JOURNAL OF MEDICINAL FOOD
Volume 4, Number 3, 2001
Mary Ann Liebert, Inc.

Clinical Effects of a Dietary Antioxidant Silicate Supplement, Microhydrin®, on Cardiovascular Responses to Exercise

KIMBERLY L. PURDY LLOYD, M.S.,[1] WENDY WASMUND, B.S.,[2]
LEONARD SMITH, M.D.,[1] and PETER B. RAVEN, Ph.D.[2]

ABSTRACT

Amorphous silicate minerals, often described as rock flour, were once common in natural water sources and abundant in glacial stream waters. Not only do the silica mineral particles bond water and other elements for transport; they also can be adsorbed with reduced hydrogen, which releases electrons, providing antioxidant or reducing potential to surrounding fluids. The purpose of this investigation was to examine the cardiovascular responses during exercise after consumption of a dietary silicate mineral antioxidant supplement, Microhydrin® (Royal BodyCare, Inc., Irving, TX). A clinical trial incorporating a double-blind, placebo-controlled, crossover experimental design was employed. Subjects received either active agent or placebo, four capsules per day, for 7 days before the trial. The trial evaluated six exercise bicycle–trained subjects performing a 40-km bicycling time trial. Ratings of perceived exertion and measurements of oxygen uptake, heart rate, performance workload, and preexercise and postexercise blood lactate concentrations were obtained. Although there were no differences ($P \geq .05$) in work performed, heart rate, oxygen uptake, and ratings of perceived exertion during the time trial, the postexercise blood lactate concentrations were significantly lower ($P \leq .05$) when the silicate mineral supplement was used, compared with placebo. These data suggest a beneficial effect of Microhydrin on lactate metabolism.

INTRODUCTION

GLACIAL STREAMS THROUGHOUT THE WORLD are abundant in amorphous silicate minerals, many of which are in the nanoparticle ($<1\ \mu$) size range.[1,2] It was reported by McCarrison[3] after visiting Hunza, West Pakistan, that Hunzukuts enjoyed outstandingly excellent health and amazing longevity. Although some have questioned the details and accuracy of the records of Hunza longevity, others have tended to support the claims that individuals had exceptional health and were indeed long-lived.[1,4–8] A team of cardiologists observed and reported that the heart health of centenarians in this area was exceptionally good and may have been a factor in delayed aging.[5] The good health and longevity was attributed in significant part to the use of glacial milk for irrigation of food crops and for drinking.[6]

Geochemical analysis indicates that colloidal silicate minerals display a variety of properties,

[1]Royal BodyCare, Inc., Irving, TX 75038.
[2]Department of Integrative Physiology, University of North Texas Health Science Center, Ft. Worth, TX 76107-2699.

including the formation of structured water around the interface, which provides a hydrated surface that adsorbs elements or compounds such as potassium, iron, magnesium, lithium, calcium, and hydrogen[2,9] (Fig. 1).

A specific silicate analog has been formulated into a dietary supplement similar to those found in glacial waters and retains the geophysical properties inherent to these minerals. Silicate particles ranging from 50 to 100 Å in diameter can be synthesized and are called clusters or Microclusters® (a proprietary formula manufactured by Flanagan Technologies, Inc., Cottonwood, AZ). The Microcluster interface can be saturated with reduced hydrogen or hydride (H^-) ions. The particle then acts as a reducing agent or antioxidant when in solution (standard reduction-oxidation potential, −550 mV). Structured water at the interface stabilizes electron transfer[2] (Fig. 1). Specific silicate interactions could possibly play a substantial role in nutrient bioavailability by enhancing solvation properties and ion and water transport and by providing free radical antioxidant protection.[2,10,11]

The silica hydride microcluster, Microhydrin® (a proprietary formula manufactured by Flanagan Technologies Inc., Cottonwood, AZ) also provides antioxidant potential in standard antioxidant assays. Preliminary results indicate that the dietary silicate antioxidant properties can reduce nicotinamide adenine dinucleotide (NADH), cytochrome C, epinephrine, and superoxide free radical in standard *in vitro* assays (Joe McCord, personal communications).

