Stabilization of *Alopex lagop*us (Fox) Collagen for its Prospective Use as Leather

Swarna Vinodh Kanth[1], R. Karthekeyan[1], M. Vinodh Kumar[1], Narasimhan Chandrababu[1], Bangaru Chandrasekaran[1], Ekaterina Tuboleva[2] and Kennet Myllykoski[2]

[1]CSIR-Central Leather Research Institute, Chennai-600 020, India

[2]Viivasuora Oy Ltd - Finland

Abstract

The collagen from the *Alopex lagop*us is characterized for its potential use for stabilization of collagen. *Alopex lagop*us, farmed Fox skins of Finland are not listed in the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and is a potential raw material for the leather sector world-wide. The collagen matrix from the *Alopex lagop*us is specifically synthesized for studying the interactions between the collagen matrixes for the permanent preservation of the skin. The study focuses on the stabilization of fox collagen crosslinked with aluminium tannins. Thermal and enzymatic stability of aluminium stabilized fox collagen was studied. The stabilized fox collagen has brought about significant increase in thermal and enzymatic stability to the crosslinked collagen. Thermal stability and crosslinking efficiency of collagen fibres was found to increase with concentration of alum. The crosslinked fox collagen exhibited denaturation temparature of 78^{o}C. The modified collagen showed 92% resistance towards collagenase. The raw fox skins are processed and dressed into fur-on tanned skins. The fur-on tanned leathers from *Alopex lagop*us were extremely silky, luxurious and attractive. The silky touch of these leathers definitely demands highest price and can be used for the preparation of highly fashionable leather products world-wide.

Key words: *Alopex lagop*us; Fox Collagen; Alum; Crosslinking; Thermal stability; Collagenase; Enzyme stability

1. Introduction

The Arctic Fox (*Vulpes lagopus*) occurs widely in captivity on fur farms and is bred for fur production for over 70 years. The Arctic fox has a long history of exploitation for the fur trade, and while hunting pressure has abated in recent years, it remains the most important terrestrial game species in the Arctic (IUCN Red List 2009). The present captive population originates from a number of wild populations and is bred for characteristics different from those found in the wild, including large size. The average size of these species varies with head-body length of 46–68 cm and shoulder height of 28 cm. The Arctic fox is

superbly adapted for life at sub-zero temperatures (Angerbjörn 2004). The species is common in the tundra areas of Finland, Russia, Canada, coastal Alaska, Greenland, Norway and Iceland. The world population of Arctic Foxes is in the order of several hundred thousand animals. Most populations fluctuate widely in numbers between years in response to varying lemming numbers. While this species is best known for its pristine, white winter coat, during the summer, the coat becomes brown on the upperparts, with light grey or white under parts (Angerbjörn 2004), and is half as thick (Burnie 2001). In addition, to the 'white' form of Arctic fox, a 'blue' form also occurs, which in some areas is light brown with a bluish sheen in the winter or dark brown to black in other areas, but becoming chocolate brown in the summer (Angerbjörn 2004, 2009). The dense, woolly coat of this species has the best insulative properties of all mammals, and helps this species survive at temperatures of -50°C in the wild and up to -80°C during captive tests (Angerbjörn 2009, 2004). Some other adaptations for life in the Arctic include small, heavily furred ears and a short nose to reduce heat loss, as well as fur on the soles of the feet, giving the name in latin "hare foot" (Angerbjörn 2008), and increased blood flow to the feet pads to prevent freezing (Nowak 1991; Angerbjörn 2004). Fortunately, this species is capable of maintaining stable populations even when heavily hunted, due to a relatively high reproductive output. Hence the global population of the Arctic fox is currently abundant and is not considered to be threatened (IUCN Red List 2009).

2. Materials and methods

The fox skins, preserved using natural plant extracts and saw dust from farmed lands of Viivasuora Oy Ltd - Finland were obtained from Finland.

2.1 Preparation of Fox collagen

Acid soluble Fox collagen solution was prepared according to the standard method (Nimni 1996).

2.2 Denaturation temperature

Fibril formation was initiated at 37°C. After rigid gel formation was completed, the temperature of the water bath was raised at a rate of approximately 1°C/5 min and the disappearance of the opacity of the fibrils was noted. The denaturation temperature was taken as that temperature at which the collagen gel was completely dissolved.

2.3 Enzymatic resistance

The enzymatic degradation of native and aluminium sulphate stabilized collagen matrix by bacterial collagenase (Type IA) from *Clostridium histolyticum* was analyzed by estimating the amount of hydroxyproline released in the solution after hydrolysis was determined using the method of Woessner (Chandrakasan 1976, Woessner 1961).

