FORMS OF FAT AS FUEL

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Abstract: Fatty acids are the primary form of fuel from fat. They are stored in fat and muscle tissue as triglycerides. The aerobic system uses fat and glycogen as fuel for ATP resynthesis. The system creates a large amount of ATP through chemical reactions in the mitochondria but without fatigue as an end product. The aerobic system is used during heavy or light activities. Fats and proteins, when used as fuel for ATP resynthesis, go through the Krebs cycle and the electron transport system.

Keywords: Fats; Fuel; Triglycerides; Glycerol; Fatty acids

1. Introduction

Like carbohydrates, fats have a basic "used form" in the body in the form of fatty acids, abbreviated as FA. Dietary fats are broken down to produce fatty acids and glycerol. After the absorption of fatty acids in the cells of the small intestine, they are converted into triglycerides [1,2].

The mobilization of fatty acids from body fat stored for muscles is an essential factor concerning the reduction of body weight through the reduction of body fat. They have two main forms of fat as fuel, which are available to the muscles during exercise: fatty acids transported by blood from adipose tissue and triglyceride stored for the needs of skeletal muscles [1,3].

2. Fatty acids in the blood

Triglycerides contain one mole of glycerol and three moles of fatty acids. When triglycerides are broken down, one mole of glycerol and three moles of fatty acids are released (Figure 1). Triglycerides are a storage form of fatty acids (FA). Triglyceride stores have been found in adipose tissue and skeletal muscle. When the muscles need fatty acids from adipose tissue, they are released from triglycerides and transported by blood to the muscles, which are oxidized [4–7].

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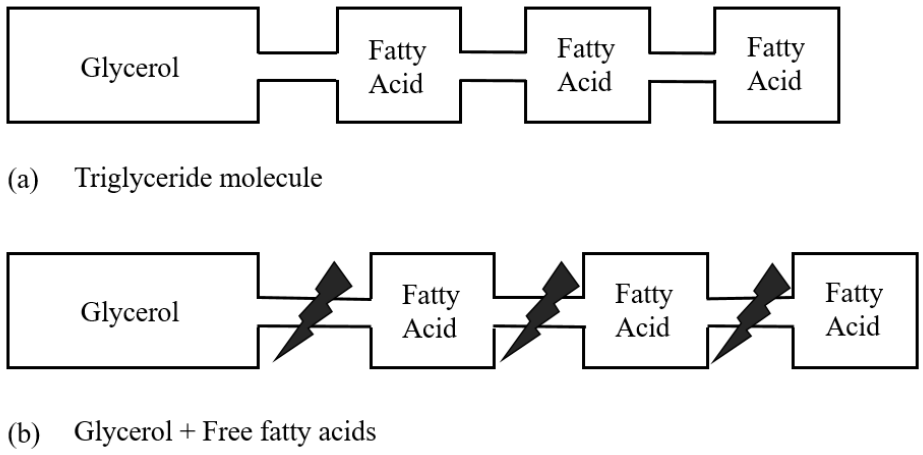

Figure 1. Triglyceride molecule as the storage form of free fatty acids (a) and glycerol and free fatty acids during decomposition (b)

Triglycerides stored in adipose tissue are broken down into fatty acids and then transported by blood to skeletal muscles. During endurance exercises of moderate intensity, these blood fatty acid molecules are the main fuel source for the production of ATP through the oxygen system. Figure 2 shows that the oxidation of fatty acids represents 11% of the total metabolism of the leg muscles (quadriceps) during a one-hour submax riding a bicycle. Fatty acids represent between 25% and 90% of the total exercise metabolism. The oxidation of fatty acids gives 11%, and muscle triglyceride stores give 32% of total fat metabolism [1,8,9].

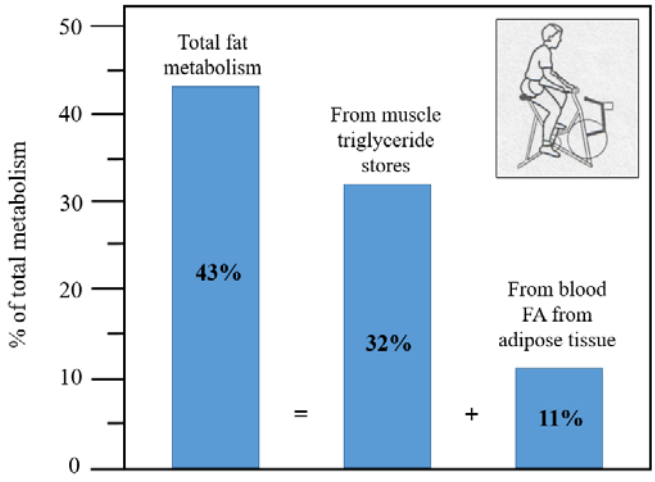

Figure 2. The oxidation of fatty acids

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3. Stores of muscle triglycerides

Muscle glycerides are used significantly during long endurance activities. Figure 2 shows that triglyceride stores provide enough fuel for 32% of total leg muscle metabolism during one hour of submax riding a bicycle. Figure 3 shows the discharge of muscle triglycerides in several activities over 1 h to 12 h. In contrast to glycogen stores, emptying triglyceride stores is unrelated to the activity's duration [10–12]. One factor that affects muscle triglyceride utilization is pre-exercise muscle triglyceride levels. This is shown in Figure 3b. The use of triglycerides in certain activities depends on the fat stored in the muscles, i.e., if fat stores are prioritized during exercise, a large amount of triglycerides will be used during that exercise (cross-country skiing shows the highest level of triglycerides-duration of 7 h, while activities of 12 h running 100 km are similar to activities of 1 h to 2.5 h) [13,14].

