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Conference Chair

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Tokyo Institute of Technology, Tokyo, Japan

Venue

Tower Hall Funabori
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Program

Monday, June 11

1:00 PM–5:00 PM The Fiber Society Governing Council Meeting, Bunka-Gakuen University
3:00 PM–7:30 PM Pre-registration and Welcome Reception, Bunka-Gakuen University

Determination of Total Comfort of Sport Caps Using Wear Trials

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The cap is a very popular product among young people. Previous studies regarding the production system and appearance of the product were conducted, however there is little research concerning their comfort. The total comfort is classified into 4 basic groups as thermo-physiological comfort, sensorial comfort, psychological comfort and ergonomic comfort.

This paper is part of an ongoing research aiming to establish a comprehension about function and comfort characteristics for sports caps, in this specific case using male volunteers. In this part of the study, ten models of caps of different types of raw materials, construction and structure levels were manufactured and afterwards submitted to perception tests of comfort by ten male volunteers.

The results regarding this comfort parameters shows that the volunteers felt the differences of the behavior of the caps between the different phases of the exercise and between the different caps indicating the best product concerning total comfort.

MATERIALS AND METHODS

Ten caps models were developed with different fabric characteristics for testing with volunteers (Tables I and II).

	Samples	A1	A2	A4	A6	A8
 Basebol Model	Composition	100% CO	100% CO	100%WO	65% PES 35% WO	Cork 100%PES
	Mass per unit area (g/m^2)	294	197	248	215	Cork 321 PES102
	Thickness (mm)	0,718	0,456	0,696	0,6	0,546
	Water vapour resistance (Pa/m^2/W^{-1})	4,2	2,88	4,48	3,22	Cork 36,5 PES -0,8
	Air Permeability (l/m^2/s)	72,4	81,8	215,6	0,6	-

Table I. Baseball caps samples.

	Sample	A3	A5	A7	A9	A10
 Snapback Model	Composition	100% CO	65% PES 35% WO	100% Cork	100%Cork 100% PES	100% PES
	Mass per unit area (g/m^2)	378	197	321	Cork 321 PES 102	430
	Thickness (mm)	0,756	0,448	0,7478	Cork 0,7478 PES 0,546	0,708
	Water vapour resistance (Pa/m^2/W^{-1})	5,38	2,44	36,5	Cork 36,5 PES -0,8	5,6
	Air Permeability (l/m^2/s)	45,67	178,6	-	45,67	138,2

Table II. Snapback caps samples.

The thermal sensations (comfort scale), micro-climate temperature and humidity under the cap (i-button sensor), pressure (Picopress equipment) and general comfort evaluation exerted on the user's head were measured and compared. The performance tests were performed in a climatic chamber that simulated specific climatic conditions (25ºC and 75% of relative humidity, simulating the climatic conditions of Apucarana–Brazil).

The volunteers evaluated the cap in three phases: 1-Pre-exercise: sitting at rest for 5 minutes (table III); 2-Exercise on the exercise bicycle: low speed (10-15 km/h) 15 minutes, following high speed (15-20 km/h) for 5 minutes; 3-Post exercise: sitting at rest for 5 minutes.

Analysis of variance (ANOVA) was conducted to determine if there were significant differences at the $p < 0.05$ level. The data were analyzed by SPSS® software.

Thermal sensations	1 very cold	2 cold	3 cool	4 natural	5 warm	6 hot	7 very hot
Humid sensation		1 dry	2 dry somewhat	3 slightly wet	4 wet	5 very wet	
Comfort		1 comfortavel	2 slightly uncomfortable	3 uncomfortable	4 very uncomfortable	5 extremely uncomfortable	
Pressure		1 no	2 slightly	3 neutral	4 very	5 extremely	

Table III. Subjective evaluation.

