

Cooling Vests Wool Fibre for Recovery Activity

Johansyah Lubis¹, Dewi Suliyanthini²

¹Sports Science Faculty, Universitas Negeri Jakarta

²Faculty of Engineering, Universitas Negeri Jakarta
(¹johansyah.sport@unj.ac.id, ²dsuliyanthini@gmail.com)

Abstract- Recovery process is strongly believed to be significant in improving athletes' performance during and after training. One of the recovery processes is physiotherapeutic. It uses cooling vests. The existing cooling vests around are made of materials such as anti-bacterial treatment, 50% nylon jersey, 50% ultra-fresh PU, and Lining: water wicking polyester fleece.

This study was carried out to develop a new model of cooling vests (CV) with protein-based fiber from the wool of merino which is abundant in Indonesia. A lab test was conducted on the fabric to know the absorption of room temperature or the moisture content (MC) and the absorption of the fabric itself or the moisture regain (MR).

Method the MR. Results: CV100% (MC: 10.14, MR: 11.26); CV80% (MC: 7.84, MR: 8.51); CV50% (MC: 2.93, MR: 3.02); CV30% (MC: 1.09, MR:1.9), Lining R/T (B) (MC: 7.67, MR: 8.31), Lining R/T (C) (MC: 6.36, MR: 6.79), comfort test was conducted with 22 athletes who were prepared for 2017 SEA Games in Malaysia in Cricket and Pencak Silat sports, using a questionnaire with Alpha Cronbach CV100%: 0.6316, CV80%: 0.7127, CV50%: 0.6451, CV30%: 0.7591.

Conclusion: Comfortable level on the developed CV with 100% wool-based fiber is 98% more comfortable than CV with syntactic-wool-based fiber.

Keywords- *Cooling Vest, Wool Fiber, Comfort*

I. INTRODUCTION

This study aimed at developing sports cooling vest with protein-based fiber. Given that sport competition circumstances nowadays are getting tougher, athletes' achievement effort has to be maximized. Since the early 1900s, physiologist has started to apply physiology and biochemistry related to physical activities and exercise adaptation. This knowledge is also applied in society about basic knowledge of muscle contraction, muscle damage and regeneration, fatigue and motor coordination. (Wyndham: 1974)

In general, athletes have to exercise 2 to 3 times a day. Exercise is a process of exposing athletes to repetitive stimulation in order to promote adaptation. The change is adjusted to certain functions such as delaying fatigue,

increasing power output, refining motor coordination, or reducing the risk of injury. The trainer must be aware of the cause-and-effect relationship between training dose and response. (M., I . Lambert and I. Mujika: 2013). This recovery must lead to at least four major goals: 1) Easier adaptation to exercise loads; 2) Decreased risk of overload; 3) Reduced risk of injury; 4) Improvement in the repeatability of performances, (Hauswirth, and Mujika, 2013)

Physiotherapeutic was the most frequent used recovery methods by high-performance athletes. Its methods are a) Massage; b) Heat or Thertherapy; c) Cold or Cryotherapy; d) Contrasts Bath; e) Oxygenotherapy; f) Altitude Cure; g) Vagal-reflexotherapy; h) Reflexotherapy; g) Chemotherapy; and h) Recovery using Hydromassage Whirlpool. Cooling vest is one of the artificial methods of physiotherapeutic which is widely developed.

Cooling vests (CV) are often used to reduce heat strain. CVs have traditionally used ice as the coolant, although other phase-change materials (PCM) that melt at warmer temperatures have been used in an attempt to enhance cooling by avoiding vasoconstriction, which supposedly occurs when ice CVs are used (J. R. House, et, al., 2012). The study conducted by Lopez RM., et. al., (2008) during the heat-stress trial by wearing cooling vest revealed that there was no significant difference from the cooling rate for the no-vest group. During recovery, the group with the cooling vests was significantly higher than the group with no vests. Lopez did not recommend using the cooling vests to rapidly reduce elevation. Ice water should remain the standard of rapid care for cooling severe hyperthermic individuals. Price M and, M. Maley.,(2015) conducted a study on skin blood flow with a consideration that ice vest pre-cooling has been shown to lower rectal temperature during intermittent exercise in hot conditions. The result is back skin temperature was cooler following PRE than for CON. It can be concluded that the delay in reducing, ice vest pre-cooling may be a result of deep body temperature measurement site rather than changes in local skin blood flow.

