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Characteristics of alpaca wool from farmed animals located on different continents

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Abstract: *Characteristics of alpaca wool from farmed animals located on different continents***.** Interest in breeding alpacas around the world is related to the acquisition of valuable fibre from these animals. The characteristics of alpaca wool are influenced by both genetic and environmental factors. The aim of the study was to compare chosen traits of Huacaya alpaca wool from three farms located in Australia, Africa and Europe. The wool samples were collected from 30 alpacas, 10 from each farm the assessed wool characteristics (fibre diameter, level of medullation and staple length) was determined. The following fibre types have been identified: with continuous medulla, with partial medulla and no-medullated. Similar results were obtained with respect to the fibre diameter, staple length, the level of medullation and even distribution of the type of medullated fibres in all tested farms.

Key words: alpaca wool, fibre diameter, medullation, geographical location

INTRODUCTION

Alpaca as the smallest species of camelids, occurring in South America, constantly expands its expansion to other continents and countries. The world population of those animals reaches 4 million. Most alpacas occur in the Altiplano region, which includes Peru, Bolivia and Chile in South America (Czaplicki 2012). Due to the great adaptability of alpacas resulting from the resistance of the organism to climatic conditions, low requirements of life and ease of maintenance and breeding, they can now be found all over the globe.

In the 1980s of the last century alpacas were successfully introduced from Chile and Peru to Australia (McGregor and Butler 2004), New Zealand (Wuliji 2000), the United States, Canada, and from Australia to Europe (Aylan-Parker and McGregor 2002).

The main reason for the spread of these animals is their fibre. Of the four South American camel species, only Alpaca characterizes with uniform wool, although showing a relatively high variability of thickness depending on the fibre location on the animal's body. Alpaca fibre is considered extremely delicate and characterized by excellent thermal insulation values (McGregor and Butler 2004, Lupton et al. 2006). The latter feature may be related to the presence of large amounts of medullated fibres (a distinctive feature of alpaca), even in very thin hair. On the other hand, a high degree of medullation can contribute to a reduction of the comfort factor as wool and of the final

products (McGregor 2006). The aim of the breeding work in alpaca flocks in Australia is the alignment of fibre thickness and elimination of fibre medullation by means of appropriate evaluation and selection methods. Unfortunately in other regions of occurrence of these animals this work can be disturbed by environmental conditions.

The main features of alpaca wool including the fibre thickness, length and large variety of colors are primarily affected by the genotype. However, these features may also be influenced by biological and climatic factors. According to some authors, the quality of wool produced by these animals can be shaped by environmental factors such as temperature differences, rainfall and altitude, which implies a differentiation of nutritional conditions (Braga et al. 2007, Montes et al. 2008).

The aim of the research was to compare selected traits of Huacaya alpaca wool from herds kept on farms located on different continents.

MATERIAL AND METHOD

The research material was the wool of Huacaya alpacas from three farms located in: Australia (Farm 1), Africa (Farm 2) and Europe (Farm 3). Australian farm was located in the southern part of the continent, in New South Wales near Canberra in Argyle Park. The Australian area characterized with the following climatic conditions: altitude – 520 m above sea level; average rainfall – 632 mm; average temperature +14°C (max +20°C, min +7.2°C). In Africa, alpacas were kept on a small farm on the west coast (Western Cape) in the Cape Town area: 230 m above sea level; 50 mm average annual precipitation; +17°C average temperature (max +22°C, min +11.5°C). European alpaca wool samples originated from a breeding center in Germany in Landebergen, in North Westphalia (51.6 m above sea level; 725 mm precipitation; +12.5°C average temperature).

Wool sample with a one-year shearing was collected from 30 alpacas, both females and males, 10 from each farm. All animals were between two and five years old and the sex ratio was as follows: Australian farm – 6♀, 4♂; African – 6♀, 4♂; European – 4♀, 6♂.

The wool samples were taken on the mid-side on the 10th rib midway between the back line and belly. These samples were used to determine the fibre diameter (FD), standard deviation of FD, coefficient of variation of FD and incidence of medullated fibres (Med) as a percentage of the number of measured fibers. In addition, the staple length (SL) was determined.