The purpose of this investigation was to test

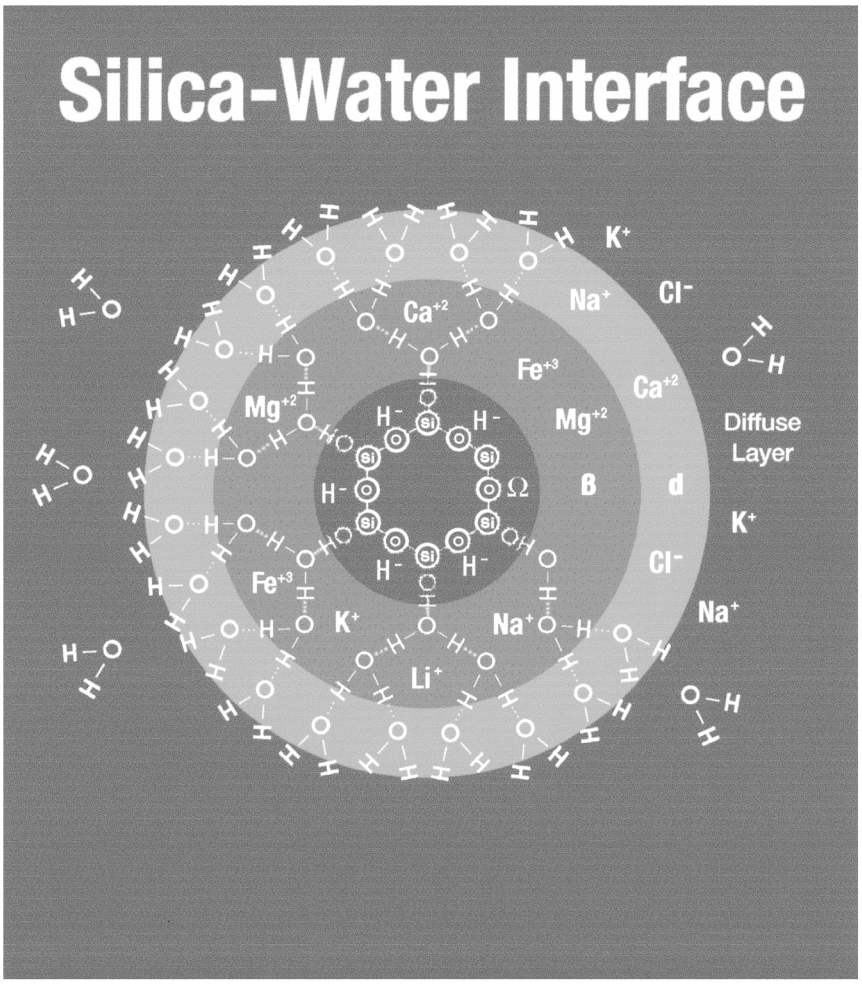

FIG. 1. A diagram showing the silica-water interface (silanol bonds SiOH) and the concentric structured water arrangement about the interface (three water layers designated omega, beta, and delta) with the adsorption of elements within the layers.

the cardiovascular effects of the antioxidant during exercise performance against a placebo. A 40-km bicycling time trial was undertaken to determine the supplement's effects on energy production during exercise.

MATERIALS AND METHODS

Clinical trial procedures were performed in accordance with ethical standards of the Committee on Human Experimentation and the Helsinki Declaration. The experimental procedure and consent forms, signed by the volunteers before participation, were approved by the Institutional Review Board of the University of North Texas Health Science Center. Each capsule contained 250 mg of colloidal silicate mineral, Microhydrin, which contains rice bran flour (350 mg) as an excipient ingredient and is distributed by Royal BodyCare Inc. of Irving, Texas. The silicate supplement consists of a proprietary colloidal mineral–containing food-grade silica, potassium carbonate, and magnesium sulfate formulated into a spherical nanocolloidal silicate particle. Placebos, taken during the control periods, contained approximately 570 mg of rice bran flour.

Six male subjects were crossed over to take either the dietary supplement or placebo for 7 days before completing a 40-km bicycling time trial. Subjects were given the appropriate number of capsules to be taken three times per day (1 capsule in the morning, 2 at midday, and 1 in the evening) for 1 week before each exercise performance testing day and on the day of testing. A sample population of six male bicyclists who were disease free, drug free, and nonsmokers, aged 20–29 years, performed a bicycle time trial performance test. Individuals were highly fit, defined as having a bicycle maximal oxygen uptake (VO_2max) greater than 60 ml/kg/min. Each subject completed a medical history form and physical activity questionnaire and had a normal resting electrocardiogram (ECG) reviewed by the collaborating physician. Each subject attended the laboratory three different times—once for the initial screening ex-