Recovery phase is one of the most important aspects in exercise. Recovery is a multi-factorial process. Therefore, both coach and athlete are insisted to understand the physiological effects on exercise and recovery intervention as well as the effects on exercise and recovery strategies (Bompa, 2009). To further explain, there are different stages of restoration, such as

a) inter exercise recovery; b) post exercise recovery; and c) long-term recovery.

Inter-exercise recovery occurs during exercise and relates to the bioenergetics of the activity being undertaken. Fatigue that happens whilst exercising relates to the amount of available Phosphagen. Adenosine triphosphate (ATP) concentration does not decrease more than 45% in response to intense training (Hirvonen, 1987).

Post exercise recovery occurs when training comes to stop and relates to metabolic by-products, the substitution of stored energy, and the initiation of tissue repair (Ivy, J, 2004), in which after the exercise has finished, the body does not immediately back to rest mode. This phenomenon is illustrated by the elevation of oxygen consumption or more well-known as excess post-exercise oxygen consumption (EPOC). The intensity and duration of EPOC are mediated by physiological disorder (intensity, duration, or combination). Therefore, the bigger the physiological disorder is, the bigger the disorder occurs.

A long-term recovery that is part of a well-planned periodised exercise plan can result in a super compensation effect. Long-term recovery relates to the peak of exercise planning. The bigger the exercise stimulation also the bigger the accumulated fatigue and fitness development, in which against each other (Stone: 2007).

Barnett (2006) and Bishop (2008) states that athlete and coach are allowed to use a variety of recovery after training or competition. These modalities include complete rest, massage, cryotherapy, hydrotherapy, thermotherapy, contrast therapy, non-steroidal anti-inflammatory drugs, compression garments, stretching, and dietary interventions. To result in good recovery, a combination of active recovery technique such as jogging and passive one such as massage has to be done.

The cooling vests in this study used various protein fiber which can be classified as follows: natural fiber includes any fiber produced by plants, animals, and geological process. There is a possibility that this type of fiber will experience weathering. The natural fibers itself are categorized as plant fiber, wood fiber, animal fiber, and mineral fiber.

Artificial / Synthetic Fibers (Man Made) are artificial fibers or synthetic fibers which generally derived from petrochemical materials. However, there are also synthetic fibers made from natural cellulose such as rayon. Synthetic fibers can be produced at cheap cost and in large quantities. Artificial fibers are formed from natural-derived polymers as well as artificial polymers made by polymerization of chemical compounds. All fiber-making processes are performed by spraying liquid polymers through small holes (spinnerets). Synthetic fiber has several qualities, such as: extremely strong and friction resistance, strong in dry and wet states except for acetate, elastic, spring (elastic and tense resistance), less absorbent, sensitive to heat, resistant to alkali, moth, mold, and insect, etc., durable, easy to maintain, easy to wash the dirt, stiffling hot to wear, becomes soft and melted if touched by hot iron.

Wool is one of the natural fibers derived from animals. Besides producing a main product, livestock animals also have

animal products. Those products can be utilized to daily life with or without processing. One of animal products is fur and one of animals whose fur can be used is sheep. According to Ensringer (1977), wool is a natural fur to protect sheep from heat and cold. Kammlade and Kammlade (1955) also support this idea by adding that naturally wool functions as a good thermoregulatory which helps the body to adjust with hot or cold weather.

