The Hidden Secrets of Cricket Balls: Inconsistent Manufacturing Quality Control and Implications for the Game

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Abstract

Cricket is the second-most popular sport in the world, and the most popular sport in India. Cricket balls are traditionally manufactured manually or semi-automated, which may affect the consistency of the production process. The objective of this study was to test the quality and consistency of manufacturing in different balls. Compression tests were applied to five different ball models (Kookaburra Special Test / Australia, Regent Match red / India, Regent Match white / India, Sanspareil-Greenlands Tournament / India, Gray-Nicolls Super Cavalier / Pakistan). Out of the five models tested, merely the Kookaburra ball was manufactured consistently. All other balls proved to be produced inconsistently with a wide range of stiffness. Additionally, the other four balls revealed two different, yet externally indistinguishable constructions, which resulted in two clusters different stiffness. The different constructions might be related to the tension of the woolen twine in Regent Match red, and lacquer surface finish and /or cork-rubber mixture in Regent Match white, Gray-Nicolls Super Cavelier was produced with 2 different core sizes (stiffer ball with smaller core), and Sanspareils-Greenlands Tournament exhibited two different core materials, namely cork or rubber core, with the latter being the softer one. The hard sub-types of Regent Match white, Regent Match red and Sanspareils-Greenlands Tournament turned out to be the hardest balls, the hard subtype of Gray-Nicolls Super Cavalier and the soft sub-types of Regent Match red and Sanpareils-Greenlands Tournament turned out to be the hardest balls, the hard subtype of Gray-Nicolls Super Cavalier and the soft sub-types of Regent Match red and Sanspareils-Greenlands Tournament showed intermediate stiffness, and the soft subtypes of Gray-Nicolls Super Cavalier and Sanspareils-Greenlands Tournament behaved like two different balls of significantly different stiffness. The latter fact may have severe implications to the match, as softer balls are more forgiving by causing a smaller impact force, a longer contact with the bat, larger deflections as well as larger contact areas during impact, and thus allow placing the ball preciser. A more stringent quality control and testing standard is required for cricket balls in order to avoid unequal chances for both teams. The different, externally indistinguishable, subtypes can be distinguished before usage from their mass and the pitch of impact sound, and after usage, once replaced by a new ball, from dissecting the used ball.

A) Mass:

The mass of a cricket ball, Grade I County, must be between 155.0 and 163g in men's games (British Standard 5993, 1994; Laws of Cricket, 2003). The mass was found to be different only in the Regent Match white and in the Sanspareils-Greenlands Tournament subtypes. In Regent Match white balls, a mass <154g and >157.5g defines the softer and harder sub-types respectively. All softer Regent Match white balls were non-conforming with the laws of cricket, as their mass was smaller than 155.9g. Some of the harder Regent Match white balls were non-conforming as well with a mass larger than 163g. In Sanspareils-Greenlands Tournament balls, a mass of 158.5g clearly separates the sub-types (harder ball with smaller mass).

B) Pitch of impact sound:

In general, when dropping a ball on a tile, the harder the ball, the higher the pitch of the impact sounds. This method, however is imprecise and is only suited for comparing different balls of the same model.C) Dissection allows distinguishing only soft and hard subtypes of Gray-Nicolls Super Cavalier (2different core sizes, stiffer ball with smaller core), and Sanspareils-Greenlands Tournament (different core materials, harder cork and softer rubber core).

Keywords: Compression Test, Rubber core, Hardestball, Regent Matchred, Stiffness, Impact, Stringent, Kookabarraball.

Introduction

Cricket is the second-most popular sport in the world behind soccer, and the most popular spoll in India. Traditionally, the ball consists of a cork nucleus (Table I), encased by leather hemispheres, and joined by a circular seam of 6 rows of stitches around its equator. The mass of a cricket ball, Grade I Country, must be between 155.9 and 163 g in men's games (British Standard 5993, 1994; Laws of Cricket, 2003). Thus, the preferred mass is the minimum of 156 g to achieve maximal acceleration (Table 1).

The condition in which the cricket ball is used has decisive consequences for the outcomes of the game be it its surface roughness and seam orientation for aerodynamics,(especially for the swing of the ball) be it its hardness, determining the ease or difficulty with which its bounce direction can be controlled. In contrast to other sport balls, specifically golf balls, most cricket balls are still hand made, which may affect the consistency of manufacturing.

In the light of the few studies on cricket balls, the need for a thorough investigation of cricket ball properties is evident.

Aim of the Study

The aim of this study is to

- investigate the internal constructions and the structural properties of a few brands of cricket balls,
- explore whether, and if, how, the construction affects the properties, and
- develop guidelines for detecting inconsistently manufactured balls.