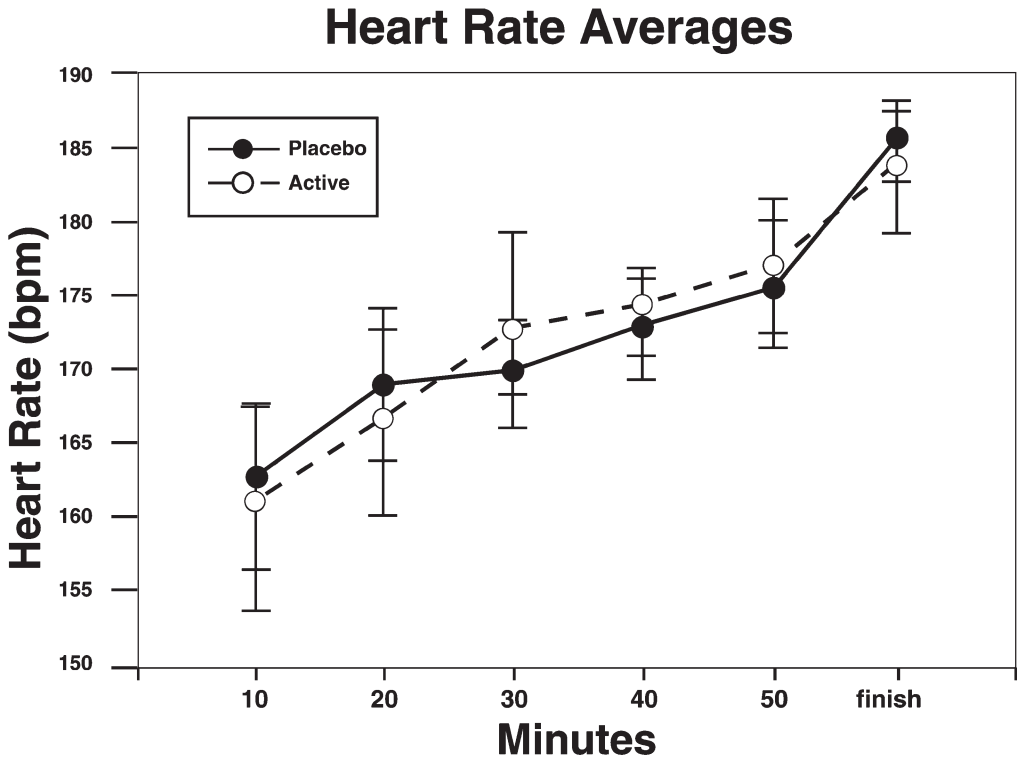

FIG. 2. Averages of six subjects' heart rates measured in beats per minute every 10 minutes during 40-km bicycling exercise trial for placebo and active conditions.

amination, once after taking placebo, and once after taking the Microhydrin supplement.

The initial screening examination included a 12-lead ECG, a resting blood pressure measurement, a medical history questionnaire, and a graded exercise stress test on an upright stationary bicycle (ID5500; Scifit Lahaina, Maui, HI) for determination of VO_2max. Subjects were asked to complete a diary on their intake of food, supplements, and liquids during the week before performance testing to ensure that dietary guidelines were followed. Subjects were instructed to refrain from using other dietary supplements during the performance test weeks. The meal eaten before testing was standardized to avoid any dietary differences. Subjects refrained from exercise, caffeine, and alcohol for 24 hours before performance testing.

Each subject performed two exercise bouts in random order, with 1 week between testing days for the washout period. On the day of testing (bicycling trial), each subject ingested the two midday capsules with a glass of water, 30 minutes before the start of exercise. Resting blood lactate samples were obtained 5 minutes before the ride (preexercise blood lactate) and 5 minutes after the ride while resting in the seated position (postexercise blood lactate).

During the 40-km time trial, ratings of perceived exertion (RPE) and measurements of heart rate, VO_2, and workload were obtained every 10 minutes. Each subject was instructed to ride a stationary cycle ergometer at a constant rate (90–100 rpm) for the 40-km (24.8 miles). Subjects were able to adjust the workload to the maximum load that they could maintain throughout the time trial. Heart rate was monitored continuously by three-lead ECG (Hewlett Packard model #78354A; Agilent Technologies, Palo Alto, CA).

