A Study on the Wave Type and the Damage of Hair according to Water content when Heat permanent is treated

- Focus on Damaged Hair -

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Abstract

The goal of this study is to provide beauticians with the fundamental material to use effectively heat permanent wave in beauty industry as well as their customer's satisfaction. It carried out an experiment with damaged hair of a woman in her late twenties to investigate the change of physical and morphological characteristics by its water content when performing heat permanent wave. After spreading 0g, 1g, 2g, 3g, and 4g of water on damaged hair respectively, heat permanent wave was treated and the change of hair was observed. The change of physical characteristic was compared through permanent wave form of hair, tensile strength and elongation. The change of morphological characteristic was observed through Scanning Electron Microscope(SEM) and Transmission Electron Microscope(TEM). The result of experiment on the physical specificity revealed that permanent wave form was the most ideal when the water content was 2g, also 3g. Though the materials with much moisture content formed the results were not satisfied. The material with 0g of water content didn't make the wave. In terms of tensile strength and elongation, tensile strength was generally reduced as per the damaged degree of hair. On the contrary, elongation was increased. It observed the changes of morphological characteristic that the damage on hair cuticle was deepen, as its moisture content was decreased, and cuticle's surface was worn away. The observation of fine structure on hair section by transmission electronic microscope also certainly showed the result that damaged hair having experience with chemical treatment had got much damaged to hair cuticle as well as hair cortex. Generally chemical treatment makes hair damaged. Under consideration of this aspect, the ultimate goal of this thesis is to minimize the damage of hair caused by chemical treatment and get the satisfaction on the hair style. According to the result of experiment, the damaged hair whose moisture content was 3g showed the best permanent wave form.

Key Words : Damaged hair, Heat permanent wave, Moisture content, Permanent wave form, Damaged degree

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Ⅰ. Introduction

The human being recognizes self through the harmony of the appearance and pursues the contentment by social existence. the aesthetic quality of like this human being develops progressively and today it is expressed in various form. Among those specially beauty art it expresses an individuality in the same time completes a fashion it takes charge of a big role because hair style is foundation stone which decides the appearance or the image of the individual with the important element the aesthetic harmony and fashion trend. It approaches in the post-industrial society the life style of masses changes quickly, and as women's society advance becomes many, as permanent's demand of hair style that time is spared and can make simple style increased more.

Permanent only other than the primary objective that forms wave, maximization possibility it will make a aesthetic value in order to individuality and character of each person, it was made to pursue wave of the design variously[1].

Recently heat permanent carrying out shorting the performance time and unartificial and unexaggerated and being natural which can sufficient the satisfaction of consumers, but a problem occurs that it generated hair damage still.

Observe the research trend which heat permanent relates until now, Jung-Eun Lee(2002)[2], "Research about hair change by Magic-Straight permanent", Soo-Kyung Choi(2004)[3], "A Study of the Morphological Damage of Hair in Accordance with the Heat Processing Time of Heat-permanent", Hui-Tae Kim(2004)[4], "A Study of the Morphological Damage of Hair in Accordance with the Softing Time of Heat-

permanent", Tae-Gune Kim(2004) [5], "The Study of Morphological damage of hair in according with thermometer in the process of heat permanent", Yang-Ja Kim(2005)[6], "Effect of Wave formation and Hair Damage when used Treatment on Digital Setting permanent", Jeong-Eun Kim(2006)[7], "Comparison of Hair Damage between Heat-treated permanent wave and Non-heat-treated permanent wave", Joo-Young Lee(2007)[8], "Dynamic Study on the hair Damage Followed by Cold permanent and Digital Setting permanent", Mi-Ja Han(2007)[9], "A Study on the Wheat Flour and Treatment Effect of Hair in Magic Straight Permanent", there is no wave form and research about hair damage by water content at although above research in being.

Heat that is heat permanent's main factor which breaks optimum water containing balance that hair wishes to keep and protein solidification (regeneration) by that temperature is high fairly happens and gives change in formation of hair.