The experimental data from mechanical testing and the observations made from internal constructions will be applied to propose a standard for quality control, and to discuss the effect and implications of inconsistent manufacturing on the outcome of the game.

Balls Investigated

The balls examined are listed in Table 1. All balls were new, and were tested only once.

Table - I

Cricket Balls Investigated and their Details

Brand	Model	Colour	Country of Origin	Construction	Abbreviation
Kookaburra	Special Test	red	Australia	MB2	Kr
Gray-Nicolls	Super Cavalier	white	Pakistan	HA4	Gw
Regent	Match	red	India	HA4	Rr
Regent	Match	white	India	HB2	Rw
SG/Sanspareils-Greenlands	Tournament	red	India	HA4	Sr

(M - machine made, H - hand made, A-woolen twine and cork layers encasing a central core, B - molded cork-rubber centre without woolen twine and cork layers, 2 and 4 = number of leather pieces; Fuss, 2008)

Method

For the compression tests, the balls were loaded by an Instron material testing machine (model no.: 3366) up to 9kN. From the load - deflection curve, the stiffness was calculated, which is the deflection derivative of the load. The planes of loading were: perpendicular to the plane of the seam (plane I), and parallel to the plane of the Seam (plane 2).

All balls used for compression testing were also analyzed by examining their internal construction. After splicing their seams open, the nature of their anatomy, the materials used and the properties of those materials, were all noted, specifically the nature, material and size of the core, the nature of layers of cork layers and woolen twine, and the consistency of the construction across different specimens of the same brand and model. Details of ball construction were correlated to the compression data and to the mass of the balls.

Results

a) Constructions

1. Kookaburra Special Test: all balls showed a uniform construction. The core consisted of cork rubber mixture.
2. Regent White Match: all balls had a construction similar to that of Kookaburra Special Test - a large core of rubber-cork without woolen twine windings
3. Gray-Nicolls Super Cavalier: all balls had layers of woolen twine along with cork that padded an inner core of molded rubber-cork. Surprisingly, the cores were not of uniform size. There were two distinct size ranges (Figure la) - a smaller set of cores (diameter 4.4 ± 0.2 cm) and a larger set of cores (diameter 5.7 ± 0.3 cm). For those with smaller cores, the cork shavings were arranged in a more irregular and haphazard manner.
4. Regent red Match: all balls had a smaller central core covered by layers of cork twined with wool.
5. Sanspareils-Greenlands Tournament: though all balls were of the same model, two distinct types of constructions could be identified: one set of balls had neat layers of cork, shaped like the leather pieces of a baseball, with woolen twine covering a rubber sphere; the 2nd set of balls had cork packed in a rough and irregular manner with woolen twine covering a core made of cork with varying degrees of woodiness, and ranging from spherical to completely irregular shape (Figure I b).

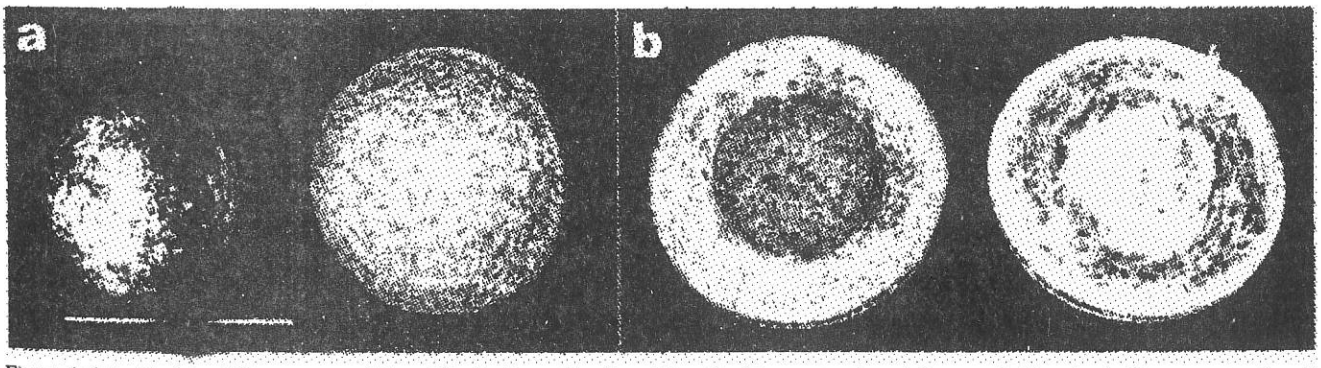

Figure 1: left side (a) - different cores of Gray-Nicolls Super Cavalier; right side (b): construction of Sanspareils-Greenlands Tournament with rubber and cork cores (Fuss, 2008).