Breath-by-breath respiratory analysis was performed by having subjects respire through a mouthpiece attached to a turbine volume meter transducer (Alpha Technologies, Laguan Hills, CA; VMM). Respired O_2 and CO_2 fractions were measured from a sampling port in the mouthpiece connected by way of a capillary sampling tube to a calibrated mass spec-

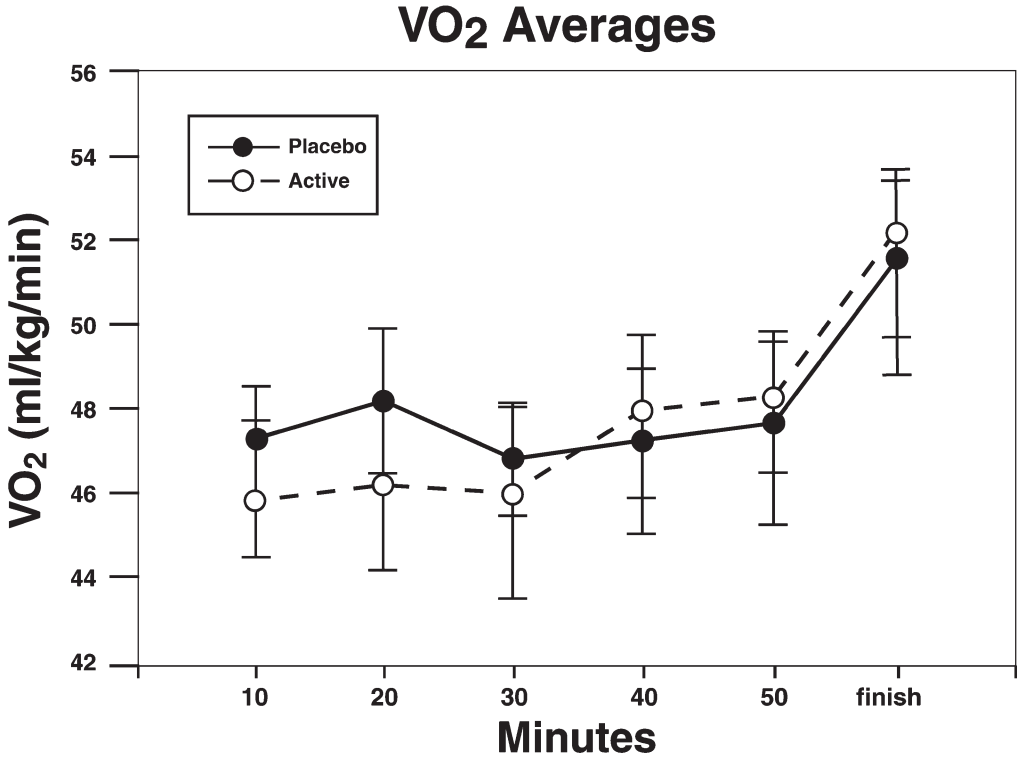

FIG. 3. Averages of six subjects' VO_2 taken every 10 minutes during 40-km bicycling exercise trial for placebo and active conditions.

trometer (Perkin-Elmer, Pomona, CA; MGA 1100). The analog signals from both the mass spectrometer and the volume meter underwent analog-to-digital conversion with the use of a laboratory computer. On-line, breath-by-breath computation was obtained using customized software for VO_2. RPE values were obtained every 5 minutes during steady-state exercise according to the methods of Dunbar.[12] Five minutes after the completion of the time trial, a postexercise capillary blood lactate sample was drawn from a finger prick. Blood lactate (15–50 μl) was measured by an Accusport (Indianapolis, IN) lactate monitor according to standard methods.[13,14]

Data analysis

All variables were statistically evaluated using analysis of variance (ANOVA) two-way repeated measures with two-factor repetition for comparisons between active and placebo status. Subject differences were evaluated by a paired two-sample for means, Student's *t* test. Changes in exercise values (VO_2, RPE, heart rate, and performance workload) were evaluated also with the ANOVA with repeated measures. The study was a crossover design in which each subject served as his or her own control in the repeated-measures ANOVA. Time to completion of the bicycling trial and measurements of lactate concentration had only one preexercise and one postexercise value.