When also transformation of combination structure occurs if because water escapes if continue warm up without water, hair hardening phenomenon is happened and these condition is maintained.

Reduction of water cause variation of hair's elasticity degree or damage degree so water content one standard in hair damage degree [3].

Therefore, this research present basis data to raise minimization of hair damage and optimize permanent formation by analyzing physical and morphological characteristic according to change of water content on damaged hair for being natural and easy-handling hair performance.

Ⅱ. Testing method

1. Experimental method

In this research the sample hair is used brightness 4 degree(thickness of hair 110μm, L* 17.27 a* 1.67 b* 1.82) of late 20's women that less physical damage and not treat chemical processing in an experiment from June 2007 to August 2007 picking hair of occipital region from root of a hair to length more than 25cm in 3cm region after grasp hysteresis through interview.

After measure hair that pick by 2g through electron balance for analysis, fixate by silicone about upper part 1cm and dried nature at normal temperature after hair washes neutral shampoo in pun lukewarm water lest should become thin and washes out enough in the third distilled water.

After spread decolorant mixing powder type of alkali agent((NH_4)$_2$$S_2$$O_8$ · $K_2$$S_2$$O_8$, pH11, 2g) and liquid type of oxidizing agent($H_2$$O_2$, pH3.4, 4ml) by 1:2's ratio in hair that dry, a lap put on with cap heat treatment (50℃ 10 minutes), the leaving(25℃ 10 minutes) before nature drying at normal temperature after washing more than three times neutral shampoo cleanly in distilled water.

It makes with same method decolorization two times repetitions which used the hair more than brightness 10 degree(thickness of hair 110μm, L* 32.56 a* 6.51 b* 5.96).

2. Heat permanent performance methods by water content

Each samples of the experimental group applied heat-permanent 1st reductive agents (Thioglycolic acid ammonium : concentration 12%, dosage 4g, pH7) which is water content with 0g, 1g, 2g, 3g, 4g and softening time after 10 minutes after 3 times rinsing immediately in the distilled water, with the analytical electronic balance in the hair they differed they measured. Digital permanent winding it with 12mm rod of the machineries after heat treatments (100℃ and 10 minutes) and natural leavings (25℃ and 10 minutes) it applied one times heat-permanent 2nd oxidizering agent (peroxide hydrogen : concentration 4%, dosage 4g, pH4~5) which is left for 10 minutes. The samples which all finishes heat permanent processes dries nature after wash out in distilled water and result of free medical care measured comparison.

3. Physical characteristics of hair

1) Permanet wave form measurement

After all performances end, it arranged the damaged hair in each groups and with the digital camera (Slim Samsung KENOX #1 and Korea) it photographed and the wave form of the hair comparison it analyzed.

2) Tensile strength and elongation measurement

The physical characteristics of the hair used the tensile strength tester (Instron 4302, C.R.E type) and it investigated, to a Korean Industrial Standards (KS K 0323) and it respects a measurement per one specimen after sorting the hair of 20 pieces which 110μm are uniform the tensile strength and the elongation it gave to do it measured. From under standard condition 30 hours free-conditioning it measured one sample at tensile speed, 20mm/min and repeat 20 times per sample, analyzed these comparison receiving mean value after statistics control.(at the nomal stats : temperature 20°, humidity 65%)

4. Morphological characteristic of hair

The sample which corresponds to each experimental group that hair from silicone processing point upper part from 12cm point, scalp near part as about 15cm on observation region decide and observed by electric field radiation style Scanning electron microscope and the transmission electron microscope.

1) The observation with Scanning Electron Microscope

For the photographing of the side in the sample which from the observation region it comes to cut at 3mm degree fixation with table (silver fasten) and operating ion evaporator (Ion Sputtering Device, JFC-1100E, Jeol, Japan) that for vacuum coating during five minutes and observe with scanning electron microscope (JSM-5410LV:Jeol, Japan) that magnify by magnification 500 times and 1500 times.

