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Determination of Goose Feather Morphology by Using SEM

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Abstract: Goose feathers have importance because of not only a widespread usage in consequence of its lighter weight, softness and more compressible than other similar insulation materials, but also its highly organized dermoidal structure. Feather samples are taken from thoracal, cervical, dorsal, ventral wing and dorsal wing regions of local geese in both sexes. Samples covered with chrome by Polaron SC 500 and are examined by JSM 7000 Scanning Electron Microscope (SEM). Plumes have peculiarities in entrapping the air. Barbs in breast feathers arise bilaterally from rachis at about 35°C. There is an increasing number of hooklets on the barbuls from proximal to distal end. The barbuls, which arise from contiguous barbs cross each other at 90°C. Contour feathers on breast region are shorter than other general contour feathers in others areas. The most notable differences between cervical feathers are that they are 4 times longer in male than female and diameter of scapus is bigger in male. It represents that there is intensive vexilla in female because of their barbs which are thinner than those in male. The most important reason of softness and puffiness of plumae and semiplumae is that barbs are not connected each other in spite of they have hamulus. It is proposed that SEM can be very useful tool for textile industry to determine quality of the goose feathers.

Key words: Goose, feather, plumae, morphology, SEM, anatomy

INTRODUCTION

Geese are waterfowls belonging to the subfamily Anserinae in family Anatidae. All geese breeds except for the Chinese goose were originated from Graylag (Anser anser). There are many different goose breeds but Emden is preferred for its high egg production and feather quality (Tilki, 1999). It was stated that goose down's keeping warm performance is twice higher than duck's down's (Yan and Yan, 2006). Gao *et al.* (2007) determined that goose down surface is more hydrophobic than wool and thus it has a better thermal insulation in humid environment. Goose feathers are used as filling material for bedding and clothing and they are bigger and softer than duck's feathers. Ventral and breast downy feathers, plumae and semiplumae are valued. These are small and very light. Other goose feathers are longer and wider thus stronger than downy feathers (Tilki, 1999). Xu *et al.* (2007) reported that output of downy feathers was determined by the density of the feather follicles and down shape, which is effected by the number, size and the length of the barbs or barbuls. According to morphological aspects, the feathers of birds can be divided into three groups as plumae (true down feathers), semiplumae and penna contourae (Nickel *et al.*, 1977; Gezici, 2002). Poultry feathers are classified by Xu *et al.* (2007) as symmetrical downy feathers, bilaterally symmetrical contour feathers and bilaterally asymmetrical flight feathers. Feathers are composed by branch (scapus), subbranches (barbs) and filaments or fibrils (barbuls).

Diameters of fibrils are the size of 2-6 microns and fibrils have triangle nodes and crotches which are located at regular intervals (Gao *et al.*, 2007). Semiplumes are the feathers, which are intermediate in structure between the true and the down feathers (Nickel *et al.*, 1977; Gezici, 2002).

Goose feathers have importance because of not only a widespread usage in consequence of its lighter weight, softness and more compressible than other similar insulation materials (Xu *et al.*, 2007; Gao *et al.*, 2007), but also its highly organised dermoidal structure (Stettenheim, 2000). Because of its shape, structure and functional differences, feather has a lot of functions as camouflage and visual signalling between animals (because of pigmentation) and additionally they serve as water repellent, in water, chemical defense and thermoregulation metabolism in waterfowls (Xu *et al.*, 2007; McLelland, 1990; Stettenheim, 2000) in evo-devo researches on birds (Widelitz *et al.*, 2003), in anthropological investigations (Dove and Peurach, 2002), in taxonomic and ecologic researches (Dove, 1997) and in aerodynamic studies (Weintraub, 2008).

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In early researches, goose feathers physical, chemical and microscopic features were examined for its industrial usage (Gao *et al*., 2007; Dweltz and Mahadevan, 1961). Aspect of category recognition and classification of the quality of goose feathers can be done by a man with microscope but this process requires a great experience (Yan and Yan, 2006).