RESULTS AND DISCUSSION

The ANOVA conducted on the 10 samples. The results of the evaluation with volunteers revealed that samples 3 and 9 (snapback) demonstrated a decrease in the sensation of pressure that the cap exerts on the head of the volunteer (fig.1-b). The sample 6 (baseball) presented a constant increase in pressure sensation. The other samples showed oscillations as in the comfort sensation as in the pressure sensation (fig. 1-a). Concerning the sensation of comfort, we highlight the samples 5 and 6 that remained stable during all phases and the other samples presented oscillations.

The samples follow the same trend in relation the thermal sensation (fig. 1-c). A great increase was realized in the thermal sensation after 15 minutes of cycling. After 20 minutes of testing, most of the samples follow the same trend of temperature increase, only sample 6 was different at this stage, remaining stable in relation to the previous phase and cooling faster than the other samples in the last sitting phase.

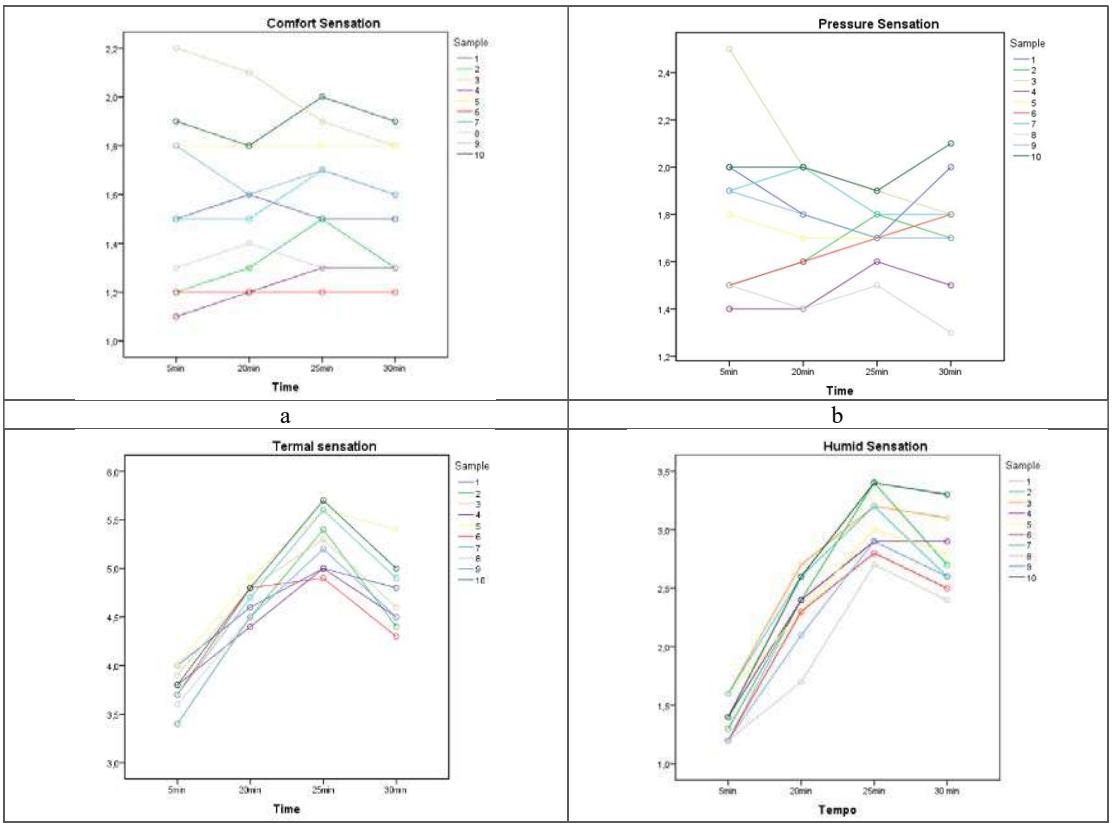

Figure 1. Objective evaluation using volunteers.

The humid sensation of all samples follows the same trend. The sample 8 that in all phases was considered by the volunteer the sample with better performance (fig. 1-d).

