EXERCISE-INDUCED CALMODULIN-DEPENDENT PROTEIN KINASE (CAMK)II ACTIVATION REGULATES SATURATED AND UNSATURATED FATTY ACIDS IN RAT SKELETAL MUSCLE

DR. SANDILE FUKU
INTRODUCTION

• ELEVATED FFA ARE PREDICTIVE OF CONVERSION FROM IMPAIRED GLUCOSE TOLERANCE TO DIABETES
• FATTY ACIDS PLAY CRUCIAL ROLE IN THE PATHOGENESIS (METS)
• EXERCISE ALLEVIATES SOME OF THE METS SYMTOMS
• CAMKII REGULATES MANY BENEFICIAL CELLULAR FUNCTIONS
  • CAMKII CAN BE ACTIVATED BY EXERCISE

(BERGMAN AND ADER, 2000; ROSE ET AL., 2006)
• UNSATURATED FATTY ACIDS HAVE BENEFICIAL EFFECTS ON METABOLIC SYNDROME,
  • REDUCE RISK FACTORS OF METS BY PROMOTING INSULIN SENSITIVITY, INCREASING GLYCAEMIC CONTROL, AND REGULATING HDL AND LDL LEVELS (LAURIC ACID)

• SATURATED FATTY ACIDS ARE KEY CONTRIBUTORS TO THE INCREASE OF RISK FACTORS OF METABOLIC SYNDROME
  • PALMITIC ACID AND MYRISITIC ACID INCREASE INSULIN RESISTANCE AND LDL CHOLESTEROL LEVELS

(MISRA ET AL., 2010; RISÉRUS ET AL., 2009)
MISSING LINK

• EXERCISE-INDUCED CAMKII ACTIVATION REGULATES SYNTHESIS AND DEGRADATION OF SATURATED AND UNSATURATED FATTY ACIDS?
METHODS
**Days 1-4:** Rats were received, housed, familiarized to handling and their health monitored.

**Days 5-8:** Rats were familiarized with swimming protocol. Rats were placed in a cylindrical drum filled to a depth of 50 cm with the tap water maintained at 35°C.

Day 5: 2×17 min swim with a 3 min rest in between bouts
Day 6: 3×17 min swim with a 3 min rest in between bouts
Day 7: 4×17 min swim with a 3 min rest in between bouts
Day 8: 5×17 min swim with a 3 min rest in between bouts

Following the final exercise session and in between each bouts rats were gently towel dried and placed in their cages.

**Days 9-14:** Rats were rested in cages

**Days 15-19:** Exercise rats performed a 5×17 min with a 3 min rest in between bouts. This was repeated for once per day for 5 days. The rats were anaesthetized after 0, 2, 4, 6, 8, 10, 12 and 15 hrs post exercise and the muscles were dissected out for analysis.
RESULTS
The graph shows protein expression (relative unit) for different conditions: Control, Exercise, and Exercise+KN93. The y-axis represents protein expression, and the x-axis represents different experimental conditions.

- **PCaMKII**
  - Control: Low expression
  - Exercise: High expression
  - Exercise+KN93: Moderate expression

- **pCaMKII**
  - Exercise: Higher expression compared to Control and Exercise+KN93

- **Total CaMKII**
  - All conditions show similar expression levels.
**A)**

Peak area ratio (relative unit)

Palmitoleic acid

**B)**

Time (s)

TIC

**C)**

Peak True - sample "Control", peak 50, at 737.5 s

Library Hit - similarity 917, "9-Hexadecenoic acid, methyl ester, (Z)-"

**D)**

Peak True - sample "Exercise+KN93", peak 42, at 737.2 s

Library Hit - similarity 927, "9-Hexadecenoic acid, methyl ester, (Z)-"
A) Oleic acid

B) 9-Octadecenoic acid (Z)-, methyl ester

C) 9-Octadecenoic acid (Z)-, methyl ester

D) 9-Octadecenoic acid (Z)-, methyl ester
Peak area ratio (arbitrary unit)

**Lauric acid**

**A)**

<table>
<thead>
<tr>
<th>Control</th>
<th>Exercise</th>
<th>Exercise+KN93</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

**B)**

**C)**

**D)**

Library Hit - similarity 913, "Dodecanoic acid, methyl ester"

Peak True - sample "Exercise T1", peak 34, at 503.7 s

Library Hit - similarity 923, "Dodecanoic acid, methyl ester"
A) B)
C) D)

Peak area ratio (relative unit)

**Control**

**Exercise**

**Exercise + KN93**

Myristic acid

Peak True - sample "Exercise (T1)", peak 39, at 611.1 s

Library Hit - similarity 933, "Methyl tetradecanoate"

Peak True - sample "Exercise+KN93 (T1)", peak 46, at 609.5 s

Library Hit - similarity 921, "Methyl tetradecanoate"
A) B) C) D) 
0 1 2
Control Exercise Exercise+KN93

Peak area ratio (relative unit)

Palmitic acid

**

400 600 800 1000 1200 1400 1600

2e+007 4e+007 6e+007 8e+007 1e+008 1.2e+008 1.4e+008

Time (s)

Hexadecanoic acid, methyl ester

TIC

40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400

100 200 300 400 500 600 700 800 900 1000

74 87 43 55 143 101 129 227 171 199 270

Library Hit - similarity 933, "Hexadecanoic acid, methyl ester"

Peak True - sample "Exercise (T1)", peak 57, at 723.3 s

Library Hit - similarity 923, "Hexadecanoic acid, methyl ester"

Peak True - sample "Exercise+KN93 (T1)", peak 56, at 721.1 s

Library Hit - similarity 932, "Hexadecanoic acid, methyl ester"
CONCLUSIONS

- CAMKII ACTIVATION BY EXERCISE REGULATES SATURATED AND UNSATURATED FATTY ACIDS
- CAMKII SELECTIVELY INCREASES THOSE LIPIDS BENEFICIAL TO HUMAN HEALTH AND DECREASES THOSE LIPIDS SHOWN TO HAVE A NEGATIVE EFFECT ON TYPE 2 DIABETES AND METABOLIC SYNDROME.