2) The observation with Transmission Electron Microscope

In the fixing solution which in 0.05 M sodium cacodylate buffer solution (ph 7.2) is composed with 2% paraformaldehyde and 2% glutaraldehyde 2 hours it digested the damaged hair's control group and the sample of water content 3g from 4℃. With the after that 0.05 M sodium cacodylate buffer solution 10 minutes 3 times wash after one, in the fixing solution which contains 1% osmium tetroxide in 0.05 M sodium cacodylate buffer solution 2 hours it digested from 4℃. The fixation ended and the respectively sample from normal temperature with two times distilled water wash after 0.5% one uranyl acetate 12 hours digested from 4℃. With the ethanol (30, 50, 70, 80%) of after that chain 10 minutes it dehydrated and did polymerization during 12 hours in 50℃ embedding by LR White Resin. The sample which is polymerized beginning ultramicrotome (MT-X; RMC, Tucson, AZ and USA) it produces second ultramicrotome to use and in the copper grid attachment; after, it dyes with 2% and uranyl acetate and lead citrate around the energy filtration transmission electronic microscope(LIBRA 120 it makes Carl Zeiss, Oberkochen and Germany) with 10,000 times and at magnification ratio it magnified and 20,000 times it observed.

5. Statistical control

Analysis of the research used Window V.12.0 SPSS statistical packs which analyze of figure processing this research yielded, average and standard deviation, and authorize the significant difference by ANOVA test and apply Duncan multiple test(Duncan's Multiple Range Test) and do individuation comparison by water content.
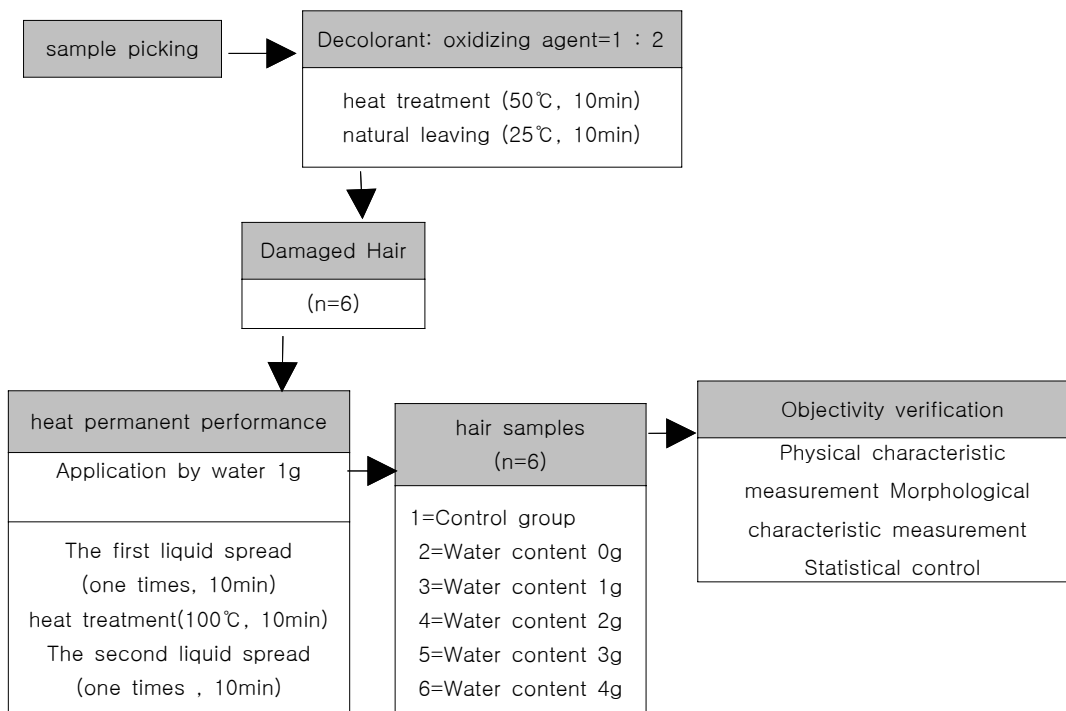
III. Result and investigation

1. Physical characteristics

1) The damaged hair's wave form comparison by water content in heat permanent performance

The water content 0g groups got insufficiency of water content and received excessive heat, wave formation of is not intact, and dry and brightness decreased.

