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Sheep Intestine Catgut String could be Used for Footwear Material

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ABSTRACT

Slaughterhouse byproducts management is an important issue for the cleaner environment. The main byproduct e.g. cow, buffalo, goat and sheep skin is the basic raw materials in the tanning industry. In the the case of byproduct: bone, blood, intestine, hooves, etc. are not managed properly. In this study, an investigation has been carried out to prepare the catgut string from the sheep intestine to use as footwear material. The study was conducted to produce an ecofriendly footwear material to replace the conventional shoelaces by the catgut string. Results showed that prepared catgut string was fulfilled the standard cycle successfully required for the footwear material (shoelace) to use in a casual shoe. It could be an attractive of marketing without ornaments everything in a shoe made from one source that is natural. In Bangladesh, every year 0.6 million sheep are slaughtered and it was estimated 1.2–1.8 million pairs shoe lace could be produced from the above slaughter sheep.

Keywords: Slaughterhouse, Catgut, Intestine, Footwear, Shoe lace.

1. Introduction

The byproduct of hide/skin from the slaughterhouse is the basic raw material for the tanning industry. Other byproducts e.g. blood, bone, hooves, raw trimmings, goat/sheep head skins are thrown away without any proper management, which cause environmental pollution. Of curse, byproducts from the slaughterhouse could be used to produce valuable products. The intestine of cow, goat and sheep are used as food. Many works have been done to produce different product other than food e.g. catgut. Catgut is a type of cord [1] that is prepared from the natural fiber found in the walls of animal intestines [2]. Catgut makers usually use sheep or goat intestines. Catgut word may have been an abbreviation of the word "cattle gut". Instead, catgut may derive by the folk etymology from kit gut or kit string; the word kit mean fiddle, having at some point been confused with the word kit for a young cat [3, 4]. For a long time, catgut was the most common material for the strings of harps, lutes, violins, violas and cellos, acoustic guitars and stringed musical instruments [5].

Anatomically, slaughter animals intestinal tract consist of four layers: i) mucose membrane ii) submucose membrane iii) muscular (circular and longitudinal) and iv) serose membrane. The catgut string is prepared from the submucose membrane of sheep intestine. The submucosa is the layer of dense irregular connective tissue or loose connective tissue (Fig. 1) [6]. Among the layers, submucose membrane of sheep intestine has its structural protein (collagen fiber). These collagen fibers are arranged i) orderly and ii) disorderly. Due to having its orderly and disorderly arrangement it provides flexible property. The mucose layer is slippery in nature and it is removed slowly by alkaline treatment.

The main material used here to produce catgut is sheep intestine. The structure of sheep intestine is figured below:

![Fig. 1 Anatomical structure of the sheep intestine](image)

The muscular and serose layers are removed during by mechanical/manual operation. These two layers become soften during alkaline treatment and it also become easier to remove those layers [7]. The objectives of making the catgut are to replace the conventional shoelaces, to produce an ecofriendly footwear material, to manage the waste produce in the slaughterhouse.

2. Experimental setup

2.1. Sample collection

Catgut from the freshly slaughtered sheep intestine provides good physical properties. Therefore, freshly slaughtered sheep intestine was collected from the

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slaughterhouse, Khulna, Bangladesh and immediately brought back to the laboratory for the next processing.

2.2. Sample preparation
After collecting, sheep intestine was cleaned and removed the unwanted parts. The small intestine was detached from the adhering mesenteric (connective and fatty) tissue. The intestinal content was removed manually (Fig. 2). The empty casings were flushed with water subsequently it was de-slimed manually.

![Fig. 2] stripping out intestinal content

Subsequently internal (mucose membrane) loosen layer of the intestine was removed which is termed as “slime”. In the slaughtered animals mucose membrane disintegrates rapidly. The loosen tissues inside the intestine was removed by pressed out manually and remainder one was rinsed off with water. Outside layer serous membrane was automatically removed (Fig. 3) during detaching the small intestine from the mesenteric tissue.