The results of the objective evaluation with the measuring equipment show a constant growth of both temperature and humidity. The heat dissipation in sample 6 showed the best performance. The snapback models 3, 5 and 7 had a better humid behavior.

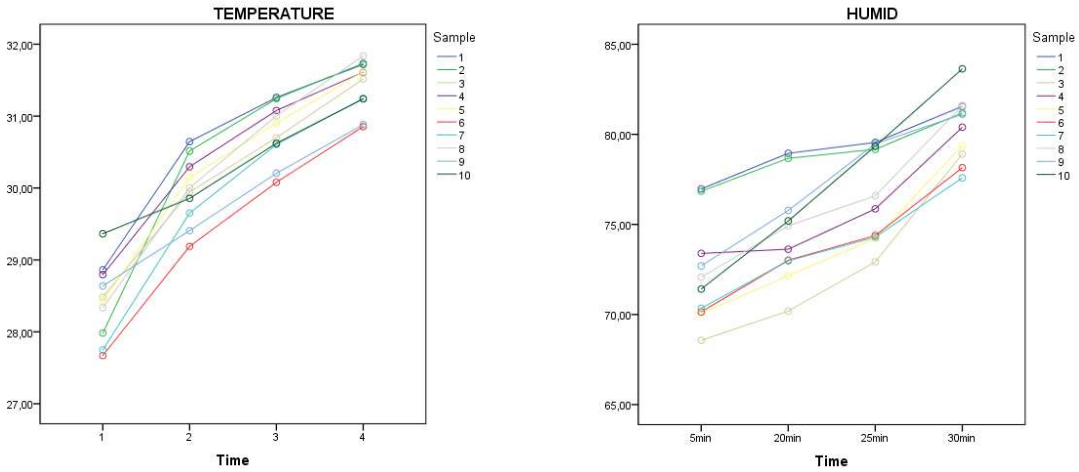

Figure 2. Objective evaluation with measuring equipment.

When comparing the two objective evaluation methods of temperature (fig.1-c, 2-a), by the end of high speed phase the graphs of the two evaluations show an increase in heat levels. In the last phase the volunteers had the sensation of decrease the temperature sensation, however using thermodata, the heat shows that the temperature continues to rise. Sample 6 had a better performance in both evaluations and the worst performing 10 sample.

When comparing the humid data of the two assessments (fig.1-d and fig. 2-c), it is realized that up to the phase of high speed cycling, there is an increase in humidity sensation in both evaluations.

The volunteer's evaluation showed that the humidity sensation was accentuated in objective evaluation (thermodata) than using the input of the inquiry of the volunteers. The last phase (sitting rested), the volunteers felt a decrease in humidity. The reason for this feeling is due to decreased physical exertion. In both evaluations sample 10 (snapback cap, 100%PES) has the poor performance and sample 8 the best (baseball cap, cork with PES) Sample 8 presented a good performance in relation to the sensation of pressure and humidity in the two of evaluation with the inquiry and evaluation using testing equipment; (front part at 100% cork and side and back straight mesh - fabric - 100% polyester, baseball model).

Sample 6 presented a good performance in relation to the comfort sensation; and heat (65% PES, 35% WO, baseball model) in both evaluations. The thermal comfort result of the evaluation using the volunteers inquiry had the worst performance of sample 5 followed by sample 10. In all evaluations the 10 sample had a poor performance (100% PES, snapback model).

CONCLUSIONS

The results regarding this comfort parameters shows that the volunteers felt the differences of the behavior of the caps between the different phases of the exercise as also between the different shapes of caps and their composition. The comparison between the results of objective evaluation with wear trial and objective evaluation with measurement equipment showed that the psychological factor influenced the volunteers' responses, mainly in the last phase of the physical test during the resting phase.

In future studies, we hope to compare these results to the results of a tactile sensory evaluation of the cap indicating the best product concerning of total sensory comfort.

ACKNOWLEDGMENT

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