RESULTS

Figure 2 summarizes the six subjects' heart rate averages measured in beats per minute (bpm) in response to exercise for placebo and dietary supplement (active) conditions during the bicycling exercise time trial taken at 10-minute intervals. No significant difference was detected between active and placebo status. Figure 3 summarizes the six subjects' VO_2 averages in response to exercise for placebo and active conditions taken at 10-minute intervals during the bicycling exercise trial. No significant difference was detected between active and placebo status. Figure 4 summarizes the six

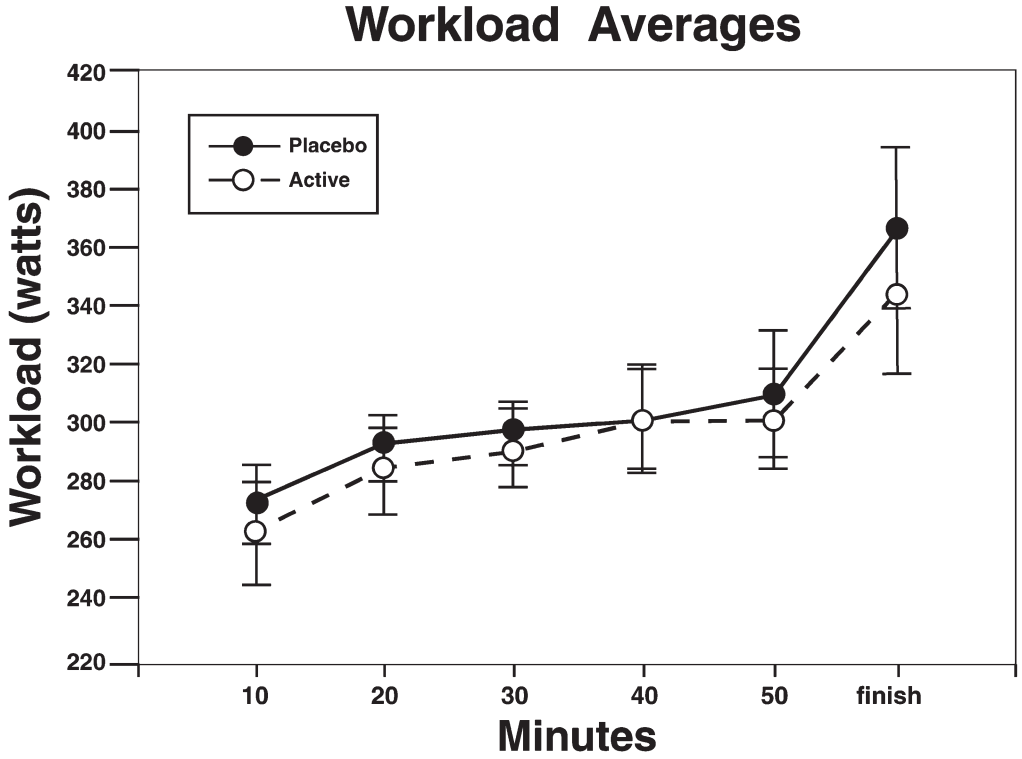

FIG. 4. Averages of six subjects' workload (watts) in response to 40-km bicycling exercise trial for placebo and active taken at 10-minute intervals.

subjects' workload averages (watts) in response to exercise for placebo and active conditions taken at 10-minute intervals. No significant difference was detected between active and placebo status. Figure 5 summarizes the six subjects' RPE averages during the exercise trial taken at 10-minute intervals. No significant difference was detected between active and placebo status.

Figure 6 summarizes the preexercise and postexercise averages for blood lactate concentration for the six cyclists. There was no significant difference in preride baseline values. Exercise resulted in a significant increase in blood lactate concentration for both placebo and active conditions. ($P = .01$ and $P = .03$, respectively). However, the postexercise blood lactate levels were significantly different ($P = .03$) between the active and placebo groups. The active group showed a lower postexercise whole blood lactate concentration (2.57 mmol/L, compared with 3.37 mmol/L for placebo). Figure 7 compares the change in lactate level after exercise for placebo versus active status. The difference between the two groups was statistically significant at $P = .03$. The lactate accumulation when cyclists consumed the active agent was significantly lower than when they used placebo.

DISCUSSION

Although standard antioxidant tests have revealed the dietary supplement, Microhydrin, to act as an antioxidant, it was of interest to observe whether Microhydrin would provide any exercise benefit. Standard exercise parameters were evaluated to observe any possible changes or benefits from the dietary supplement during an endurance performance exercise trial.

