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Research Note

Muscle Fiber Types of the Tunica Muscularis Externa at the Upper Part of the Sparrow (*Passer domesticus*) Esophagus

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Abstract: Muscle fiber types of the tunica muscularis externa of the upper part of the sparrow esophagus were characterised by the method of myofibrillar adenosine triphosphatase (mATPase). Muscle fibers were described as type II and type III. Muscle fiber types were histochemically different from those of the esophagus of broiler ross. It is thought that this difference should be evaluated according to the functional difference between the esophagus of domestic and wild bird species.

Key Words: *Passer domesticus*, Aves, Esophagus, Histochemistry, Muscle

Serçe (*Passer domesticus*) Özofagusunun Yukarı Bölümünde Tunika Muskularis Eksterna'da Kas Lifi Tipleri

Özet: Serçe özofagusunun yukarı bölümünde, tunika muskularis eksterna'nın kas lifi tipleri miyofibriller adenozin trifosfataz (mATPase) metodu ile karakterize edildi. Kas lifleri bu metoda göre, tip II ve tip III olarak tanımlandı. Kas lifi tipleri, histokimyasal olarak etlik besi pilici özofagusundakinden farklıydı. Bu farklılığın, evcil ve yabani kuş türleri arasında özofagusun fonksiyonuna bağlı olarak değerlendirilmesi gerektiği kanaatine varıldı.

Anahtar Sözcükler: Serçe, Kuş, Özofagus, Histokimya, Kas

Introduction

The esophagus of birds was studied experimentally (1) and comparative physiological investigations of mammalian and bird digestive systems were performed (2). It has been reported that the striated muscle fibers of birds are less developed in various nutritional conditions (3) whereas smooth muscle fibers show different development (4). Myogenic variations depending on oxygen and nutrition have been discussed previously (5, 6).

There are more studies on the neuronal control of the esophagus than on the myogenic control system (MCS) (7). Irregularity of the esophageal movements is thought to be related to the upper esophagial striated muscles instead of the lower esophageal smooth muscles (8).

There are many investigations on the mammalian esophagus (9-14) while less studies have been done on the bird esophagus (15-18). The mammalian upper esophageal sphincter muscles have been studied by the mATPase method (19). Cryostat sections used for mammalian muscle fibers (20) have also been used to study bird breast and leg muscles (21,22). It has been reported that the morphological and physiological study of the muscle structures of different animal groups is very important for evaluating the pharmacological properties of the esophagus (23). Birds have been chosen as a model to study the pharmacological properties of the skeletal muscle (24). When a comparison was made between domestic and wild bird species, it was observed that there were differences in the mATPase activity of the muscle fibers (25). However, until now, there has been no study on the histochemical structure of the esophagus muscles of the sparrow. Therefore, in this study, cryostat sections from the upper esophagus of the sparrow were analyzed by the mATPase method and the types of muscle fibers were evaluated histochemically.

Materials and Methods

Ten sparrow esophagus samples were removed. Frozen sections of the wet upper esophagus were cut at 12-15 µm thickness in a cryostat. These sections were subjected to the mATPase method at 25ºC at pH 4.25 for five minutes and at pH 10.4 for 15 minutes after acid and alkaline preincubations at 40ºC in order to determine the fiber types (26-30). Evaluation of the fiber types was similar to that carried out by other authors (27,31-35).

Results and Discussion

As in the striated muscle of the birds (3,36,37), and as in our previous studies (38,39) three fiber types were identified in the esophagus of the broiler ross (broiler chicken) (type I, type IIA and type IIB). In this study, two fiber types (II and III) were determined in the sparrow esophagus. With the application of mATPase following acid preincubation, it was observed that type II fibers and type III fibers with small diameters give weak and mid–level mATPase reactions respectively (Fig. 1). It has been reported that small fiber diameters have a high degree of aerobic capacity (40). After alkaline preincubation, following differentation with acid preincubation, fibers were stained dark and showed high mATPase reaction (Fig. 2a, b).