From the water content 1g group the edge of hair's side was visible the formed curl that wave cycle is short and strong in form that the water content 1g group is loosest but curl of root of a hair hangs down.

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┌──────────────────┐        ┌─────────────────────────────────────┐
│  sample picking  │───────▶│ Decolorant: oxidizing agent=1 : 2   │
└──────────────────┘        ├─────────────────────────────────────┤
                            │  heat treatment (50℃, 10min)        │
                            │  natural leaving (25℃, 10min)       │
                            └─────────────────────────────────────┘
                                            │
                                            ▼
                            ┌──────────────────┐
                            │  Damaged Hair    │
                            ├──────────────────┤
                            │     (n=6)        │
                            └──────────────────┘
                                    │
                                    ▼
┌────────────────────────────┐   ┌──────────────────┐   ┌──────────────────────────────┐
│ heat permanent performance │   │  hair samples    │   │  Objectivity verification    │
├────────────────────────────┤   │    (n=6)         │──▶├──────────────────────────────┤
│  Application by water 1g   │──▶├──────────────────┤   │  Physical characteristic     │
├────────────────────────────┤   │ 1=Control group  │   │  measurement Morphological   │
│  The first liquid spread   │   │ 2=Water content 0g│  │  characteristic measurement  │
│  (one times, 10min)        │   │ 3=Water content 1g│  │  Statistical control         │
│  heat treatment(100℃, 10min)│  │ 4=Water content 2g│  └──────────────────────────────┘
│  The second liquid spread  │   │ 5=Water content 3g│
│  (one times , 10min)       │   │ 6=Water content 4g│
└────────────────────────────┘   └──────────────────┘
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<Figure 1> Processing method by moisture content at heat permanent performance

Control group	water content 0g	water content 1g	water content 2g	water content 3g	water content 4g

<Figure 2> The damaged hair's wave form
comparison by water content in heat permanent performance

In formation of curl that cycle of wave is most short and equal and elastic on the whole water content 2g county and 3g county stable wave of form and wave of the water content 4g group observed in form that cycle and formation of curl are not equal and hang down.

Wave cycle displayed short and elastic stable wave form water content 2g and water content

3g as result that compare and observe damaged hair's wave form.

Content of water could confirm that wave formation of sample that much have water was achieved wave formation but while intoxication and elasticity degree of wave drop, also content of water is little does not show hardly <Figure 2>.

2) The damage hair's tensile strength and elongation comparison in heat permanent performance

The hair giving a force and pulling and with extending, the thickness comes to be thin simultaneously, finally it breaks. Ratio that hair increases height rate (%), force that pull that is heavy when cut by strength (g) mark. tensile strength of hair and elongation's characteristics can assume is characteristics of cortex being hair fiber whole characteristics that it is no surface [10].

Control group hair displayed 145.94g and showed 14.46% big change because reducing 21.10g by 124.84g after performance with water content 0g by result about damaged hair's tensile strength by water content at heat permanent performance, and displayed 9.11% change because hair of performance with water content 1g displays 11.05% change reducing 16.13g by 129.81g and hair of performance with

water content 2g reduces 13.30g by 132.64g and hair of performance with water content 3g displays 6.78% change reducing 9.90g by 136.04g and hair of performance with water content 4g reduces 12.28g by 133.66g, displayed 8.41% change.

The difference was recognized p < 0.01 level in the difference according to the water content to care.

Can speak that according to Duncan test tensile strength is dwindling and water content are decreased and control group and the water content 0g group is big difference of tensile strength, damage degree of cortex is considered that strength decreases rising by protein regeneration by heat at heat permanent performance when there is no water in hair.

this is agree with the research result of jeong-eun kim [7].