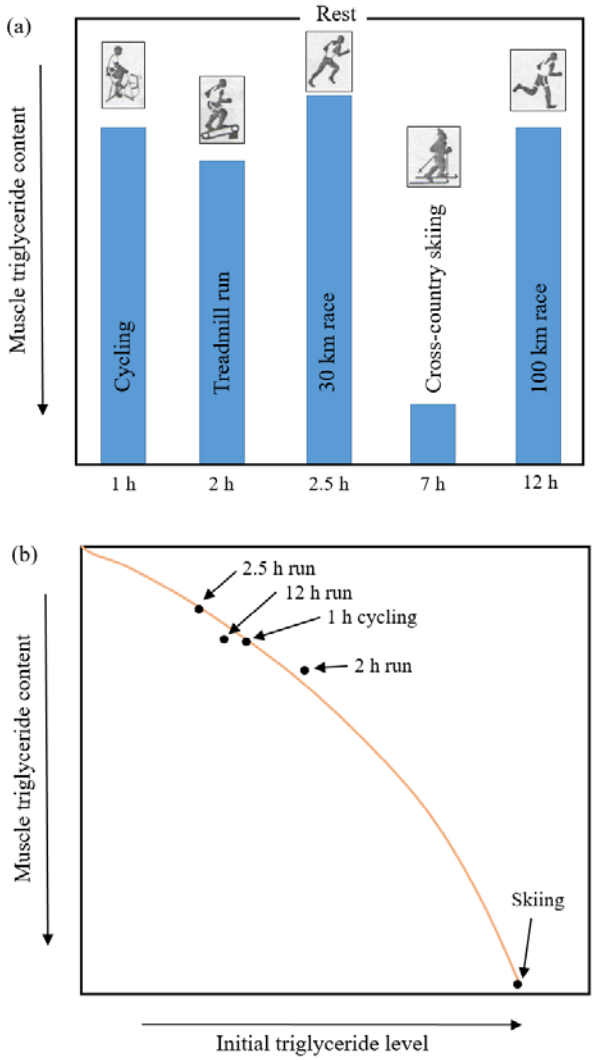

Figure 3. Levels of triglycerides used during different activities (a) and dependency of muscle triglyceride content and initial triglyceride level (b)

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4. Fuels for sprint training and endurance-type activities

Stored muscle glycogen is the main food source of fuel during short, high-intensity exercises. In activities lasting a few seconds, the main fuel source is creatine phosphate (CP), without the participation of blood fuel molecules nor food storage as fuel (Figure 4). During 1 h of cycling, muscle stores of triglycerides and glycogen supply 76% of fuel, while blood fatty acids and glucose provide the remaining 24% [15,16].

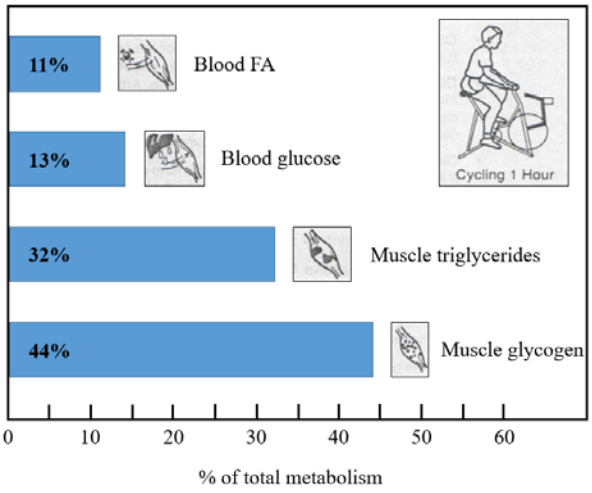

Figure 4. The main fuel source during 1 h of cycling

Muscle stores of triglycerides and glycogen supply endurance-type activities with about 76% fuel, and blood fuel molecules, fatty acids, and glucose supply the remaining 24% [17].

5. Conclusions

Dietary fats are dissolved, producing fatty acids and glycerol. Fatty acids are a basic form of fuel derived from fat. They are stored in fat and muscle tissue like triglycerides.

The mobilization of fatty acids from the body's fat stores is an important factor during exercise to reduce body weight by reducing the percentage of body fat. There are two basic forms of fat as fuel for muscles during exercise. These are fatty acids transported by blood from adipose tissue and triglyceride stores for the needs of skeletal muscles.

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