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Effects of seasonal acclimatization on action potentials and sarcolemmal K^+ currents in roach (Rutilus rutilus) cardiac myocytes.

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Abstract

Temperature sensitivity of electrical excitability is a **potential** limiting factor for high temperature tolerance of ectotherms. The present study examines whether heat resistance of electrical excitability of **cardiac myocytes** is modified by **seasonal** thermal **acclimatization** in **roach** (**Rutilus rutilus**), a eurythermal teleost species. To this end, temperature dependencies of ventricular **action potentials** (APs), and atrial and ventricular K^+ currents were measured from winter-acclimatized (WiR) and summer-acclimatized (SuR) **roach**. Under patch-clamp recording conditions, ventricular APs could be triggered over a wide range of temperatures (4-43°C) with prominent changes in resting membrane **potential** (RMP), AP duration and amplitude. In general, APs of SuR were slightly more tolerant to high temperatures than those of WiR, e.g. the break point temperature (T_{BP}) of RMP was 37.6±0.4°C in WiR and 41±1°C in SuR ($p<0.05$). Of the two major **cardiac** K^+ currents, the inward rectifier K^+ **current** (I_{K1}) was particularly heat resistant in both SuR (T_{BP} 39.4±0.4°C) and WiR (T_{BP} 40.0±0.4°C) ventricular **myocytes**. The delayed rectifier K^+ **current** (I_{Kr}) was not as heat resistant as I_{K1}. Surprisingly, I_{Kr} of WiR tolerated heat better (T_{BP} 31.9±0.8°C) than I_{Kr} of SuR (T_{BP} 24.1±0.5°C) ($p<0.05$). I_{Kr} (Erg2) channel transcripts of both atrial and ventricular **myocytes** were up-regulated in WiR. I_{K1} (Kir2) channel transcripts were not affected by **seasonal acclimatization**, although ventricular I_{K1} **current** was up-regulated in summer. Collectively, these findings show that thermal tolerance limits of K^+ currents in isolated **myocytes** between seasonally acclimatized **roach** are much less pronounced than the heat sensitivity of ECG variables in intact fish.

KEYWORDS: Climate warming; Electrical excitability; Fish heart; Temperature tolerance; Thermal **acclimatization**

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