Control group hair displayed 75.69% and showed 7.43% change because increasing 5.62% by 81.31% after performance with water content 0g by result about damaged hair's elongation, and displayed 5.87% change and hair of performance with water content 1g displays 9.33% big change increasing 7.06% by 82.75% and hair of performance with water content 2g increases 4.44% by 80.13% and hair of performance with water content 3g displays

<Table 1> Damaged hair's tensile strength and elongation by water content at heat permanent performance

		(Control group)	(Water content 0g)	(Water content 1g)	(Water content 2g)	(Water content 3g)	(Water content 4g)	F	유의수준
tensile strength (g/1hair)	M	145.94^c	124.84^a	$129.81^{a\ b}$	$132.64^{a\ b}$	136.04^b	$133.66^{a\ b}$	5.515	.001**
	SD	6.33	13.17	6.81	5.41	10.45	6.05		
elongation (%)	M	75.69^a	$81.31^{c\ d}$	82.75^d	$80.13^{b\ c\ d}$	$78.31^{a\ b\ c}$	$76.56^{a\ b}$	3.714	.007*
	SD	2.83	4.19	3.52	1.53	5.87	4.84		

Duncan Test
**p<0.01
*p<0.05   a<b<c<d   M: mean value S.D: Standard deviation

3.46% change increasing 2.62% by 78.31% and hair of performance with water content 4g increases 0.87% by 76.56%, displayed 1.15% change.

The difference was recognized p < 0.05 level in the difference according to the water content to care.

According to Duncan test water content are decreased, hair is damaged can know that elongation increases gradually, because cystine combination is fainted, elongation is considered that increase.

2. Morphological characteristic

1) The observation of damaged hair's cuticle through Scanning Electron Microscope at the heat permanent performance

The cuticle of the healthy hair which is generally occupying about 10~15% in the whole hair and it is the more strong and luster usually the more strength about moisture and attrition. Because scale of cuticle this gives luster in hair and protect water evaporation about 15% that exist in hair itself and protect thing which hair becomes dryness as well as have function that protect hair interior from external stimulation being piled up regularly on the hair surface as thin and pellucid best thing of all cell of hydrophobicity.[11]

Is as following that observe aspect of outer skin by damaged hair's water content through Scanning Electron Microscope.

Space of cuticle of hair widens already on hair that have experience in chemical treatment that control group than health hair and cuticle can see that flaking·crack phenomenon of new cuticle and some floor of cuticle are lost on region that drop.

