# A Study of the Comfort of the Materials for Self-Grown Fashion Creation

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## ABSTRACT

There have been increasing attempts for fashion material production to be re-defined towards cost effective, low environmental impact, labour friendly and biodegradable. Among them, biotechnology is believed to be one fine substitute for fashion creation in future. A study is being carried out with an aim to explore futuristic development of fashion design and applications where and when the materials can be grown from natural renewable resources and degradable rather than being designed and produced in the traditional tedious way. This paper reports the investigation of the bacterial cellulose formation process in different concentrations of tea broth and different incubation times. Through the comparison and evaluation of the comfort factors of the materials, the optimal favourable material towards self-grown fashion creation was presented.

**Keywords**: Self-grown, Nature, Bacterial Cellulose, Comfort, Fashion Creation

## INTRODUCTION

Bacterial cellulose can be grown directly from the fermentation of sweetened tea by a symbiotic relationship between acetic acid bacteria and yeasts (Durfresne and Farnworth, 2000; Teoh *et al*., 2004; Malbasa *et al*., 2011). It has shown tremendous potential as an effective biopolymer in various fields (Ul-Islam, Khan and Park, 2012a; Ul-Islam, Khan and Park, 2012b). The mechanical strength of the cellulose is higher than those of plant cellulose, which has increased its utilisation in biomedical and other related fields. It has been applied for wound dressings, tissue regeneration and skin substitutes materials (Bae and Shoda, 2004; Czaja, Krystynowicz, Bielecki and Brown, 2006; Czaja, Young, Kawechi and Brown, 2007). However, seldom has the idea been conceived for artistic purposes, and in particular, in the fashion fields. This study is being carried out to investigate the bacterial cellulose formation process in different concentrations of tea broth and different incubation times. Through the comparison of the comfort factors of the materials which were grown out from different cultivated conditions, the favourability of the self-grown material towards fashion creation was identified and presented.



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# MATERIALS AND METHODS

## Materials

Green tea was the substrate for the fermentation whereas sucrose was the carbon source. Tea fungus was obtained from a microbiology institute in Mainland China.

## Culture Media and Cultivation

Substrate for cellulose fermentation was prepared by adding 60g/L of commercial sucrose to tap water and after boiling 5g/L of dry green tea was added. The tea leaves were steeped for 15 minutes and removed by filtration, after cooling to about 30˚C and it incubated under aerobic conditions at 28˚C.

## Effect of Various Concentrations of Tea Broth on the Bacterial Cellulose Formation

Different amounts of dry green tea was added into boiled water with the same amount of sucrose as sweetened tea broth for bacterial cellulose pellicle formation, these amounts were 10, 15, 20 g/L respectively.

## Effect of Different Incubation Time on the Bacterial Cellulose Formation

The effects of different incubation times (every other day) for the bacterial cellulose pellicle formation were examined.

# RESULTS

The bacterial cellulose pellicle grew well in sweetened green tea broth after 8 days of cultivation. With the increase of the amount of tea, the colour of tea broth changed from light yellow to yellow. In the first three days of fermentation, only bubbles appeared but with no pellicle. The cellulose pellicle was yielded on the fourth day of fermentation and grew thicker gradually. Table 1 shows the effect of different tea concentrations and against incubation times of bacterial cellulose formation. The symbols ‘+’ and ‘-’ stand for 'exist' and 'nil' respectively.

Table 1 Effect of different tea concentrations and incubation times on the bacterial cellulose formation

| Concentration | 2 days | 4 days | 6 days | 8 days |
|---|---|---|---|---|
| | F B P | F B P | F B P | F B P |
| 10g | - + (-) | + - (+) | + - (+) | + - (++) |
| 15g | - + (-) | + - (+) | + - (++) | + - (++) |
| 20g | - + (-) | + - (+) | + - (++) | + - (+++) |

F=floc, B=bubble, P=pellicle; -: nil; +: exist

# APPRAISAL AND EVALUATION

After cultivation, bacterial cellulose was formed at the interface of air in fermentation vessel. Six specimens of the biofilm (i.e., C1T4, C1T6, C1T8, C2T4, C2T6 and C2T8) were selected from two different broths by 10g/L and 20g/L of tea concentration in different cultivation times of 4 days, 6 days and 8 days respectively. These cellulose specimens were further evaluated for the comfort performance when they dried out.

Tactile sensations like smoothness, roughness, stickiness, scratchiness, softness and stiffness were obtained by touching the material (Kaplan and Okur, 2009; Liu and Little, 2009). The sensation of comfort was directly recognised by the person experiencing it (Slater, 1977). In this study, five professional fashion designers were invited to participate in the evaluation of these specimens by scaling and rating their objective perceptions (Ng, 2013). The factors of evaluation are hand comfort, flexibility comfort and breathability comfort (Sztandera, Cardello, Winterhalter and Schutz, 2013). For hand comfort, specimen being rotated between the thumb and one or two other fingers of the same hand to feel the texture, structure, and friction; for flexibility comfort, specimen were stretched and manipulated by two hands to assess how flexible or stiff the material were; for breathability comfort, the materials were laid on the arm skin to assess whether people feel sweating or uncomfortable after five minutes. The sample size of the material was 20cm x 20cm. Subjects assessed the samples using a 5-point scales, with 1 being uncomfortable and 5 being comfortable. Table2 shows the appraisal result. According to the result, the average scores of the attributes are graded and presented in Table 3.