Wool is covering sheep and helps them to protect themselves from outside effects. Wool has soft texture. Similar to the idea asserted by Devendra and Mcleroy (1982), they said wool is a body cover fiber which soft, smooth, with many curls, and scaly surface. The usage of wool is easily found these days in the form of handicrafts or clothes. This usage needs careful handling process in order to produce a safe and good quality handicrafts or clothes.

The sport cooling vests designed in this study are made of wool-based fiber. In Indonesia, Wool is available in great quantities and produced from many types of sheep especially domestic sheep *Batur* (crosses of *Texel*) and *wedes gembel* (*Ekor tipis*). This cooling vest prototype development was hoped to be able to keep Indonesian athletes' cold temperature. The problem of this study was: How is the development of sports cooling vest with wool based fiber for athlete's comfort?

II. METHODS

This research employed Research & Development method (Borg & Gall; 1983: 251-258). The model to be developed was a sport cooling vest model developed in accordance with conditions in Indonesia, with an average environmental temperature of 23 - 32°C and 70- 92% humidity level. Meanwhile, the convenience test used quantitative experiments, instrument; oven desiccator alpha analyzer 0.01. Convenience instrument used questionnaire to 22 athletes as respondent samples, 10 questions with a scale range 1-10 with Alpha Cronbach validity test, convenience test used factor analysis on 4x5 samples 22 on 4 different fiber types (5 VC100%, 5 VC80%, 5 VC50%, 5 VC30%). Respondents in this study were the SEA Games Malaysia 2017's martial arts and cricket preparation athletes.

The analysis was conducted on the data obtained at each stage of the study. Analysis of consistency and accuracy of the contents was performed on the data obtained from the analysis and design stages. The preview (*kisi-kisi*) analysis is carried out on the training stage. The model feasibility analysis is performed on the whole model. Descriptive analysis was performed on all data that could be tabulated thus became meaningful.

III. RESULTS OF NEEDS ANALYSIS

Based on the general purpose of the study, preliminary study was conducted using in-depth interview instrument to National Training Center (*Pelamas*) martial arts and cricket athletes as well as through survey. The results of the

preliminary study or field findings were further described and analyzed in order to obtain a formulation of the results of data that had been collected. The formulation of these results is descriptive and analytical, with reference to the purpose of the preliminary study. The results of the preliminary needs analysis and field findings are described in the following table:

TABLE I. RESULTS OF NEEDS ANALYSIS AND FIELD FINDINGS

No	Questions	Findings
1	Do you think recovery is necessary?	As many as 14% respondent answered that it is important and 86% answered it is very important and that they needed it after training especially heavy training.
2	What kind of recovery process is often performed by trainers?	As many as 18% of respondents answered massage and jogging, 9% answered ice, and 55% answered never manipulate recovery.
3	How many times do you perform recovery manipulation in 1 week?	As many as 9% answered once (1) a week, 14% answered twice (2) a week, 23% answered hesitantly, and 55% never performed it.
4	Have you ever used cooling vest before as a recovery?	100% respondents answered they never used it.
5	Do you think cooling vest is useful for athlete's recovery process?	59% of respondents were hesitant and 41% answered that it is useful.

Based on the results of the initial observation, there is a necessary need to assist the recovery process while practicing physically. The focus of the development includes the design aspects of vest products that are widely available in the country. Based on the results of the needs analysis, discussions with several biochemistry and coaching experts were carried out. The result of the discussion suggested that it is necessary to develop cooling vest model.

IV. INITIAL PRODUCT

Initial product draft development of cooling vest: it is designed similar to the existing product, although it is very difficult to find in Indonesia. The researchers use a reference in the internet and YouTube and found that the existing product uses polyester as a material. Meanwhile, the cooling vests in this study use protein fiber inside and lining and outer cloth. The convenience test of the prototypes was performed.