![Fig. 3] Removal of serosa membrane from the intestine

The rest of the outside and intermediate (muscular) layers were removed in casing de-sliming and cleaning operation. The remaining strong elastic tissue layer is composed of mainly of connective tissue (submucose membrane), which is the major part for catgut production [8].

2.3. Catgut processing
Catgut processing flow chart is shown in Fig. 4. After removing the unwanted layers from the intestine, soaking operation was done in plastic bawl with some surfactant. After soaking, several times alkaline was performed with sodium hydroxide to remove the remaining non-structural substances including serosa, muscular and mucose membranes (Fig. 5a).

In alkaline treatment, intestine was swelled up, which accelerates removal of unwanted parts except the submucose membrane. Then, it was beaching with hydrogen peroxide that turn into yellowish color (Fig. 5b). Before bleaching operation, the alkaline treated intestine was cut into the required size.

![Fig. 4] Flow chart for catgut processing

Cutting helps to maintain the width of the final catgut. After cutting, it was twisted and dried at room temperature. The twisted drying catgut shape was like string (Fig. 6).

![Fig. 5] Alkaline treatment a) and bleaching operation b)

![Fig. 6] Twisted dried string catgut
Twisting angle is proprietary to each shop and greatly influences the quality of the finished string. Generally speaking, twisted fibers reach maximum strength at a twist angle of about 17º [9].

2.4. Abrasion resistance test
Breaking of shoelace is a frustrating problem that can spoil the performance of good footwear. Predicating the probable life of shoe lace or determining the abrasion resistance e. g. lace to eyelet and lace to lace is carried out. Abrasion resistance provides a much better indication than tensile strength of the service life of a boot or shoelace. SATRA STM152 and SATRA STM439 methods were applied for lace to eyelet and lace to lace abrasion resistance, respectively.

3. Results and Discussion
3.1 Estimation of catgut string
In Bangladesh, every year 0.6 million sheep are slaughtered [10] and it was estimated that 1.2-1.8 million pair shoelaces could be produced from the slaughtered sheep intestine.

3.2 Process optimization
All the steps for the production of catgut from sheep intestine e.g. washing, alkaline treatment, bleaching, twisting, drying were optimized. All the steps, dwell time were very important which was standardized by repeating the steps several times. On alkaline treatment, the alkali solution was changed after 6 hours. Similarly, the other step was fixed by repeating the procedure several times.

3.3 Physical properties of catgut string
The catgut was prepared from the sheep intestine is shown in Fig 7. The final catgut was natural in color. Of course, any desire color, width, softness could be done.

![Sheep intestine catgut string](image)

**Fig. 7 Sheep intestine catgut string**

The performance of the prepared catgut was evaluated investigating physical tests e.g. lace to eyelet and lace to lace results, which is the most important to verify the acceptability as a footwear material. The tests results of lace to eyelet and lace to lace are inserted in Table 1 and Table 2.

The tested results imply that the produced catgut string was fulfilled the standard value required for footwear material (shoelace). In case of other footwear materials like mocca cord, sandal straps, welt (used in welted construction) and as a strap in different topline treatment; feasibility test should done.

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<tr>
<th>Test cycle</th>
<th>Observation</th>
<th>Standard cycle</th>
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<tbody>
<tr>
<td>1000</td>
<td>Very slightly damage</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>Very slightly damage</td>
<td>3000</td>
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<td>3000</td>
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It seems that after 3000 cycles catgut condition was good and was close to the standard result. It implies that the prepared catgut could be used for use as shoe lace.

**Table 2 Test results of lace to lace abrasion**

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4. Conclusion
Manufacturing of catgut from the sheep intestine showed satisfactory results which covers the required physical properties for shoe lace. It could be an attractive way to produce usable footwear products from the sheep intestine. Every year, Bangladesh could produce a large numbers of shoelaces from the sheep intestine.

5. References