Most endurance trials measuring the effects of antioxidants tend to measure lipid peroxidation products and performance improvement but do not necessarily measure lactic acid levels. One study evaluated the effects of 5 months of α-tocopherol supplementation on

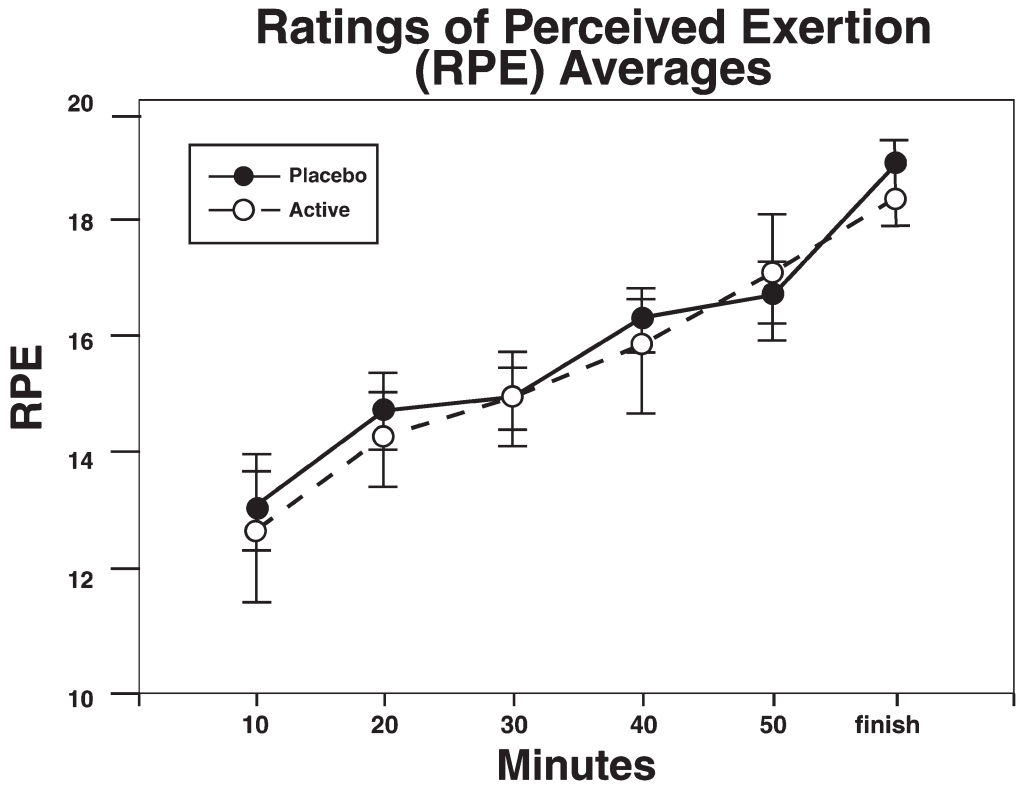

FIG. 5. Averages of six subjects' ratings of perceived exertion (RPE) taken at 10-minute intervals during 40-km bicycling trial for placebo and active conditions.

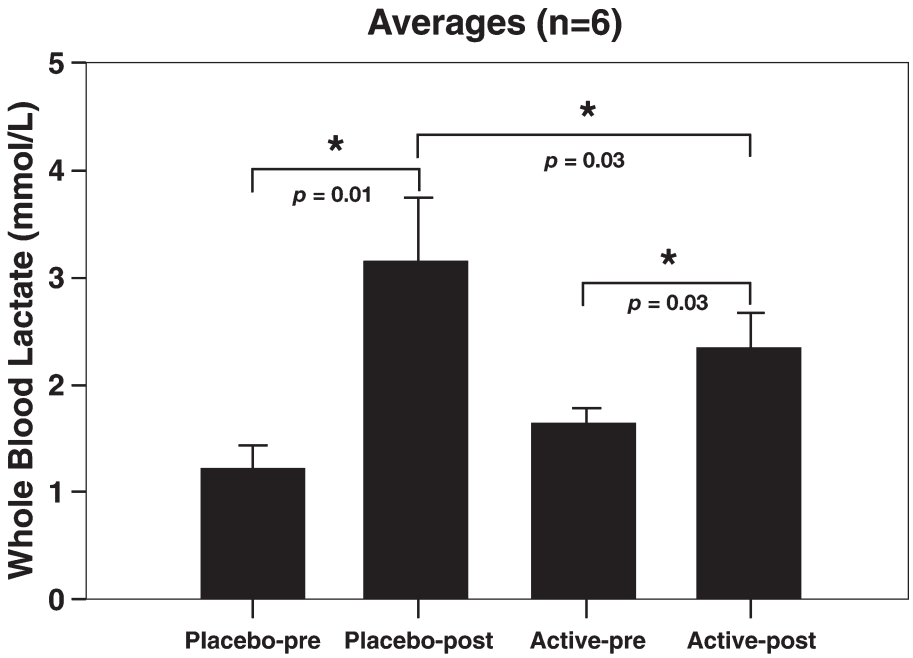

FIG. 6. Averages of six subjects' preexercise and postexercise blood lactate levels for placebo and active conditions with probability values.

