. | | | 1 2 3 4 5 |

*INTENSITY: 1 – Not vigorous at all (very light) 2 – Somewhat vigorous (light)
3 – Moderately vigorous (medium) 4 – Vigorous (heavy)
5 – Extremely vigorous (very heavy)

**Subject Availability**

All tests and exercise sessions will be scheduled at your convenience. Remember that the test day will take from 9am-5pm. Please indicate the days when you are available for testing and exercise sessions. You will be required to attend a testing day at the end of each ginseng treatment period.

| TIME SLOT | MON | TUES | WED | THURS | FRI | SAT | SUN |
|---|---|---|---|---|---|---|---|
| 9am-5pm | | | | | | | |

Please feel free to add other comments you think are important for us to know:

________________________________________
________________________________________
________________________________________
________________________________________
________________________________________

# Appendix F

## Diet Record Information Sheet

## WHAT DO YOU EAT ???

You will be recording your daily intake of food and fluids for a series of consecutive days. They must include at least *one* weekend day (Saturday or Sunday).

It is imperative that you record EVERYTHING that you eat and drink (water as well!!). In addition, you must be as ACCURATE as possible when determining the amount (volume or weight) of the food and drink you are recording. It may be difficult for those in residence or for those who are not in complete control of your food intake (preparation, amount, etc.). Use measuring cups/spoons and weigh scales whenever possible.

### HINTS FOR RECORDING DIETARY INTAKE

**ACCURACY**

1. Accurate Measurement Read the weights or volumes of foods or drinks from packages. Example: milk carton, juice box, chocolate bar, potato chips. A "fistful" of meat = 100 gm, "fistful" veggies = 1 cup, 1 cheese single = 1 oz.

2. Method of cooking Indicate how your food was cooked. Example: fried, steamed, baked, broiled etc.

3. "Extras" Don't forget the EXTRAS. Example: ketchup, mustard, mayonnaise, gravy, or butter.

4. Food Types Be specific about TYPES of food/drink. Example: cheddar cheese, 2% milk, margarine or butter. Whenever possible, identify brand names of the foods.

5. Cooked or Dry Measurement Indicate whether the food measurement is "cooked" or "dry". Example: chicken weight before or after cooked.

6. Specific Parts Indicate the exact part of the food you ate or what was removed before eating. Example: chicken (white or dark, bone in or out, skin or skinless), baked potato (skin or skinless), ground beef (lean, extra lean, or regular).

7. Labels Read the nutritional information label from the container (box/can/bag). This will help identify specific brand food nutrients. If you can't find the specific food during your analysis, then you can enter the required data from the label.

**BEVERAGES**

8. TEA AND COFFEE should be included as well along with the cream, milk and sugar you add.

9. Don't forget WATER.

10. Yes, you do have to record BEER and ALCOHOL as well.......!!

**PREPARED OR RESTAURANT MEALS**

11. Use PORTION PAKS whenever possible. Example: salad dressing, butter, jams, peanut butter, cheese. It is easier to quantify the volume of these foods...1 portion pak = 1 tablespoon.

12. Fast Foods Include FAST FOOD items by name. Example: McDonald's, Pizza Hut, Wendy's.

13. Recipes Record the amount/volume of ingredients, the number of servings or volume the entire recipe makes and how many servings or what volume you ate.

14. Restaurant Meals When you eat at a restaurant (other than a fast food place, eg. Earl's), record the name of the meal you ate, list the different ingredients on your plate and the quantities of each.

***TAKE THE RECORD BOOK WITH YOU AT ALL TIMES.....IT'S EASIER TO RECORD WHAT YOU'RE EATING.***

- - - - - - - - - - - - - - -

# Appendix G

## Baecke Activity Questionnaire

## *Baecke Questionnaire*

1. What is your main occupation?

Please check the box that most accurately answers the following questions:

| | Never | Seldom | Sometimes | Often | Always |
|---|---|---|---|---|---|
| 2. At work I sit… | | | | | |
| 3. At work I stand… | | | | | |
| 4. At work I walk… | | | | | |
| 5. At work I lift heavy loads… | | | | | |
| 6. At work I sweat… | | | | | |
| 7. After work I am tired… | | | | | |

Circle the most appropriate response.