Different mATPase reactions have been reported for type III fibers in the bird skeletal muscle (27,28,30,36,41). But, as we have reported for the sparrow triceps (30), the term type III, generally used for the sparrow esophagus in this study, is preferred also for this fiber type due to its resistance to both alkaline and acidic applications (31,41). When we compared it with the other fiber types, we thought that different mATPase reactions in type III fibers are specialized (42,43) for slow and supportive contractions in the sparrow esophagus, as in the bird skeletal muscle (27,28,30,36,44).

The fibers we have differentiated in the sparrow esophagus that are irresistant in acid and resistant in alkaline, are called twitch (28,33), fast–twitch (27,36,45) or type II (31,32,41) by various authors. The fibers that we have described as type II using the mATPase method are also called fast–twitch glycolytic (IIB) (46-50) or white (51,52) after nitroblue tetrazolium nicotinamide adenin dinucleotide phosphate (NBT) or succinic dehydrogenase (SDH) staining methods. It is reported that they have low mATPase activity (53) and low aerobic capacity (3,52), like the mammalian type IIB fibers, and consume glycogen (48). As in the bird skeletal muscle (49-55), in the chicken esophagus (38) and sparrow esophagus, these fibers might be related to the ability to increase the rate in the swallowing motion as well (56).

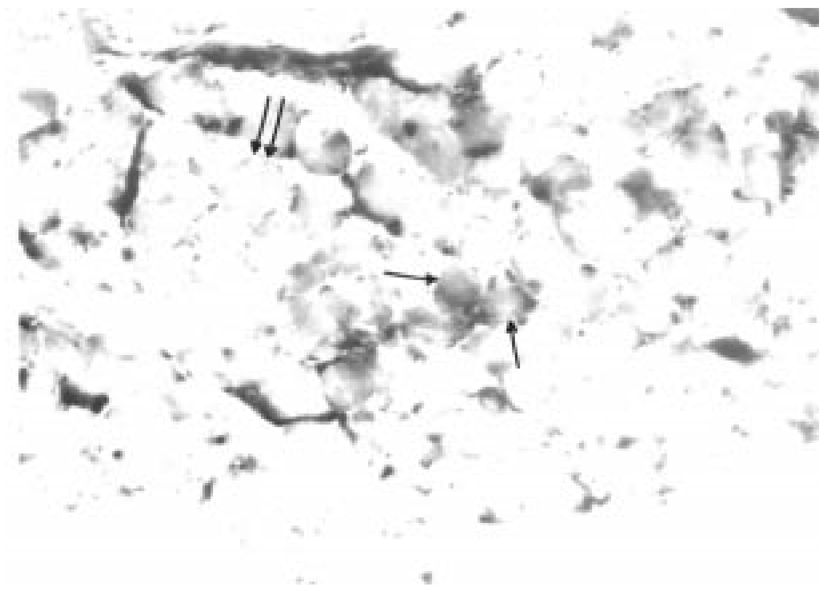

Figure 1. Muscle fiber types of the tunica muscularis externa of the upper part of the sparrow esophagus. Arrow: type III. Double arrow: type II. mATPase after acid preincubation (x256).

Figure 2. Tunica muscularis externa at the upper part of the sparrow esophagus (serial transversal sections). Arrow: type III, Double arrow: type II, Asterisk: The part evaluated in section. a) mATPase after acid preincubation, b) mATPase after alkaline preincubation (the fiber types are stained dark) (x40).

Different types of muscle fibers (32) in every species and in every particular muscle (21,33,57-61) may have adapted to meet functional needs (60,61). Furthermore, morphological adaptations of bird muscles depending on changes in nutrition type and nutrition model are recorded (62). Similar adaptations have also been reported histochemically (50). The mATPase activity of the muscle fibers was compared with that in the chicken, and it was found to be higher in wild bird species (25). Thus, in birds such as the sparrow (eating hard cereals, fruits, insects, etc.) (63,64), the muscle fibers at the upper portion of the esophagus can be differentiated into specific types according to their functional roles (types II and III). We think that the muscle fibers of the upper esophagus of the bird should be analyzed morphologically, histochemically and functionally, with more intensive and different approaches.

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