In this study, it was aimed to determine morphological features of goose feather's which has an importance in textile industry, with SEM and thereby to contribute to textile sector for determination of goose feather quality by examined features.

MATERIALS AND METHODS

Feather samples are taken from thoracal, cervical, dorsal, ventral wing and dorsal wing regions of 5 male and 5 female, total of 10 geese.

To all feather samples carried out cleaning process. For this purpose the samples are taken to acetone for 30 min and kept 50% in acetone-distilled water solution for 15 min and in distilled water 10 min. Then the samples are kept in the etuve in petri plates for a night. Samples covered with chrome by Polaron SC 500 and are examined by JSM 7000 Scanning Electron Microscope (SEM).

RESULTS AND DISCUSSION

Breast has deep and superficial feathers and these have very good air retention capacity because of excessiveness of deep feathers. Plume have a thin rachis (Fig. 1).

Filamentous structures called barbs are very thin and arise from rachis an irregular form. Barbule diameter is 2-3 microns and lenght of them are about 500-700 microns. There were hooklets whose numbers increase from proximal to distal end of barbuls of deep feathers. Numbers of hooklets are between 6 and 10 (Fig. 2 and 3).

Divergent hooklet ends were observed as a narrow arrow or crotch shape. Because of this shape, barbuls can not cling each other and they seem fluffy and softer.

Semiplumae have long rachis. Hooklets on hypopenna which are the proximal filaments of semiplumae, short and narrow and semiplumae seem like fluffy as plumae do. Towards distally hypopenna left its place to vexilla. In vexilla (Fig. 1), barbuls cling each other by prominent hooklets.

Outer surface of thoracal region covered by contour feathers. They have a prominent calamus and a rachis.

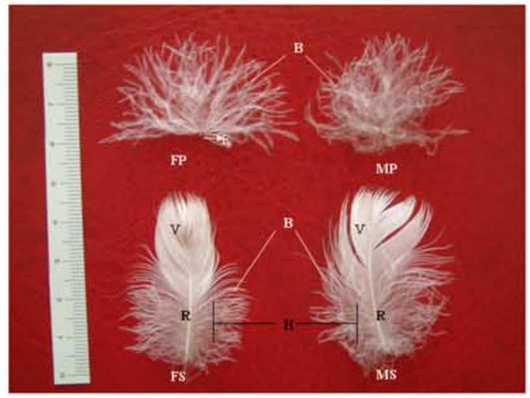

Fig. 1: Macroscopic appearance of deep and superficial breast feathers of male and female goose. FP: Female Plume, MP: Male Plume, FS: Female Semiplumae, MS: Male Semiplumae, R: Rachis, B: Barb, V: Vexilla, H: Hypopenna

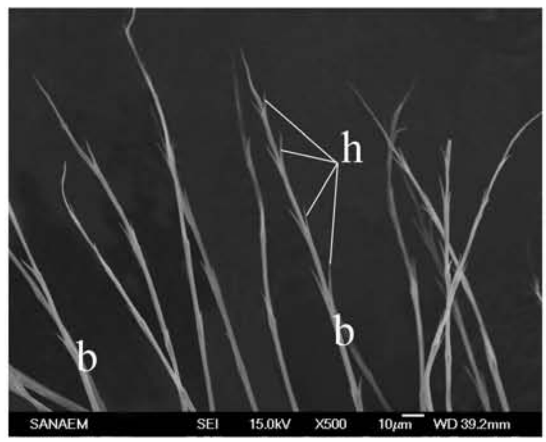

Fig. 2: Female breast feather. b: Barbul, h: Hooklets

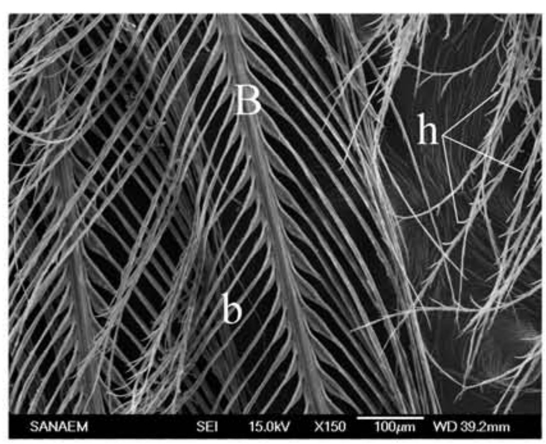

Fig. 3: Male cervical feather, hooklet number increases from proximal to distal end of barbuls of deep feathers. B: Barb, b: Barbul, h: Hooklets