8. In comparison with others of my own age, I think my work is physically…

much lighter    lighter    as heavy    heavier    much heavier

9. Do you play a sport?  Yes  No

If yes:

-Which sport do you play most frequently?
-How many hours per week?  <1  1-2  2-3  3-4  >4
-How many months per year?  <1  1-3  4-6  7-9  >9

If you play a second sport:

-Which sport is it?
-How many hours per week?  <1  1-2  2-3  3-4  >4
-How many months per year?  <1  1-3  4-6  7-9  >9

Circle the most appropriate response.

10. In comparison with others my own age, I think my physical activity during leisure time is….

much less    less    the same    more    much more

Please check the box that most accurately answers the following questions:

| | Never | Seldom | Sometimes | Often | Always |
|---|---|---|---|---|---|
| 11. During leisure time, I sweat… | | | | | |
| 12. During leisure time, I play sport(s)… | | | | | |
| 13. During leisure time, I watch TV… | | | | | |
| 14. During leisure time, I walk… | | | | | |
| 15. During leisure time, I cycle… | | | | | |
| 16. During leisure time, I work in the garden… | | | | | |
| 17. During leisure activities, I do do-it-yourself activities… | | | | | |

18. How many minutes per day do you walk and/or cycle to and from work, school and shopping?

<5    5-15    15-30    30-45    >45

19. How many hours do you sleep (on average)?

<5    6    7    8    >9

# Appendix H

## Data Collection Sheets

# AEROBIC FITNESS TEST
## Data Sheet – Monark 818E Cycle Ergometer

**Name:** ______________________ **Phase:** ______________

**Date:** ____________ **ID Number:** __________ **Weight (kg):** __________

| TIME (minutes) | RESISTANCE (kg) | REVOLUTIONS (rpm) | HEART RATE (bpm) | COMMENTS |
|---|---|---|---|---|
| 0:00 – 1:00 | 1.0 | | | |
| 1:00 – 2:00 | 1.0 | | | |
| 2:00 – 3:00 | 1.5 | | | |
| 3:00 – 4:00 | 1.5 | | | |
| 4:00 – 5:00 | 2.0 | | | |
| 5:00 – 6:00 | 2.0 | | | |
| 6:00 – 7:00 | | | | |
| 7:00 – 8:00 | | | | |
| 8:00 – 9:00 | | | | |
| 9:00 – 10:00 | | | | |
| 10:00 – 11:00 | | | | |
| 11:00 – 12:00 | | | | |
| 12:00 – 13:00 | | | | |
| 13:00 – 14:00 | | | | |
| 14:00 – 15:00 | | | | |

**TEST RESULTS:**

**Max HR:** ______ (bpm) **$VO_{2max}$:** __________ (L/min); __________ ($ml \cdot kg^{-1} \cdot min^{-1}$)

**VT:** _________ (L/min); _________ ($ml \cdot kg^{-1} \cdot min^{-1}$) **VT (% of $VO_{2max}$):** _________ (%)

**HR @ VT:** ________ (bpm) **Workload @ VT:** _________ (kg) **RPM's @ VT:** ________ (rpm)

**80% of VT:** ______ (L/min); _______ ($ml \cdot kg^{-1} \cdot min^{-1}$) **80% of VT (% of $VO_{2max}$):** _______ (%)

**Estimated Workload @ 80% of VT:** ________ (kg)

# BODY COMPOSITION ANALYSIS
## Data Sheet

Name:______________________ Group:______________

Date:______________________ Age:______________

Tester(s): ________________________________________

Height (cm):______________ Weight (kg): ______________

| HYDROSTATIC WEIGHING | | |
|---|---|---|
| | PREDICTED(age, height) | ACTUAL |
| RESIDUAL VOLUME (L) | | |
| BODY FAT (%) | | |
| FAT BODY MASS (kg) | | |
| LEAN BODY MASS (kg) | | |

## RESULTS:

Body Mass Index (kg/m$^2$) (CPAFLA, 1996): ____________

Body Fat (%) (Siri et al.,1963): ____________

Fat mass (kg):______________

Lean Body Mass (kg): ____________

# EXERCISE STRESS PROTOCOL
## Data Sheet

Name:______________________ Phase:__________ ID Number:__________

Date:______________________ Tester (s):______________________

| Time (min) | Intensity (% VT) | $O_2$ Consumption L/min | ml/kg/min | Resistance (kg) | Revolutions (rpm) | Heart Rate (bpm) |
|---|---|---|---|---|---|---|
| 0:00 – 6:00 | N/A | | | 1.5 | | |
| 6:00 – 11:00 | 80 | | | | | |
| 11:00 – 16:00 | 80 | | | | | |
| 16:00 – 21:00 | 80 | | | | | |
| 21:00 – 26:00 | 100 | | | | | |
| 26:00 - 31:00 | 100 | | | | | |
| 31:00 - 36:00 | 100 | | | | | |