b) Stiffness

- Figure 2 shows the stiffness of all models and subtypes. The compression tests revealed hard and soft subtypes in all balls but the Kookaburra ball. These subtypes are externally indistinguishable. The hard sub-types of Regent Match white, Regent Match red and Sanspareils-Greenlands Tournament (cork core) turned out to be the hardest balls, the hard subtype of Gray-Nicolls Super Cavalier (small core) and the soft sub-types of Regent Match red and Sanspareils-Greenlands Tournament (rubber core) showed intermediate stiffness, and the soft subtypes of Gray-Nicolls Super Cavalier (large core) and Regent Match red as well as the Kookaburra Special Test ball proved to be the softest. The two different constructions (sub types) of Regent Match white, GrayNicolls Super Cavalier and Sanspareils-Greenlands Tournament behaved like two different balls of significantly different stiffness.
- In all subtypes but the hard Regent Match white, the stiffness increases with deflection. The hard subtype of Regent Match white is the stiffest ball at deflections smaller than 3 mm; after 3 mm, the stiffness decreases.
- The harder and softer subtypes can be distinguished from the pitch of the impact sound, when dropped on a rigid floor. The higher the stiffness, the higher the pitch.

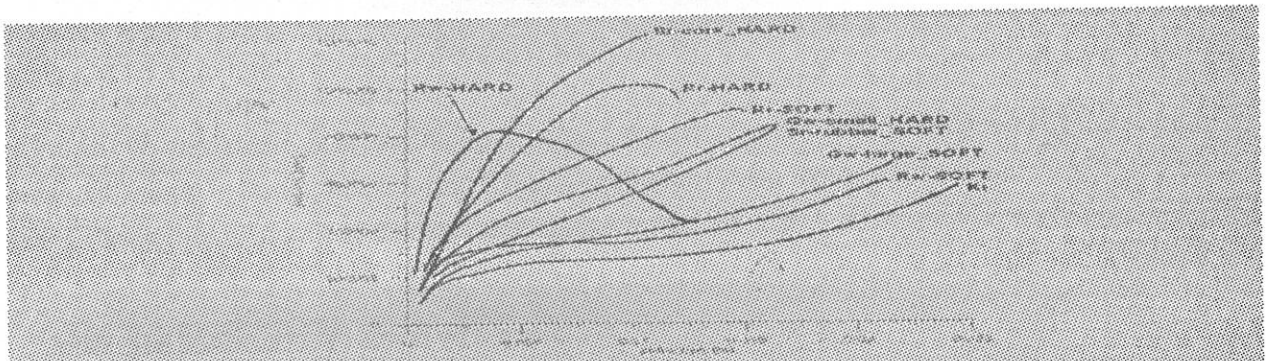

Figure 2: stiffness against deflection of all models, and hard and soft subtypes (Foss, 2008). © 2008 John Wiley and Sons Asia Pte Ltd

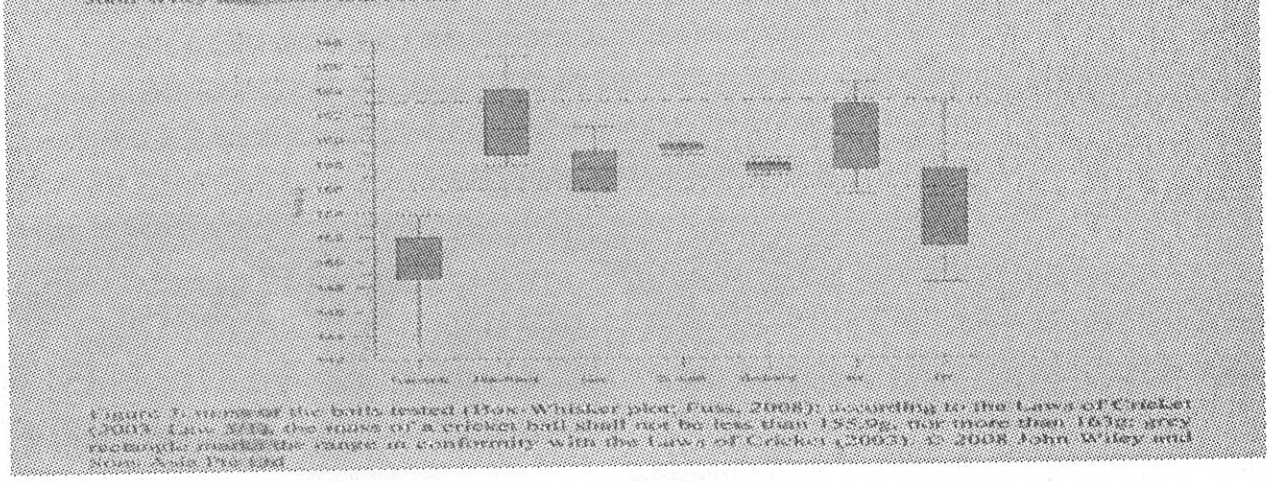

Figure 3: mass of the balls tested (Box-Whisker plot; Foss, 2008); according to the Laws of Cricket (2003, Law 5.3), the mass of a cricket ball shall not be less than 155.9g, nor more than 163g; grey rectangle marks the range in conformity with the Laws of Cricket (2003). © 2008 John Wiley and Sons Asia Pte Ltd