physical performance during aerobic exercise training in 30 cyclists. Vitamin E supplementation resulted in no significant effects on lactate concentration or exercise performance, compared with placebo.[15]

Although the literature on interpretation of endurance performance has varied, endurance capacity has most often been expressed by the VO_2max.[16,17] However, VO_2max was recently found not to be the best predictor of endurance performance capability.[18–20]

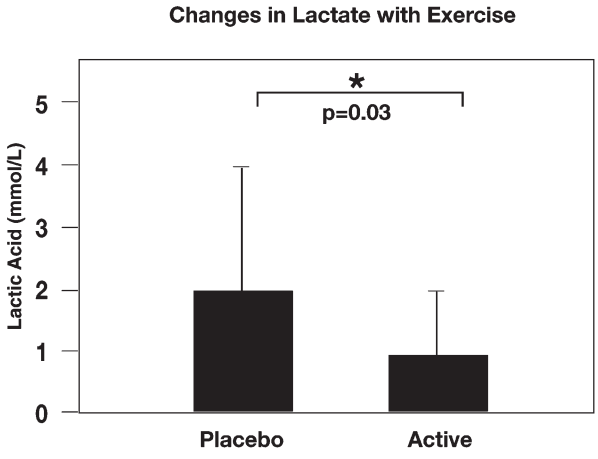

FIG. 7. Averages of six subjects' change in blood lactate level after exercise for placebo and active conditions, showing the statistically significant change ($P = .03$) between groups.

The Rating Scale of Perceived Exertion (RPE, from 6 to 20) was initially described by G. V. Borg in 1970, and thereafter numerous studies showed that this scale was a good indicator of physical stress and physical working capacity. However, there still remains a large variability in RPE values for subjects performing the same relative constant workload (percentage of maximal oxygen consumption).[23]

In determining anaerobic threshold, some rely on heart rate analysis and others on lactate levels or respiratory parameters. Although cardiovascular parameters were monitored in the exercise trial, there were no significant changes during the cycling trial in VO_2max, RPE, workload, or heart rate. Venous capillary postexercise blood lactate levels were significantly lower ($P = .03$) during supplementation compared with placebo consumption.

Capillary blood lactate assessment is increasingly used by well-trained runners to monitor the intensity of endurance exercise.[24] Often athletic trials monitor lactate to compare individuals who are well or poorly endurance trained for threshold levels. Endurance training before exercise testing was

shown in some studies to significantly decrease postexercise blood lactate levels.[21] Spengler et al.[21] postulated that the reduction in blood lactate concentration may be caused by improved lactate uptake or an increased ability to metabolize lactate, speculating that the trained respiratory muscles may be affecting lactate utilization.

In the present study, the trial athletes were similarly matched and were well fit but participated in no additional respiratory or endurance training before the exercise trial. Respiratory VO_2 showed no significant change before or after exercise according to use of placebo or Microhydrin. Increases in aerobic versus anaerobic energy production would have been associated with an increased VO_2.[21] The double-blind crossover design indicated that the dietary supplement was exerting some effect on postexercise lactate levels.

We have postulated that lowered lactate levels may reflect a metabolic effect of the dietary antioxidant supplement, restoring energy function during exercise. However, several possible pathways could be responsible for lactate production or lactate removal from the blood during various exercise protocols.[22] Observation of a significant difference in postexercise lactic acid levels may indicate (1) that lactate clearance was increased or (2) that lactate production was reduced. Additional biochemical studies in a similar trial are necessary to ascertain which lactate-related mechanisms may be involved with the use of the supplement.

In summary, Microhydrin may positively affect lactate metabolism during exercise and may induce a glycogen-sparing effect and therefore should benefit performance and endurance exercise.

ACKNOWLEDGMENTS

We wish to thank Patrick Flanagan, the inventor of Flanagan Microclusters® and Microhydrin™, for his assistance and contribution to the Microhydrin tested.

The authors thank the cyclists for their participation in the study. This project was funded by Royal BodyCare, Inc. Irving, Texas. We wish to thank Joe McCord of Webb-Waring Antioxidant Research Institute, University of Colorado Health Sciences Center, Denver, Colorado, for the antioxidant studies.