# BLOOD MEASUREMENTS
## Data Sheet

Name: ______________________ Treatment Period: __________ ID Number: ______________

Date: ____________________ Tester (s): ______________________________________

| Time (min) / Actual Time | -15:00 [Pre] ______pm | 0:00 [Start Ex] ______pm | 6:00 * [6 min @ 1.5 kp] ______pm | 21:00 * [15 min @ 80% VT] ______pm | 36:00 * [15 min @ 100% VT] ______pm | 51:00 [15 min post-exer] ______pm | 1:06:00 [30 min post-exer] ______pm | 1:36:00 [1 hour post-exer] ______pm |
|---|---|---|---|---|---|---|---|---|
| Immune | 10 ml (1x10cc) | | | | 10 ml (1x10cc) | | 10 ml (1x10cc) | |
| CBC | 3 ml (1x10cc) | | | | 3 ml (1x10cc) | | 3 ml (1x10cc) | |
| Hormone/ Lactate | 7 ml | 7 ml (1x10cc) | | 7 ml (1x10cc) | 7 ml | 7 ml (1x10cc) | 7 ml | 7 ml (1x10cc) |
| TOTAL | 20 ml (2x10cc) | 7 ml (1x10cc) | | 7 ml (1x10cc) | 20 ml (2x10cc) | 7 ml (1x10cc) | 20 ml (2x10cc) | 7 ml (1x10cc) |

* Metabolic Cart used to measure gases, RER for first 6-min stage and then for ~25-30 min and ~40-45 min to ensure steady state has been reached at VT and 80% VT.

# Appendix I

# Side Effects Record

# Ginseng and Exercise Study
## Adverse Experiences

Name:____________________
Treatment Period:____________
ID#:_____________________

Please record any adverse experiences or side effect that you have throughout the treatment period. Please feel free to add any information that you feel is relevant. Indicate if you believe your experience is a result of an illness or of taking your supplement.

| Description | Date of Onset | Time | Severity mild | moderate | severe | Duration | Notes |
|---|---|---|---|---|---|---|---|
| e.g., headache | August 26, 99 | Early morning | X | | | Morning only | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

# Appendix J

## Raw Data

| CORTISOL (μg/dl) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Group | Subject | -15 min | 0 min | 21 min | 36 min | 51 min | 66 min | 96 min |
| Ginseng | 1 | 17.847 | 17.756 | 19.197 | 17.004 | 14.947 | 13.382 | 10.965 |
| | 2 | 27.484 | 25.804 | 21.056 | 18.609 | 15.716 | 13.180 | 9.677 |
| | 3 | 10.640 | 16.116 | 12.137 | 10.386 | 8.485 | 7.501 | 6.408 |
| | 4 | 12.705 | 10.037 | 8.420 | 6.958 | 7.460 | 6.420 | 5.850 |
| | 5 | 9.745 | 9.171 | 8.742 | 10.867 | 11.116 | 8.505 | 5.767 |
| | 6 | 12.313 | 11.611 | 11.371 | 11.982 | 9.771 | 8.779 | 8.149 |
| | 7 | 9.463 | 13.078 | 12.696 | 10.949 | 11.023 | 10.387 | 13.816 |
| | 8 | 10.713 | 16.104 | 11.052 | 9.302 | 8.185 | 7.435 | 5.834 |
| | 9 | 5.895 | 11.418 | 13.051 | 11.772 | 12.604 | 11.019 | 8.187 |
| | 10 | 11.053 | 18.173 | 16.950 | 14.166 | 10.924 | 10.772 | 7.894 |
| Placebo | 1 | 10.265 | 8.691 | 6.737 | 6.131 | 4.294 | 4.081 | 4.034 |
| | 2 | 11.417 | 16.544 | 13.519 | 11.360 | 9.659 | 8.855 | 8.432 |
| | 3 | 10.024 | 12.752 | 9.818 | 7.127 | 6.138 | 5.916 | 6.093 |
| | 4 | 9.371 | 6.715 | 7.554 | 8.362 | 8.712 | 7.592 | 7.303 |
| | 5 | 12.637 | 19.599 | 17.162 | 12.559 | 10.642 | 9.238 | 6.800 |
| | 6 | 12.210 | 12.379 | 14.531 | 12.364 | 14.638 | 10.647 | 8.614 |
| | 7 | 8.288 | 12.058 | 15.378 | 16.384 | 14.005 | 12.349 | 13.463 |
| | 8 | 7.617 | 7.067 | 5.907 | 8.074 | 8.336 | 6.116 | 5.243 |
| | 9 | 17.083 | 22.298 | 25.017 | 24.741 | 17.892 | 19.006 | 14.629 |
| | 10 | 6.759 | 6.944 | 11.461 | 16.540 | 16.784 | 16.354 | 11.530 |

