CHAPTER V

DISCUSSION

The present study aimed to compare physiological and biochemical changes during exercise between trained (athletes) and untrained(control individuals). It was also aimed to investigate whether the well-known changes in plasma electrolyte during exercise are accompanied by alternations in the intraerythrocyte cationic concentrations, or by changes in the activity and number of erythrocyte Na-K-ATPase.

Effect of exercise training in human being

The results of this study demonstrate that a large amount of specificity was noted for the improvement in Vo_2max and exercise work load in the athletes as compared to control subjects. Based on available researchs(Ekblom, 1969., Pechar, 1974., Mcardle, 1978., and Klausen et al, 1981.), exercise training for specific aerobic activity like cycling, swimming and running and bring about specific metabolic and physiologic adaptation that induced increases in maximal stroke volume and cardiac output as well as in the capillarization and respiratory capacity of skeletal muscle. The VO_2max represent an index of a person has maximal aerobic power and the ability to sustain high intensity exercise. Factors including age, sex and level of training can effect an individuals' VO_2max (Reynold, 1989). In this study, the maximal external work load reached by the athlete subjects averaged 184 $\pm$ 12 watt and VO_2max 49.1 $\pm$ 4.7 ml/kg/min and slightly lower than the previously reported data(Chumura, 1994 and Wendy, et al., 1993) and maximal heart rate was 165 $\pm$ 5.9 beats/min, are similar to young male socker player obtained previously by Kumera, et al., 1994.

Effect of exercise training on plasma and erythrocyte electrolytes concentration

In this study, the pattern of the exercise-induced changes in the plasma concentrations of electrolytes was similar to previously reported data(Coester, Elliott and Luft., 1973). The plasma concentrations of sodium, chloride, magnesium and potassium increase during maximal exercise. The plasma osmolality also increase during maximal exercise, so the increase of plasma electrolyte is mainly due to osmoconcentration. In athletes, although the plasma potassium increase during maximal exercise but not strikingly and not proportionally more than the plasma concentration of other electrolytes as reported by other studies(Hirche, Schumacher and Hagermann., 1980, Hnik, et al., 1976, Kilburn, 1966). Greenleaf, et al in 1979, repored that when exercise is performed at moderate intensity, the plasma potassium concentration increases by approximately 0.5 meq/L. and may amount to as much as 1 or 2 meq/L at higher work level. Recent findings by Klitgaard, Henrik and Torben, in 1989, provided evidence that exercise-induced hyperkalemia canbe reduced in human subjects by moderate training and demonstrated increased concentration of [^{3}H] ouabain binding sites in trained subjects as compared to untrained subjects. The upregulation of the concentration of Na-K pumps induced by training will improve the capacity to clear K^{+} from the extracellular space and plasma during and after exercise. This could in part explain that training reduces exercise-induced hyperkalemia. Because hyperkalemia is associated with fatigue and interferes with physical performances, this effect may contribute to the beneficial effects of training. Furthermore, the less pronounced hyperkalemia will reduce the risk for cardiotoxic effects of exercise. Na-K-ATPase activity was not studied in that studies. In our studies, we studied both [^{3}H]ouabain binding site and Na-K-ATPase activity(but in erythrocytes instead of skeletal muscles) and finds that it was not correlated with peak plasma concentration, so it cannot explain the plasma potassium concentration that not increase so much as in control subjects regarding to [^{3}H]ouabain binding site and Na-K-ATPase activity. [^{3}H]ouabain binding site and Na-K-ATPase activity in erythrocytes may not be ideal source for study as compared to skeletal muscles. In Thailand, there have not been any reports or data of electrolytes change during and after exercise. This study show that our subjects, both control and athletes, the peak plasma potassium concentration which increase at maximal degree of exercise was not so much as in western people. We think that exercise design is not the limited factors because maximal heart rate during exhaustion canbe achieved to 75-80% of maximal heart rate according to Fox's formula (220 - age). Environment factors and diet may be factors to explain the difference in peak plasma potassium concentration.

The exercise in the present study produced acidosis, as evidenced by the marked increase in the plasma lactate concentration and marked decrease in the plasma bicarbonate concentration. The blood lactate is an index of anaerobic metabolism. Increased lactate level, in muscle and blood indicates an anaerobic supplement to aerobic production of ATP. Osnes and Hermansen(1972), studied the blood lactate concentration after maximal exercise of short duration and found that the blood lactate concentration varied between 0.8 to 32.1 mM. In the present study the blood lactate concentration varied between 3.9 to 9.3 mM. The range of the blood lactate concentration is wide because the production of lactate depends on several factors, i.e., intensity, duration, and type of work (Bouhuys, et al., 1966).

The intraerythrocyte sodium concentrations decreased significantly in control subjects during recovery period of exercise, our data was similar to other study(Hespel, et al, 1986). The mechanism responsible for the decrease in the intraerythrocyte sodium concentration in recovery period is not clear. It may due to alternations of Na/H exchange. Regulation of Na/H exchange activity is determined by a balance between stimulatory and inhibitory hormonal actions. Hormones shown to stimulate Na/H exchange include angiotensin II, glucocorticoids, thyroid hormone, endothelin, $1,25(OH)_2$ vitamin D_3, etc., while PTH is the main inhibitory hormone. Igarashi, et al, 1992 reported that metabolic acidemia cause an increase in Na/H-exchange activities in LLC-PK1 clone-4 cells. Because the plasma bicarbonate in both groups are not different significantly, so, the studies of Na/H-exchange and hormones that previously stated may disclose the mechanisms for the decrease in the intraerythrocyte sodium concentration. This decrease in the intraerythrocyte sodium concentration may explain the decreased Na-K-ATPase activity that observed in the same period in the control subjects because the Na-K-ATPase activity is determined to a large extent by the intracellular Na concentration.

In conclusion, the present data provide evidence that baseline ouabain binding sites in athletes are more than in control subjects. During moderate to severe exercise, the plasma concentrations of electrolytes and lactate are elevated both in controls and athletes. However, the plasma potassium in the athletes was not increased so much as in control subjects. The data also show that exercise does not change the intraerythrocyte cations and the activity of the erythrocyte Na-K-ATPase pump in athletes but decrease the intraerythrocyte sodium and the activity of the erythrocyte Na-K-ATPase pump after 10 minute exercise in the control subjects.