2.4 Tanning and dressing of fur-on skins

The saw dust preserved and dried fox skins are soaked for two hours in borax solution. The skins were carefully fleshed using fleshing knife traditionally. The soaking and fleshing is repeated two more times as the fat content of the fox skins were very high and the skins were very thin in substance. The skins were rinsed thoroughly and tanned using a tawing paste made from aluminium sulfate, potash alum and ammonium alum along with water and salt. Wheat flour was added to the tanning agent to make it into a paste. The paste was applied on the flesh side and covered to ensure they are not dried. The paste was scraped off and reapplied twice till the tanning is complete. The skins were immersed in borax solution for 10 minutes, neutralized with baking soda, alternatively wringling it out and returning to the water. The skins were further washed in fresh, clean water to remove the borax. The water was sqeezed out of the skin as much as possible using a slicker. The skins were stretched out and a good coating of sulphonated

neat's foot oil is applied and before it is completely dried the skins are vigrously softened over staking board. The oil coat was applied as three to four coats and ensured they do not run on to the hair. The skins were not allowed to dry by wrapping in a damp cloth for an hour and continuing beaming, staking and tumbling action. The skins are were skived to remove hard spot. The skins were staked untill they are as soft as a cloth.

2.5 Physical Testing and Visual Assessment

The samples were conditioned at 80±4°F and 65±4% R.H. for 48 h. The tensile strength and % elongation were measured as per standard methods (SLTC 1996). Experienced technologists assessed the organoleptic properties such as fullness, feel and general appearance. The leathers were rated on a scale of 0-10 points for each functional property, where higher points indicate better property.

3. Results and Discussions

Fox skins are farmed and available in enormous quantity for the use of fur. It is estimated that around 650 million square feet of fox skins are available every year in the world that have potential for highly fashionable leather and leather products. The hair on preserved skins were characterized and converted into fur on finished leathers by using traditional tanning methodology. The denaturation temperature and enzymatic resistance of the tanned leathers was determined to study the efficacy of tanning. To study the effect of tanning and dressing of the fur-on skins was studied using physical testing analysis.

3.1 Denaturation temperature of tanned fox fibrils

Thermal stability of the tanned collagen at various concentrations of tanning was carried out. The behavior of the aluminum tanned collagen at the lower ratios of aluminum was dependent on the salt concentration in the tawing paste. However, higher concentration of tanning contributes to higher reactive groups to stabilize the collagen. The ratios of the tanning concentration applied for crosslinking plays a crucial role in the denaturation temperature of collagen. Fox collagen gets destabilized at 58°C, whereas tanned fox collagen crosslinked showed good stability up to the temperature of 78°C.

3.2 Collagenase resistance of fox native and tanned collagen

Degradation of collagen (based on hydroxyproline released) for fox collagen and tanned collagen by collagenase at various concentration was determined. Tanned collagen exhibited 6% degradation of collagen as against 99% degradation in the case of native fox collagen at 96 h period of incubation. The enzyme stability of the collagen matrix increases with increase in concentration of tawing paste applied.

3.3 Chemical and Physical properties of fox taned leathers

The moisture content of the raw fox tanned leathers was found to be 63.5% w/w. However the moisture content was reduced to 50%w/w. The nitrogen content in these skin samples was 7.2% w/w and the fat content is 18.6% w/w. From these values it is observed that the fat content is very high for the *Alopex lagop*us farmed fox tanned skins. Hence, the hair on tanned leathers displayed extreme softness in the final finished hair-on tanned leathers. The hair on the leathers were also very soft without any major modifications. However a small amount of hair was slipping off the tanned skins, which could be due to climatic conditions and the temperatures being high while processing the hides and skins. The compactness of the fibre bundles seemed to be compressed and dense and increased after tanning. The hair on tanned fox leathers lead to extreme softness and fullness due it basic nature of fat content being high. The leathers produced more distinctive natural hair pattern. The unique and natural uniform hair pattern is

major economic feature of these fox tanned leathers, making it more valuable and above all beautiful. The strength properties of the tanned leathers were also carried out. The leathers were subjected to tensile strength analysis. The tensile strength was 99 kg/cm^2. The percentage elongation is however low in value with 17% elongation. But this property would be considered as an advantage, where the leathers for making articles from hair on tanned skins need a minimum value of percentage elongation. Visual assessment data of the hair on leathers reveals that fullness, hair pattern and feel are better in the tanned leathers. The beautiful farmed *Alopex lagop*us fox leathers definitely demand highest price and can be used for the preparation of highly fashionable leather products world-wide.

4.0 Conclusions

The present study establishes a possible use of collagen from the *Alopex lagop*us farmed Fox skins of Finland. The study demonstrates that collagen matrix from the *Alopex lagop*us brings about a significant increase in denaturation temperature with alum tannins. The farmed fox skins crosslinked collagen was found to be resistant to degradation by collagenase and the resistance to degradation was found to be high at higher concentration of tannins. The crosslinked fox collagen exhibited denaturation temparature of 76^{o}C with 86% resistance towards collagenase. The raw hair on fox skins were also processed and dressed into fur-on tanned skins. The fur-on tanned leathers from *Alopex lagop*us were extremely silky, luxurious and attractive.

5.0 References

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