| LACTATE (mM) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Group | Subject | -15 min | 0 min | 21 min | 36 min | 51 min | 66 min | 96 min |
| Ginseng | 1 | 1.30 | 1.14 | 4.10 | 3.61 | 2.13 | 1.55 | 1.38 |
| | 2 | 1.23 | 1.32 | 2.74 | 3.43 | 1.91 | 1.64 | 1.51 |
| | 3 | 1.57 | 1.40 | 2.10 | 2.02 | 1.65 | 1.64 | 1.32 |
| | 4 | 1.40 | 1.26 | 2.13 | 2.61 | 1.94 | 1.75 | 1.44 |
| | 5 | 1.07 | 1.15 | 1.60 | 2.65 | 1.69 | 1.30 | 1.25 |
| | 6 | 1.35 | 1.26 | 2.06 | 2.42 | 1.65 | 1.27 | 1.20 |
| | 7 | 1.15 | 1.14 | 1.53 | 1.67 | 1.63 | 1.37 | 1.22 |
| | 8 | 1.53 | 1.49 | 2.04 | 2.25 | 1.55 | 1.60 | 1.35 |
| | 9 | 1.11 | 1.22 | 1.67 | 1.76 | 1.35 | 1.22 | 1.15 |
| | 10 | 1.28 | 1.18 | 1.71 | 1.63 | 1.36 | 1.27 | 1.28 |
| Placebo | 1 | 2.21 | 1.86 | 1.80 | 1.63 | 1.43 | 1.20 | 1.04 |
| | 2 | 1.09 | 1.07 | 2.00 | 3.33 | 1.85 | 1.39 | 1.13 |
| | 3 | 1.13 | 1.11 | 1.54 | 1.82 | 1.24 | 1.20 | 1.23 |
| | 4 | 1.61 | 1.20 | 3.04 | 4.25 | 2.57 | 2.14 | 1.51 |
| | 5 | 1.19 | 1.17 | 1.38 | 1.77 | 1.44 | 1.24 | 1.16 |
| | 6 | 1.45 | 1.44 | 2.94 | 4.05 | 2.78 | 1.93 | 0.99 |
| | 7 | 1.51 | 0.97 | 1.67 | 2.24 | 1.60 | 1.28 | 1.05 |
| | 8 | 1.46 | 1.29 | 2.49 | 2.79 | 1.68 | 1.53 | 1.39 |
| | 9 | 1.28 | 1.21 | 1.29 | 1.44 | 1.16 | 1.15 | 1.21 |
| | 10 | 1.42 | 1.18 | 2.64 | 3.03 | 1.76 | 1.55 | 1.32 |