There are hypopennas on boundary between calamus and rachis. Hypopenna are similar to the plumuloceous barbuls and their origins are irregular. Barbs which originated bilaterally from rachis at about 35°C run parallelly and establish vexilla. Barbuls of adjacent barbs cross each other at 90°C (Fig. 4). Contour feathers of breast are shorter than contour feathers in other part of the body.

Feathers from neck scapus diameter were 190 micron in male and 110 micron in female and thickness of barb was about 25 micron for both genders. Remarkable difference exists between neck feathers of both genders and they were about four times longer in male than those in female (Fig. 5).

In tectrix from dorsal wing, diameter of scapus is 135 and 300 micron and thickness of barb is 35 and 20 micron male and female respectively (Fig. 6 and 7). Smaller size of barb thickness in female refers to intensive vexilla in comparison with male. The hooklets are far from each other and distance between them was about 65 micron.

In tectrix from ventral wing, diameter of scapus was 100 micron in female and 70 micron in male, barb thickness was about 20 micron for both genders.

There was no other difference between the characters used to determine feather quality but neck feathers of male were remarkably longer than those of female. General features of the barbs, barbuls and hamulus in all examined feathers were similar with the findings of McLelland (1990) and Stettenheim (2000). In contradiction with the result of Gao *et al*. (2007) it was observed in this study that hooklets were not exist at the beginning of barbuls; they were arranged at the end of barbuls as Yan and Yan (2006) reported. It was determined that distance between hooklets in goose feather about 1.4 times longer than duck's (Yan and Yan, 2006). In this study, it was understood that distance between hooklets are longer than that in ducks, which was reported by Dove and Agreda (2007).

McLelland (1990) informed that barbuls from adjacent barbs start about at 45°C in chicken. In this study the arising angle of the barbuls from barbs are determined as about 35°C. The findings that 90°C crossing angle of the barbuls which start from adjacent barbs are same with McLelland (1990), which was informed for chicken.

Xu *et al*. (2007) postulated that in spite of the sexual dimorphism of feathers in adult geese was easily observed, it can not be detected for feather follicles at embryonic life because of no distinct sexual organs. Widelitz *et al*. (2003) determined that sexual hormones can influence the size, shape and color of feathers. Although, male geese were bigger in size than female, there weren't any observed in difference except length. The density of secondary feather follicles on dorsal tract was found to be smaller than thoracic and ventral tracts at same embryonic age (Xu *et al*., 2007).

These results support the fact that, plumuloceous feathers in breast have peculiarity in entrapping the air because of their density, which we clearly obviously observed in this study.

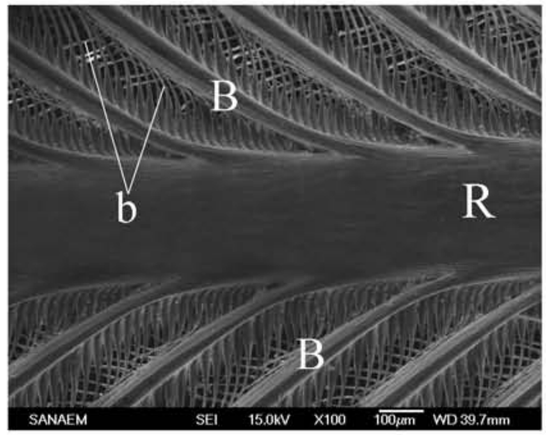

Fig. 4: Male breast feather. Arising angle of the barbuls from barbs are about 35°, crossing angle of the barbuls which start from adjacent barbs are at 90°. R: Rachis, B: Barb, b: Barbul