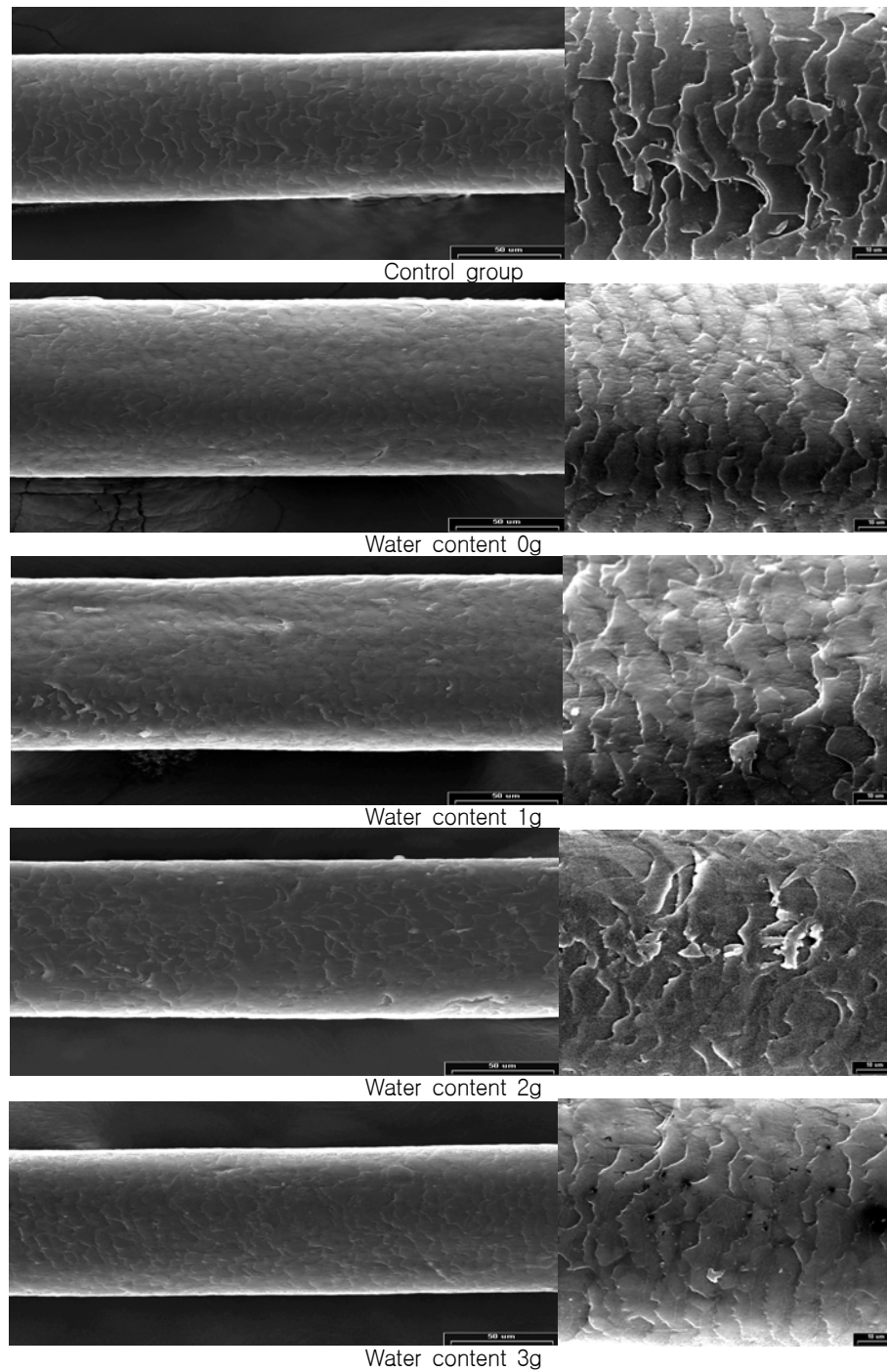The water content 0g group which got high heat and water quantity evaporate and is difficult to see arrangement state of cuticle because almost most of outer skin are been worn away almost being dehydrated and smooth image observed without the border mutually.

The water content 1g group disappearance of cuticle looks like big and dry fairly by a little abnormal and rude impression than smooth image on the whole and can see that cuticle is condensed to push.
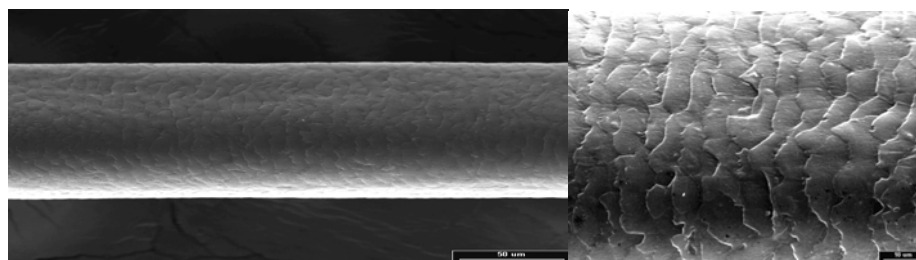
The water content 2g group exfoliation·folium progress of scale and image that some cuticle remains disappearance of the border and side of hair mutually during whole area look and beginning of state and cortex class smelted through cuticle from part weakness part observed.