| INSULIN (μIU/ml) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Group | Subject | -15 min | 0 min | 21 min | 36 min | 51 min | 66 min | 96 min |
| Ginseng | 1 | 18.113 | 11.401 | 4.566 | 3.740 | 3.299 | 3.974 | 5.087 |
| | 2 | 11.101 | 24.076 | 6.013 | 7.455 | 30.958 | 31.328 | 15.594 |
| | 3 | 14.131 | 11.092 | 7.486 | 5.392 | 5.919 | 5.399 | 8.549 |
| | 4 | 47.099 | 21.887 | 14.496 | 15.133 | 16.608 | 14.718 | 16.068 |
| | 5 | 10.656 | 13.270 | 4.625 | 4.930 | 6.349 | 6.034 | 5.041 |
| | 6 | 18.507 | 25.631 | 8.184 | 10.796 | 19.815 | 9.782 | 8.076 |
| | 7 | 11.417 | 26.636 | 8.647 | 4.734 | 12.750 | 9.038 | 6.553 |
| | 8 | 24.810 | 32.029 | 10.196 | 5.749 | 16.635 | 16.806 | 11.160 |
| | 9 | 20.706 | 40.921 | 9.583 | 7.553 | 7.909 | 7.411 | 5.403 |
| | 10 | 9.804 | 8.206 | 6.685 | 5.425 | 7.258 | 8.159 | 7.470 |
| Placebo | 1 | 41.085 | 21.402 | 8.330 | 4.380 | 4.926 | 4.609 | 5.633 |
| | 2 | 12.471 | 13.795 | 6.748 | 5.021 | 11.887 | 8.700 | 8.126 |
| | 3 | 11.745 | 10.623 | 4.099 | 3.444 | 5.832 | 5.000 | 4.970 |
| | 4 | 12.163 | 27.141 | 10.247 | 7.277 | 8.170 | 12.407 | 18.233 |
| | 5 | 5.390 | 7.611 | 3.886 | 2.523 | 3.477 | 5.800 | 6.263 |
| | 6 | 15.337 | 26.369 | 6.720 | 5.127 | 12.473 | 12.524 | 8.183 |
| | 7 | 9.287 | 12.329 | 4.515 | 4.100 | 4.011 | 3.852 | 8.025 |
| | 8 | 10.265 | 13.677 | 6.065 | 4.265 | 5.717 | 6.399 | 7.222 |
| | 9 | 17.499 | 11.383 | 5.175 | 3.775 | 5.867 | 5.553 | 7.559 |
| | 10 | 10.706 | 20.339 | 6.106 | 11.360 | 5.376 | 8.602 | 7.615 |

| GROWTH HORMONE (ng/ml) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Group | Subject | -15 min | 0 min | 21 min | 36 min | 51 min | 96 min |
| Ginseng | 1 | 0.012 | 0.025 | 0.936 | 7.856 | 5.159 | 0.054 |
| | 2 | 4.289 | 8.697 | 4.588 | 3.939 | 1.971 | 0.237 |
| | 3 | 5.480 | 1.364 | 23.072 | 25.450 | 20.798 | 4.369 |
| | 4 | 0.279 | 0.209 | 6.841 | 10.301 | 6.584 | 0.700 |
| | 5 | 0.000 | 0.000 | 4.439 | 7.420 | 5.201 | 0.470 |
| | 6 | 0.000 | 0.008 | 2.484 | 9.055 | 7.832 | 0.562 |
| | 7 | 0.028 | 0.000 | 0.000 | 0.722 | 0.000 | 1.824 |
| | 8 | 0.053 | 0.055 | 3.665 | 7.515 | 4.741 | 0.402 |
| | 9 | 0.368 | 0.222 | 4.705 | 17.584 | 15.206 | 9.522 |
| | 10 | 0.000 | 0.000 | 0.280 | 2.925 | 2.057 | 0.103 |
| Placebo | 1 | 0.000 | 0.000 | 0.075 | 3.583 | 4.200 | 1.135 |
| | 2 | 0.074 | 15.671 | 24.898 | 26.352 | 21.508 | 4.038 |
| | 3 | 0.000 | 0.000 | 1.232 | 13.661 | 9.505 | 6.159 |
| | 4 | 0.000 | 0.074 | 4.599 | 12.755 | 8.357 | 3.012 |
| | 5 | 1.432 | 5.952 | 11.272 | 13.129 | 6.364 | 1.641 |
| | 6 | 0.000 | 0.000 | 17.174 | 13.248 | 10.130 | 3.941 |
| | 7 | 0.084 | 0.000 | 0.015 | 4.897 | 6.310 | 0.701 |
| | 8 | 0.000 | 0.000 | 2.478 | 10.217 | 6.422 | 0.370 |
| | 9 | 2.251 | 13.370 | 19.654 | 21.338 | 11.160 | 1.992 |
| | 10 | 0.000 | 0.000 | 2.801 | 13.252 | 9.085 | 3.696 |