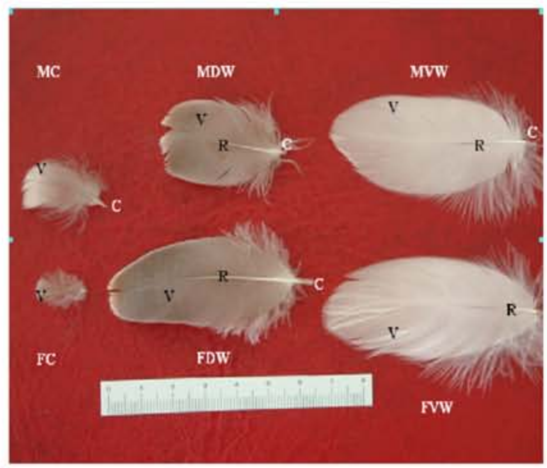

Fig. 5: Macroscopic appearance of cervical, tectrix from dorsal wing and ventral wing of male and female goose. MC: Male Cervical, MDW: Male Dorsal Wing tectrix, MVW: Male Ventral Wing tectrix, FC: Female Cervical, FDW: Female Dorsal Wing tectrix, FVW: Female Ventral Wing tectrix, V: Vexilla, R: Rachis, C: Calamus

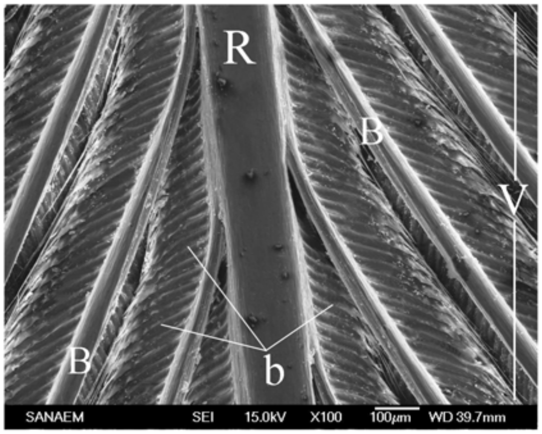

Fig. 6: Dorsal wing tectrix in male. R: Rachis, B: Barb, b: Barbul, V: Vexilla

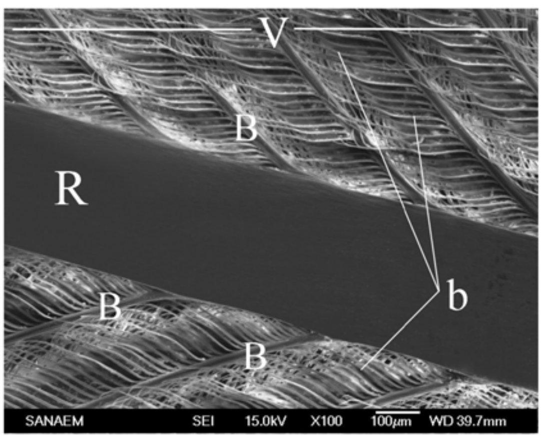

Fig. 7: Dorsal wing tectrix in female. R: Rachis, B: Barb, b: Barbul, V: Vexilla

CONCLUSION

Morphological characters of goose feather, which is an important material for textile industry were examined with SEM and there were no importance sexual dimorphism in morphological aspects of feathers. Best feathers as filling material were deep plumuloceous feathers in thoracic and ventral regions. In these feathers hooklets were not formed vexilla and higher filling strength of these feathers causes entrapping the air but resistance to air was very low.

It has importance to determine quality of goose feather of different body regions of different goose breeds; however length of plumae and semiplumae, diameter of rachis, number and shape of hooklets and joining of barbuls are influence fluffiness and softness of goose feather. But it is necessary to identify the quality standards of feathers in different breeds, by determining moisture regain capacity with chemical analyses. The most important reason of softness and puffiness of plumae and semiplumae is barbs are not connected each other in spite of they have hamulus. It is obviously figured that using SEM to determinate goose feather quality can help textile industry.

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