Table 2 Appraisal result of comfort performance for the selected Self-grown materials

| Subject | Specimen | HC | FC | BC |
|---|---|---|---|---|
| A | C1T4 | 2 | 1 | 4 |
| | C1T6 | 3 | 2 | 3 |
| | C1T8 | 3 | 3 | 3 |
| | C2T4 | 2 | 2 | 4 |
| | C2T6 | 4 | 5 | 4 |
| | C2T8 | 4 | 4 | 2 |
| B | C1T4 | 2 | 1 | 3 |
| | C1T6 | 3 | 2 | 4 |
| | C1T8 | 4 | 4 | 2 |
| | C2T4 | 2 | 1 | 4 |
| | C2T6 | 4 | 5 | 3 |
| | C2T8 | 5 | 4 | 2 |
| C | C1T4 | 2 | 1 | 4 |
| | C1T6 | 3 | 2 | 3 |
| | C1T8 | 3 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| | C2T4 | 2 | 3 | 4 |
| | C2T6 | 4 | 5 | 3 |
| | C2T8 | 4 | 4 | 2 |
| D | C1T4 | 3 | 1 | 4 |
| | C1T6 | 4 | 3 | 3 |
| | C1T8 | 4 | 4 | 3 |
| | C2T4 | 3 | 1 | 4 |
| | C2T6 | 4 | 5 | 4 |
| | C2T8 | 5 | 4 | 3 |
| E | C1T4 | 2 | 1 | 4 |
| | C1T6 | 3 | 2 | 3 |
| | C1T8 | 4 | 3 | 2 |
| | C2T4 | 2 | 1 | 4 |
| | C2T6 | 4 | 5 | 3 |
| | C2T8 | 5 | 3 | 2 |

HC=Hand Comfort, FC=Flexibility Comfort, BC=Breathability Comfort

C1= 10g/L tea concentration broth, C2= 20g/L tea concentration broth

T4=4 days, T6=6 days, T8=8 days

Table 3 Average scores of the evaluation factors among the selected self-grown materials

| Specimen | HC | FC | BC |
|---|---|---|---|
| C1T4 | 2.2 | 1.0 | 3.8 |
| C1T6 | 3.2 | 2.2 | 3.2 |
| C1T8 | 3.6 | 3.4 | 2.6 |
| C2T4 | 2.2 | 1.6 | 4 |
| C2T6 | 4 | 5.0 | 3.4 |
| C2T8 | 4.6 | 3.8 | 2.2 |

## RANKING AND WEIGHTING

The three factors that are most critical to the comfort performance were ranked for their relative importance towards self-grown fashion creation. A weighting from 1 to 3 was assigned to each factor, with 3 being the most important and 1 being the least. Table 4 shows the result of the ranking. The six specimens with average scores of comfort performance evaluation were then multiplied by the weighting of the factors to obtain the average weighting of the specimens for each factor. Table 5 shows the results.

Table 4 Ranking of the three factors most critical to the comfort performance of self-grown fashion creation.

| Ranking in Order of Importance | Weighting | Factors |
|---|---|---|
| 1st | 3 | FC |



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| | | |
|---|---|---|
| 2nd | 2 | BC |
| 3rd | 1 | HC |

Table 5 Results of the ranking of the factors among the selected self-grown materials.

| Specimen | HC(1) | FC(3) | BC(2) | Total |
|---|---|---|---|---|
| C1T4 | 2.2(2.2) | 1.0(3.0) | 3.8(7.6) | 12.8 |
| C1T6 | 3.2(3.2) | 2.2(6.6) | 3.2(6.4) | 16.2 |
| C1T8 | 3.6(3.6) | 3.4(10.2) | 2.6(5.2) | 19.0 |
| C2T4 | 2.2(2.2) | 1.6(4.8) | 4.0(8.0) | 15.0 |
| C2T6 | 4.0(4.0) | 5.0(15.0) | 3.4(6.8) | 25.8 |
| C2T8 | 4.6(4.6) | 3.8(11.4) | 2.2(4.4) | 20.4 |

The sums of the average weightings of the six selected materials were obtained. The results suggested the overall favourability of comfort performance towards self-grown fashion creation. Table 6 shows the results.

Table 6 Results of the ranking of the overall comfort performance of the six specimens towards self-grown fashion creation.

| Ranking in Order | Sum of the Average Weighting | Specimen |
|---|---|---|
| 1st | 25.8 | C2T6 |
| 2nd | 20.4 | C2T8 |
| 3rd | 19.0 | C1T8 |
| 4th | 16.2 | C1T6 |
| 5th | 15.0 | C2T4 |
| 6th | 12.8 | C1T4 |

# CONCLUSION

This study has been carried out to investigate the bacterial cellulose formation process in different concentrations of tea broth and different incubation times. Through comparison and evaluation of the comfort factors of the materials which were grown out from different cultivated conditions, the favourability of the materials towards self-grown fashion creation were evaluated and presented. As the result, the material was grown from 20g/L of tea concentration broth on 6-day cultivation has the most comfortable for fashion creation.

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