| BODY COMPOSITION | | | | | | |
|---|---|---|---|---|---|---|
| Group | Subject | Weight (kg) | BMI (kg/m2) | Body Fat (%) | Lean Body Mass (kg) | Fat Mass (kg) |
| Ginseng | 1 | 77.2 | 23.6 | 10.1 | 69.4 | 7.8 |
| | 2 | 74.8 | 23.7 | 21.1 | 59.0 | 15.8 |
| | 3 | 78.5 | 24.3 | 12.8 | 68.5 | 10.0 |
| | 4 | 70.0 | 23.2 | 20.6 | 55.6 | 14.4 |
| | 5 | 74.4 | 23.7 | 26.0 | 55.0 | 19.4 |
| | 6 | 68.4 | 20.3 | 11.9 | 60.3 | 8.1 |
| | 7 | 75.6 | 21.6 | 10.8 | 67.4 | 8.2 |
| | 8 | 79.4 | 23.6 | 13.9 | 68.4 | 11.0 |
| | 9 | 68.3 | 21.3 | 10.9 | 60.2 | 7.4 |
| | 10 | 82.5 | 23.4 | 17.5 | 68.1 | 14.4 |
| Placebo | 1 | 79.2 | 24.3 | 10.0 | 71.7 | 8.0 |
| | 2 | 77.6 | 24.6 | 23.5 | 59.4 | 18.2 |
| | 3 | 77.8 | 24.0 | 14.4 | 66.5 | 11.2 |
| | 4 | 70.8 | 23.4 | 20.6 | 56.2 | 14.6 |
| | 5 | 73.7 | 23.5 | 26.7 | 54.0 | 19.7 |
| | 6 | 67.0 | 19.9 | 11.0 | 59.6 | 7.4 |
| | 7 | 77.1 | 22.0 | 11.3 | 68.4 | 8.7 |
| | 8 | 81.5 | 24.2 | 14.6 | 69.6 | 11.9 |
| | 9 | 66.6 | 21.0 | 10.4 | 59.7 | 6.9 |
| | 10 | 84.6 | 23.9 | 17.9 | 69.5 | 15.1 |

| AEROBIC FITNESS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Group | Subject | $VO_{2max}$ (l/min) | $VO_{2max}$ (ml/kg/min) | VT (l/min) | VT (ml/kg/min) | VT: $\%VO_{2max}$ | Max HR (bpm) |
| Ginseng | 1 | 3.91 | 50.6 | 3.07 | 39.8 | 79 | 178 |
| | 2 | 2.91 | 38.4 | 1.75 | 23.1 | 60 | 175 |
| | 3 | 3.74 | 47.6 | 2.60 | 33.2 | 70 | 180 |
| | 4 | 2.41 | 34.4 | 1.60 | 22.9 | 66 | 186 |
| | 5 | 2.71 | 36.5 | 1.87 | 25.2 | 69 | 198 |
| | 6 | 3.34 | 48.9 | 1.84 | 27.0 | 55 | 174 |
| | 7 | 3.84 | 50.4 | 2.71 | 35.6 | 71 | 175 |
| | 8 | 3.49 | 44.0 | 2.69 | 33.9 | 77 | 173 |
| | 9 | 2.94 | 43.0 | 1.99 | 29.1 | 68 | 204 |
| | 10 | 3.71 | 45.0 | 2.33 | 28.2 | 63 | 190 |
| Placebo | 1 | 3.53 | 44.3 | 2.44 | 30.6 | 69 | 174 |
| | 2 | 3.05 | 39.3 | 2.22 | 28.6 | 73 | 174 |
| | 3 | 3.56 | 45.4 | 2.39 | 30.5 | 67 | 187 |
| | 4 | 3.08 | 43.5 | 2.20 | 31.0 | 71 | 170 |
| | 5 | 2.80 | 38.0 | 2.00 | 27.2 | 72 | 185 |
| | 6 | 3.25 | 48.5 | 2.02 | 30.1 | 62 | 187 |
| | 7 | 3.96 | 51.3 | 2.56 | 33.2 | 65 | 177 |
| | 8 | 3.16 | 38.7 | 1.77 | 21.7 | 56 | 173 |
| | 9 | 3.49 | 51.3 | 2.25 | 33.1 | 65 | 198 |
| | 10 | 4.23 | 50.0 | 2.49 | 29.5 | 60 | 199 |

| RESTING ENERGY EXPENDITURE | | | | |
|---|---|---|---|---|
| Group | Subject | REE (kcal/day) | REE (kcal/kg body weight/day) | REE (kcal/kg LBM/ day) |
| Ginseng | 1 | 1957 | 25.3 | 28.2 |
| | 2 | 1815 | 24.3 | 30.8 |
| | 3 | 2069 | 26.4 | 30.2 |
| | 4 | 1408 | 20.1 | 25.3 |
| | 5 | 1302 | 17.5 | 23.7 |
| | 6 | 1752 | 25.6 | 29.1 |
| | 7 | 2191 | 29.0 | 32.5 |
| | 8 | 2168 | 27.3 | 31.7 |
| | 9 | 1787 | 26.2 | 29.7 |
| | 10 | 2090 | 25.3 | 30.7 |
| Placebo | 1 | 2021 | 25.5 | 28.2 |
| | 2 | 1875 | 24.2 | 31.6 |
| | 3 | 2048 | 26.3 | 30.8 |
| | 4 | 1561 | 22.0 | 27.8 |
| | 5 | 1292 | 17.5 | 23.9 |
| | 6 | 1815 | 27.1 | 30.5 |
| | 7 | 2215 | 28.7 | 32.4 |
| | 8 | 2064 | 25.3 | 29.7 |
| | 9 | 1929 | 29.0 | 32.3 |
| | 10 | 2054 | 24.3 | 29.6 |