The water content 3g group can see that exfoliation of cuticle·eruption·adhesion is deepened on the whole, scale cell small fragments partly being scatted.

The water content 4g group can see that could observe surface that expanded due to scale of cuticle being smelted on the whole and progress very minutely. Sample that water content is high as result that observe damaged hair's cuticle in side, part that is damaged in state such as control group was no big difference with control group. But such as exposure of cortex by cuticle's swelling·exfoliation·eruption·adhesion·disappearance that damage can see to grow gradually water content is dwindling observed in state that is been worn away almost <Figure 3>.

<Figure 3> The observation of damaged hair's cuticle through Scanning Electron Microscope at the heat permanent performance (Magnification : ×500 · ×1500)
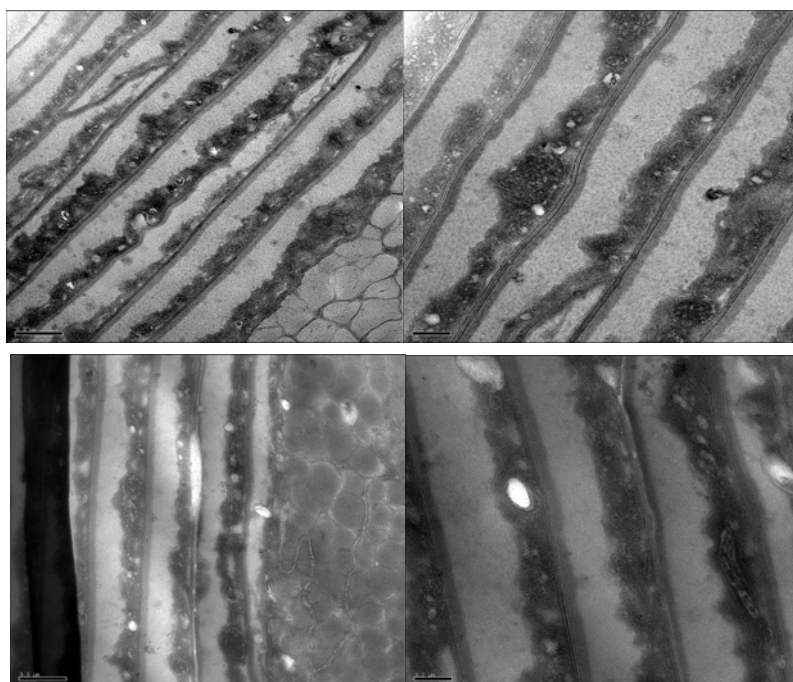
Water content 4g

<Figure 3> Continue

2) The observation of damaged hair's cuticle through transmission electron microscope at the heat permanent performance

Figure 4 and Figure 5 are Investigation result of The observation of damaged hair's cuticle through transmission electron microscope at the heat permanent performance. Cuticle layer is made of eight cuticle cell in damaged hair's control group which has border is fixed and clear but boundary between each cell walls is observed some crack with vacuole originated from chemical·physical effect. Damaged hair with water content 3g was observed that exfoliation ·vacuole·crack between cuticles and damage degree of hair is deepened. And the cuticle the part which is visible with black of the outside
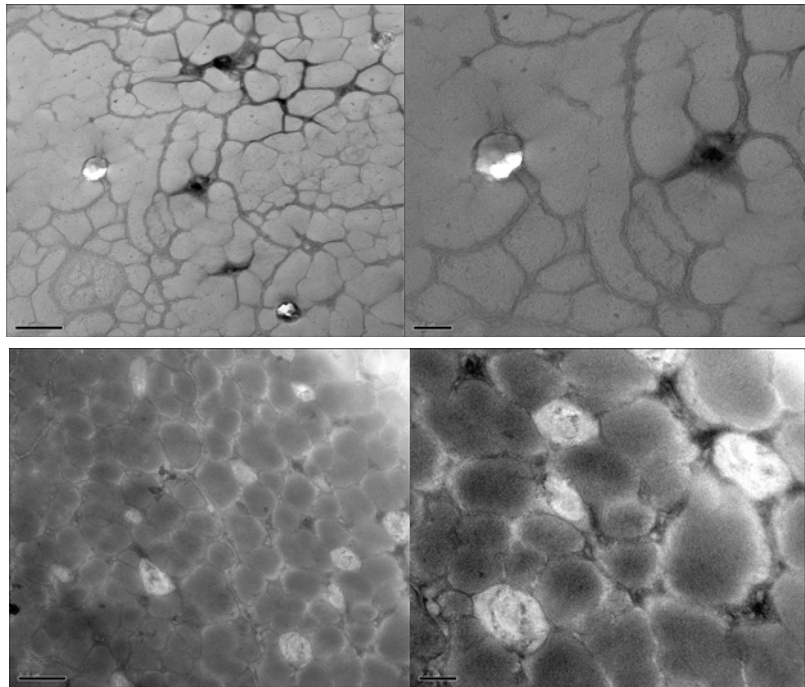