REFERENCES

1. Keller WD, Feder GL: Chemical analysis of water used in Hunza, Pakistan. In: *Trace Substances in Environmental Health XIII: Proceedings.* (Hemphill DD, ed). University of Missouri–Columbia, Columbia, MO, pp. 130–137.
2. Dove PM, Rimstidt JD: Silica-water interactions. In: Heany PJ, Prewitt, C.T., Gibbs GV (eds): *Silica, Physical Behavior, Geochemistry, and Materials Application Reviews in Minerology* 1994;29:259–301.
3. McCarrison R: *Nutrition and Health*. Faber and Faber, London, England, 1936, 1961, p. 270.
4. Leaf A: Getting old. *Scientific American* 1973;229:44–52.
5. Murray MJ, Murray AB: Diet and cardiovascular disease in centenarians of Hunza. *Arteriosclerosis* 1984; 4:546A.
6. Keller WD: Drinking Water: A geochemical factor in human health. *Geol Soc Am Bull* 1978;89:334–336.
7. Taylor R: *Hunzaland*. Tandem Books, London, England, 1962.
8. Taylor R: *Hunza Health Secrets for Long Life and Happiness*. Award Books, Tandem Books, London, England, 1964.
9. Keller WD: Argillation and direct bauxitization in terms of concentrations of hydrogen and metal cations at surface of hydrolyzing aluminum silicates. *Bull Am Assoc Petroleum Geologists* 1958;42:233–245.
10. Riddick TM: *Control of Colloid Stability Through Zeta Potential; with a Closing Chapter on its Relationship to Cardiovascular Disease*, Vol. 1. Library Congress # 67-18001 Livingston Publishing Co. Wynnewood, PA, 1968, pp. 24–27.
11. Degani Y, Willner I: Photoinduced hydrogen evolution by a zwitterionic diquat electron acceptor: The functions of SiO_2 colloid in controlling the electron-transfer process. *J Am Chem Soc* 1983;105:6228–6233.
12. Dunbar CC, Robertson RJ, Baun R, Blandin MF, Metz K, Burdett, Goss FL: The validity of regulating exercise intensity by ratings of perceived exertion. *Med Sci Sports Exerc* 1992;24:94–99.
13. Gambke B, Berg A, Fabian K, Francaux M, Haber P, Hartmann U, Kamber M, Lormes W, Rosskopf P, Schwarz L, Berger D: Multicenter evaluation of a portable system for determining blood lactate. *J Lab Med* 1998;21:250–256.
14. Slomovitx BM, Lavery RF, Tortella BJ, Siegal JH, Bachl BL, Ciccone A: Validation of a hand-held lactate device in determination of blood lactate in critically injured patients. *Crit Care Med* 1997;26:250–256.
15. Rokitzki L, Logemann E, Huber G, Keck E, Keul J: Alpha-tocopherol supplementation in racing cyclists

during extreme endurance training. *Int J Sport Nutr* 1994;4:253–264.
16. Costill DL: The relationship between physiological variables and distance running performance. *J Sports Med Phys Fitness* 1967;7:61–66.
17. Saltin B, Astand PO: Maximal oxygen uptake in athletes. *J Appl Physiol* 1967;23:353–358.
18. Heck H, Mader A, Hess G, Mucke S, Muller R, Hollmann W: Justification of the 4 mmol/L lactate threshold. *Int J Sports Med* 1985;6:117–130.
19. Jacobs I: Blood lactate: Implications for training and sports performance. *Sports Med* 1986;3:10–25.
20. Weltman A: The blood lactate response to exercise. *Human Kinetics*. Champaign, IL, pp. 1–14.
21. Spengler CM, Roos M, Laube SM, Boutellier U: Decreased exercise blood lactate concentrations after respiratory endurance training in humans. *Eur J Appl Physiol* 1999;79:299–305.
22. Gladden LB: Lactate transport and exchange during exercise. In: *Handbook of Physiology. Exercise: Regulation and Integration of Multiple Systems*. American Physiological Society, Bethesda, MD. Sect. 12, Chapt. 14, pp. 614–648.
23. Garcin M, Vautier JF, Vandewalle H, Wolff M, Monod H: Ratings of perceived exertion (RPE) during cycling exercises at constant power output. *Ergonomics* 1998; 41:1500–1509.
24. Held T, Marti B: Substantial influence of level of endurance capacity on the association of perceived exertion with blood lactate accumulation. *Int J Sports Med* 1999;20:34–39.

Address reprint requests to:
Kimberly L. Purdy Lloyd
Royal BodyCare, Inc.
2301 Crown Court
Irving, TX 75038

E-mail: klloyd@rbcglobenet.com