| BAECKE ACTIVITY QUESTIONNAIRE | | |
|---|---|---|
| Group | Subject | Score |
| Ginseng | 1 | 6.75 |
| | 2 | 8.52 |
| | 3 | 6.54 |
| | 4 | 8.68 |
| | 5 | 6.30 |
| | 6 | 7.07 |
| | 7 | 8.16 |
| | 8 | 7.55 |
| | 9 | 7.00 |
| | 10 | 9.10 |
| Placebo | 1 | 7.05 |
| | 2 | 8.39 |
| | 3 | 6.64 |
| | 4 | 6.86 |
| | 5 | 7.20 |
| | 6 | 7.81 |
| | 7 | 9.34 |
| | 8 | 8.04 |
| | 9 | 7.18 |
| | 10 | 10.10 |

| DIET RECORDS – ENERGY INTAKE | | | | |
|---|---|---|---|---|
| Group | Subject | Energy Intake (kcal/day) | Energy Intake (kcal/kg/day) | Energy Intake (kcal/kg FFM/day) |
| Ginseng | 1 | 2136.96 | 27.68 | 30.79 |
| | 2 | 2642.01 | 35.32 | 44.78 |
| | 3 | 2199.91 | 31.43 | 39.57 |
| | 4 | 2642.34 | 35.52 | 48.04 |
| | 5 | 2898.12 | 42.37 | 48.06 |
| | 6 | 2245.86 | 28.29 | 32.83 |
| | 7 | 2828.38 | 41.41 | 46.98 |
| | 8 | 2518.04 | 30.52 | 36.98 |
| | 9 | 2136.96 | 27.68 | 30.79 |
| | 10 | 2642.01 | 35.32 | 44.78 |
| Placebo | 1 | 2192.95 | 27.69 | 30.59 |
| | 2 | 2698.6 | 34.78 | 45.43 |
| | 3 | 1954.64 | 27.61 | 34.78 |
| | 4 | 3498.88 | 47.47 | 64.79 |
| | 5 | 2624.05 | 39.16 | 44.03 |
| | 6 | 2357.42 | 28.93 | 33.87 |
| | 7 | 2978.19 | 44.72 | 49.89 |
| | 8 | 2198.48 | 25.99 | 31.63 |
| | 9 | 2192.95 | 27.69 | 30.59 |
| | 10 | 2698.6 | 34.78 | 45.43 |

| DIET RECORDS – CARBOHYDRATE (CHO) INTAKE | | | | | |
|---|---|---|---|---|---|
| Group | Subject | CHO Intake (kcal/day) | CHO Intake (kcal/kg/day) | CHO Intake (kcal/kg FFM/day) | Percent of Total Energy Intake |
| Ginseng | 1 | 331.96 | 4.30 | 4.78 | 63 |
| | 2 | 384.63 | 5.14 | 6.52 | 57 |
| | 3 | 283.95 | 4.06 | 5.11 | 50 |
| | 4 | 351.03 | 4.72 | 6.38 | 53 |
| | 5 | 345.08 | 5.05 | 5.72 | 47 |
| | 6 | 400.28 | 5.04 | 5.85 | 70 |
| | 7 | 408.62 | 5.98 | 6.79 | 57 |
| | 8 | 365.38 | 4.43 | 5.37 | 57 |
| | 9 | 331.96 | 4.30 | 4.78 | 63 |
| | 10 | 384.63 | 5.14 | 6.52 | 57 |
| Placebo | 1 | 340.88 | 4.30 | 4.75 | 62 |
| | 2 | 316.64 | 4.08 | 5.33 | 46 |
| | 3 | 278.28 | 3.93 | 4.95 | 55 |
| | 4 | 545.99 | 7.41 | 10.11 | 62 |
| | 5 | 407.82 | 6.09 | 6.84 | 62 |
| | 6 | 357.49 | 4.39 | 5.14 | 60 |
| | 7 | 475.56 | 7.14 | 7.97 | 63 |
| | 8 | 294.19 | 3.48 | 4.23 | 53 |
| | 9 | 340.88 | 4.30 | 4.75 | 62 |
| | 10 | 316.64 | 4.08 | 5.33 | 46 |