c) Mass

Figure 3 shows the mass of the balls investigated. Only the 2 subtypes (hard and soft) of Regent Match white and Sanspareils-Greenlands Tournament can be distinguished from the mass m:

- Regent Match white soft: m<154g
- Regent Match white hard :m>157.5g
- Sanspareils-Greenlands Tournament hard (cork core):m<158.5g
- Sanspareils-Greenlands Tournament soft (rubbercore):m<158.5g

Discussion

In this study all analyses involved new balls only. This is due to the fact, that new balls are permanently deformed after the first compression. During the game, however, a cricket ball becomes softer with time. This is why the "openers" are usually the most experienced batsmen of the team, as they have to face a new, and thus hard ball as well as the most aggressive fast bowlers (high ball speed). Yet, ball degradation and softening is a feature of every cricket ball and thus affects both teams.

There are, however, 2 specific features, identified in this study, which can cause an advantage or disadvantage to a team:

- inconsistent manufacturing of balls of identical construction, causing a wide range of ball stiffness (as balls investigated except Kookaburra), and
- Manufacturing of one specific ball of two different, yet externally indistinguishable constructions, and there by even more widening the range of the originally inconsistently produced ball (Sanspareils-Greenlands Tournament and Gray-Nicolls Super Cavalier).

According to Bhatia (2005), Sanspareils-Greenlands "balls are checked exhaustively at every stage within the factory… A minor element out of place could change the way a ball behaves". Accordingly, Sanspareils-Greenlands claim that "all of their cricket equipment is manufactured to strict quality controls: (SG Cricket,2007). The present study, however, proves those claims untrue, as the 2 Sanspareils-Greenlands subtypes contained either rubber or cork cores, resulting in different stiffness. This clearly indicates a failure of both quality control and consistent manufacturing techniques. For a brand that is used at the highest levels of the game in India, this is a very disappointing finding.

According to the rules of cricket (Laws of Cricket, 2003) a team captain may demand a new ball at the start of each innings. This rule, however, leads to unequal chances for both teams, as a softer ball provides one team with an advantage over the other team.

This skill of playing a shot is related to the swing style, the timing and the placement of the ball or direction aimed to avoid fielders. As mentioned above, more experienced batsmen deal more easily with faster bowling velocities and initially harder balls.

Softer balls are more forgiving: they cause a smaller impact force, are longer in contact with the bat, and show larger deflections and thus larger contact areas during impact. This allows placing the ball preciser.

The different, externally indistinguishable, subtypes can be distinguished before usage from their mass and pitch of impact sound, and after usage, once replaced by a new ball, from dissecting the used ball (Table 2). As advice, a coach can attempt to distinguish harder and softer balls (within one specific model) by dropping the balls from a height of about 1m on a smooth and hard surface and judge the balls from the pitch of the impact sound: the higher the pitch, the harder the ball. This procedure, however, is rather a rough guideline than an accurate test. A preciser method is to weigh the balls, which allows distinguishing between soft and hard types (Table 2).

Table - II
Guide for Distinguishing the Hard and Soft Subtypes
(+ and -: High and Low Pitch Respectively)

Models	Subtype & stiffness	Pitch of different impact sound construction		Different mass
Gray-Nicolls	Super HARD	+ +	smaller core	no difference
Cavalier	SOFT	- -	larger core	
Regent Match	HARD	+		no difference
	SOFT	- -		
Regent Match white	HARD	+ +		m> 157.5 g
	SOFT	- -		m < 154 g
Sanspareils-Greenlands	HARD	++	cork core	m < 158.5 g
Tournament	SOFT	--	rubber core	m> 158.5 g

Interestingly, the former head coach of the Pakistan cricket team, Bob Woolmer (1948 2007) used three different brands of cricket balls in practice matches (Javed, 2005), specifically Kookaburra, Grays, and a South African ball as Ist, 2nd, and 3rd new balls. Playing with different ball models within one innings is supposed to keep the batsman concentrated and to avoid getting him used to one ball. Thus playing with more balls per innings reduces the advantage or disadvantage which results from inconsistent manufacturing and different ball constructions, and possibly makes the match more interesting.

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