<Figure 4> Damaged hair's hair-section(cuticle) in control group and water content 3g group
(Magnification : ×10,000 · ×20,000)

part occasioned from sample's overlap. Cortex cell space is abnormal in control group's case as damaged hair's control group and damaged hair with water content 3g that compare cortex length, it observed cellular swelling that holes that the part border is formed by melting of melanin granule also look like dim by cell matrix's loss with breakdown of cell wall in done appearance exist in cortex. Damaged hair with water content 3g through heat and chemical agents cortex by protein regeneration boundary line by damage of cell wall collapse and cell matrix disappeared and cell and cell interval big vacuole is formed and was expose that is detached because crack is looked and vacuole of melanin granule is formed <Figure 5>. The observation of damaged hair's cuticle through transmission electron microscope revealed that

certain damage of cortex as well as cuticle. Considered that when the cuticle damaged, the function becames weak and so the physical·chemical stimulation generate damage at cortex as well as cuticle in variously and complexly.

IV. Conclusion

This research selects damaged hair more than brightness 10 degree by decolorization processing which is picking healthy hair of woman in her late twenties to provide beauticians with the fundamental material for them to use effectively heat permanent wave and satisfy their customers.

<Figure 5> Damaged hair's hair-section(cortex) in control group and water content 3g group
(Magnification : ×10,000 · ×20,000)

When performing the heat permanent wave on hair, then it compared and observed the wave type, tensile strength and elongation for its physical change also observed the morphologic change by scanning electronic microscope and transmission electronic microscope. The result of experiment on the physical specificity revealed that the wave was the most ideal when the water content was 2g and 3g which have equal cycle of wave forming and elastic curl. The material with much water content made wave but the result was not satisfied. In the case of hair with water content of nearly 0g didn't make wave. In terms of tensile strength and elongation, the tensile strength was generally reduced as hair was damaged, on the contrary, the elongation was increased. It observed the change of morphologic characteristic and got the result that the damage on hair cuticle was deepen as its water content was decreased. It also showed the result that damage happened on hair cuticle more than hair cortex with the observation of fine structure on hair section by transmission electronic microscope. Also, damaged hair that have experience of chemical treatment in result that observe micro-structure of hair section by transmission electron microscope could assume certainly to cortex damage as well as damage of cuticle. Damage degree of hair that water content is contained much at heat-permanent was not big, but wave form brought unsatiated result. In the meantime, hair that it is little water content hair damage was many and wave formation degree was low remarkably.

Generally chemical treatment damaged hair. Under consideration of this aspect, the ultimate goal of this thesis is to minimize the damage of hair caused by chemical treatment and get the satisfaction on the hair style. The result of experiment presented that the hair showed the best result when its water content was 3g.

This is considered that if the moisture content of hair is less, hydrogen bond can not get effective wave because it being not cut and if the moisture content becomes much on the contrary, hydrogen bond does not accomplish reunion smoothly.

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