| DIET RECORDS – FAT INTAKE | | | | | |
|---|---|---|---|---|---|
| Group | Subject | Fat Intake (kcal/day) | Fat Intake (kcal/kg/day) | Fat Intake (kcal/kg FFM/day) | Percent of Total Energy Intake |
| Ginseng | 1 | 46.62 | 0.60 | 0.67 | 20 |
| | 2 | 77.64 | 1.04 | 1.32 | 26 |
| | 3 | 83.03 | 1.19 | 1.49 | 33 |
| | 4 | 91.16 | 1.23 | 1.66 | 31 |
| | 5 | 117.1 | 1.71 | 1.94 | 36 |
| | 6 | 48.19 | 0.61 | 0.70 | 19 |
| | 7 | 92.7 | 1.36 | 1.54 | 29 |
| | 8 | 70.89 | 0.86 | 1.04 | 25 |
| | 9 | 46.62 | 0.60 | 0.67 | 20 |
| | 10 | 77.64 | 1.04 | 1.32 | 26 |
| Placebo | 1 | 56.45 | 0.71 | 0.79 | 23 |
| | 2 | 82.16 | 1.06 | 1.38 | 27 |
| | 3 | 51.71 | 0.73 | 0.92 | 23 |
| | 4 | 89.45 | 1.21 | 1.66 | 23 |
| | 5 | 52.08 | 0.78 | 0.87 | 18 |
| | 6 | 51.1 | 0.63 | 0.73 | 19 |
| | 7 | 66.33 | 1.00 | 1.11 | 20 |
| | 8 | 68.02 | 0.80 | 0.98 | 27 |
| | 9 | 56.45 | 0.71 | 0.79 | 23 |
| | 10 | 82.16 | 1.06 | 1.38 | 27 |

| DIET RECORDS – PROTEIN INTAKE | | | | | |
|---|---|---|---|---|---|
| Group | Subject | Protein Intake (kcal/day) | Protein Intake (kcal/kg/day) | Protein Intake (kcal/kg FFM/day) | Percent of Total Energy Intake |
| Ginseng | 1 | 94.26 | 1.22 | 1.36 | 17 |
| | 2 | 106.41 | 1.42 | 1.80 | 17 |
| | 3 | 102.5 | 1.46 | 1.84 | 17 |
| | 4 | 77.85 | 1.05 | 1.42 | 16 |
| | 5 | 102.01 | 1.49 | 1.69 | 17 |
| | 6 | 60.61 | 0.76 | 0.89 | 11 |
| | 7 | 102.99 | 1.51 | 1.71 | 14 |
| | 8 | 118.25 | 1.43 | 1.74 | 18 |
| | 9 | 94.26 | 1.22 | 1.36 | 17 |
| | 10 | 106.41 | 1.42 | 1.80 | 17 |
| Placebo | 1 | 82.95 | 1.07 | 1.16 | 15 |
| | 2 | 143.66 | 1.92 | 2.42 | 27 |
| | 3 | 93.34 | 1.33 | 1.66 | 22 |
| | 4 | 86.06 | 1.16 | 1.59 | 15 |
| | 5 | 108.45 | 1.59 | 1.82 | 20 |
| | 6 | 91.1 | 1.15 | 1.31 | 21 |
| | 7 | 130.05 | 1.90 | 2.18 | 17 |
| | 8 | 110.18 | 1.34 | 1.59 | 20 |
| | 9 | 82.95 | 1.07 | 1.16 | 15 |
| | 10 | 143.66 | 1.92 | 2.42 | 27 |

| RELATIVE DOSES FOR GINSENG TREATMENT (3g/day) | | |
|---|---|---|
| Subject | g/kg Body Weight | g/kg Fat Free Mass |
| 1 | 0.039 | 0.043 |
| 2 | 0.040 | 0.051 |
| 3 | 0.038 | 0.044 |
| 4 | 0.043 | 0.054 |
| 5 | 0.040 | 0.055 |
| 6 | 0.044 | 0.050 |
| 7 | 0.040 | 0.045 |
| 8 | 0.038 | 0.044 |
| 9 | 0.044 | 0.050 |
| 10 | 0.036 | 0.044 |