The comfort meant in this research is physical comfort associated with the sensation of the body perceived by the individual itself. Psycho-spiritual comfort is related to the internal self-consciousness, which includes self-concept, self-esteem, and meaning of life, sexuality, even an intimate and higher relationship. Environmental comfort is associated with environmental, external conditions and influences to humans such as temperature, color, lighting, sound, etc. Socio-cultural comfort is linked to interpersonal, family, and social or

community relationships (financial, individual health care, religious activities, and family traditions).

TABLE II. CONTENTS OF COMFORT INSTRUMENT:

No	Indicators	Items
1	Physical comfort	1,2
2	Psycho-spiritual comfort	3,4,5
3	Environmental comfort	6,7,
4	Socio-cultural comfort	8,9,10

V. ANALYSIS OF MODEL NEEDS MAPPING

The development of the sports cooling vest model was executed based on the mapping of the needs in the field. Testing of protein fibers was conducted in the Physics evaluation laboratory - High School of Textile Technology (STTT Bandung), fiber test was conducted on 100%, 80%, 50% and 30% protein fiber. This experiment was aimed at determining the absorption of Moisture Content (MC) and Moisture Regain (MR).

TABLE III. RESULTS OF FIBER TEST CALCULATIONS

Fiber	Moisture Content (MC)	Moisture Regain (MR)
100%	9,99 10,28 Average 10,14	11,10 11,46 Average 11,26
80%	7,89 7,79 Average 7,84	8,57 8,45 Average 8,51
50%	3,26 2,59 Average 2,93	3,37 2,66 Average 3,02
30%	1,13 1,05 Average 1,09	1,14 1,06 Average 1,10
Outside Fabric TC	1,86 1,86 Average 1,86	1,9 1,9 Average 1,9
Lining R/T (B) Upholstery	7,54 7,79 Average 7,67	8,16 8,45 Average 8,31
Lining R/T (C) Upholstery	6,63 6,09 Average 6,36	7,09 6,49 Average 6,79

Based on the fabric's lab test results, it is shown that: MR is the absorptive capacity of the fabric meanwhile the MC is the absorptive capacity of room temperature condition. In the W1 sample (100%): when it is not in use, MC has a power absorption of 10.14% and when it is used, it can absorb in maximum of up to 11.26% (maximum limit is 12%).

The result of convenience instrument trial shows data as follows:

TABLE IV. TRIAL CALCULATION

MODEL	VC100%	VC80%	VC50%	VC30%
n	22	22	22	22
Average	7.44	6.8	5.34	4.56
SD	0.903	0.78	0.804	0.663
Variance	0.829	0.629	0.656	0.449
Total Variant	1.18	0.814	0.918	0.545
Number of Variants	8.292	6.299	6.569	4.498
Alpha Cronbach	6.316	7.06	6.451	7.591

The validity of convenience instrument is valid with Alpha Cronbach 0.6316. Based on the normality test, it was obtained that $Lo = 0.9875$. Since the value of $Lt = 0.304$ and $Lo > Lt$, categorized as normal, it can be concluded that the distribution of data on variables is normally distributed.

VI. RESULTS OF STUDY

Cooling vest models for 100% wool fiber; MR 11.26. MC 10.14. Alpha Cronbach validity 0.6316, 98% feasibility respondents. 80% wool fiber; MR 7.84. MC 8.51. Alpha Cronbach validity 0.7127, 67% feasibility respondents. 50% wool fiber; MR 2.93. MC 3.02. Alpha Cronbach validity 0.6141, 42% feasibility respondents. And 30% wool fiber; MR 1.09. MC 1.9. Alpha Cronbach validity 0.7659, 23% feasibility respondents.

VII. CONCLUSION

Cooling Vests with 100% protein-based fiber is 98% more feasible than synthetic-protein-based fiber. Therefore, the developed cooling vest could be seen as having successfully promoted feasibility for athletes in maintaining high performance during exercise.

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