Aerodynamic characteristics of synthetic shuttlecocks in badminton.

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Summary

The Badminton World Federation (BWF) has approved the use of synthetic feathered shuttlecocks in international competitions [1] but it is not widespread. One of the reasons for this might be a lack of understanding of the characteristics of synthetic shuttlecocks. We therefore compared the aerodynamic properties of synthetic and traditional water-fowl feathered shuttlecocks. The results showed that the synthetic shuttlecock has a predominantly larger attitude angle post racket impact and a possible longer flight distance than the traditional shuttlecock.

Introduction

The BWF has approved the use of synthetic shuttlecocks, but the impact on competition, particularly the properties of synthetic shuttlecocks, remains unclear. This study aims to clarify the aerodynamic and flying characteristics of BWF-approved synthetic shuttlecocks and their differences from traditional ones based on aerodynamics data.

Methods

Twenty collegiate badminton players participated, with each player smashing both synthetic (TECH FEATHER 03, Speed: 4, Mizuno Corporation.) and traditional (TOURNAMENT F-90, Speed: 4, YONEX Co., Ltd.) shuttlecocks launched by a badminton feeder machine (S4025, SIBOASI, China) into a target area. The shuttlecock's motion was recorded using high-speed cameras and motion capture systems to analyze key parameters. Wind tunnel tests were also conducted in conjunction with 0°, 15°, 30° and 45° shuttlecock angles against the wind flow. Based on the wind tunnel results, 2D flight simulations were also carried out at a velocity of 90 m/s. The attitude angle of the shuttlecock was assumed to be at 0° in the simulations.

Results and Discussion

Synthetic shuttlecock was heavier, longer and greater in skirt diameter than traditional one (Table1). Traditional and synthetic shuttlecocks were compared in initial velocity, momentum, launch angle, and attitude angle (Figure1). Traditional shuttlecock had higher initial velocities, while synthetic ones had higher maximum attitude angles and greater changes in attitude after impact. Wind tunnel tests showed drag force increased with wind speed for both shuttlecocks. Traditional shuttlecock had higher drag force at 0° and 15°, but synthetic ones surpassed at 45° in the high speed range. 2D flight simulation showed similar trajectories for both shuttlecocks initially, but the synthetic shuttlecock flew farther at 90 m/s (Figure2). Experiments revealed that immediately after impact, the synthetic shuttlecock decelerated due to the large attitude angle change. In the latter part of the flight, the flight distance was longer than that of a traditional shuttlecock because the drag force of synthetic shuttlecock was less than the traditional shuttlecock. However, the simulations were carried out assuming a constant attitude angle, so further research is needed.

Table1. Synthetic and traditional shuttlecock dimensions.

		Traditional shuttlecock	Synthetic shuttlecock
Mass	[g]	5.24	5.33 **
Skirt diameter	[mm]	65.2	65.8 **
Shuttlecock length	[mm]	85.2	82.7 **

** $p < 0.01$.

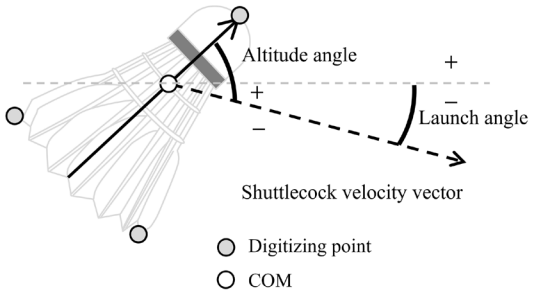

Figure 1: Definition of the altitude angle and the launch angle.

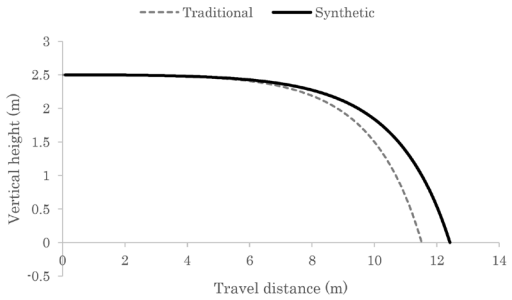

Figure 2: Results of shuttlecock flight distances from 2D flight simulations at 90 m/s.

Conclusions

The synthetic shuttlecock may differ from the traditional shuttlecock in behavior immediately after impact and in the flight distance during smash. Even if the synthetic and traditional shuttlecocks fall at the same point, a speed perceived by net player may differ from that by a back player because of the different deceleration ways.

Reference

[1] BWF Corporate website. (2020, January 20). Retrieved September 4, 2022.