Fibre diameter was measured using projection microscope method at 500× magnification in accordance with PN-72/P-04900 standard. In each sample a minimum of 600 fibres was measured. The percentage of medullated fibres in all samples was estimated together with the diameter measurement. The following fibres: with continuous medulla, with partial medulla and no-medullated have been identified. In total, over 18,000 fibres were analyzed.

The staple length was measured to an accuracy of 0.5 cm, butt to tip staple length without disturbing its structure (without stretching and straightening of the crimps).

The obtained values have been processed statistically through a single-factor ANOVA using SPSS 23.0.

RESULTS AND DISCUSSION

The average fibre diameter in the alpaca wool from farms located in Australia, Africa and Europe was 20.20, 22.78 and 24.14 μm, respectively. It should be noted that differences in average diameter, standard deviation of fiber diameter (FD) and coefficient of variation of FD between alpaca wool from farms located on different continents were not statistically significant (Table 1).

The wool of the tested alpacas, both from Farm 1 and Farm 2, was thinner and more aligned than the Huacaya breed wool originating in Peru examined by Gutierrez et al. (2009) and Cervantes et al. (2010). In studies, the authors determined the fiber diameter and coefficient of variation in diameter of Peruvian alpaca wool as 23.0 μm and 24% and 23.07 μm and 23.31% respectively. Compared to the present study, Valbonesi et al. (2010) reported even greater values of fibre diameter and coefficient of variation (27.41 μm and 36.65%), for the fibres of three Peruvian domesticated camel species. McGregor and Butler (2004) determined thickness of Australian alpaca wool as 29,1 μm. In turn, Wuliji et al. (2000) using different methods of fiber diameter measurement in alpaca from New Zealand, obtained the value of this parameter in the range from 28 to 31.9 μm. In the examined alpacas from the United States and Poland, the wool thickness was 27.85 and 27.4 μm respectively (Lupton et al. 2006, Czaplicki 2012).

The differing values of the examined parameter obtained by the above-mentioned authors may result from differences in the number of tested samples, age differentiation of animals and the use of different test methods. According to Cortez (1984), the production of thinner wool is associated with an increase in altitude. In this study and in the research presented by Braga et al. (2007) the authors did not observe this relationship.

The average thickness of males' wool was lower compared to the females wool (21.27 vs 23.34 μm), but the differences were not statistically significant (Table 2). The lack of correlation between the wool thickness and sex was confirmed in studies conducted by Frank et al. (2006) and Lupton et al. (2006). The thinner fibres in Huacaya males' wool

TABLE 1. The effect of geographical conditions on the characteristics of alpaca wool

Item	Farm 1		Farm 2		Farm 3		*P*-value
	$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD*	
Fibre diameter (μm)	20.20	3.00	22.78	3.55	24.14	6.64	0.180
Standard deviation of FD (μm)	4.40	1.31	4.82	0.93	4.40	0.90	0.600
Coefficient of variation of FD (%)	21.55	4.61	21.61	5.24	19.29	5.83	0.536
Medullation percentage (%)	53.56	21.89	51.73	13.66	52.84	25.30	0.914
Staple length (cm)	10.36	1.86	9.27	1.77	10.49	2.78	0.403

TABLE 2. The effect of sex on the characteristics of alpaca wool

Item	Males		Females		*P*-value
	$\bar{x}$	*SD*	$\bar{x}$	*SD*	
Fibre diameter (μm)	21.27	3.54	23.34	5.64	0.247
Standard deviation of FD (μm)	4.61	0.99	4.48	1.12	0.735
Coefficient of variation of FD (%)	21.93	4.73	19.84	5.52	0.277
Medullation percentage (%)	54.25	25.36	44.42	15.11	0.751
Staple length (cm)	10.54	1.98	9.61	2.32	0.251

maintained in the Huancavelica region, as in the present study, were also found by Montes et al. (2008). Opposite results were obtained by McGregor (2006) indicating that males produce thicker and more rough wool than females.

A detailed analysis of the fibre diameter variation did not show differentiation in this range depending on the place of keeping the tested alpacas (Fig. 1). Curves of variation indicate that all the analyzed wool samples can be classified as uniform wool, which is consistent with the widespread recognition (McColl et al. 2004, Hoffman 2006). Although alpaca wool does not have a clear division into thin and no-medullated and thicker with the medulla fibres, the occurrence of medullation in these animals has been confirmed in many studies (Aylan-Parker and McGregor 2002, Lupton et al. 2006, McGregor 2006).

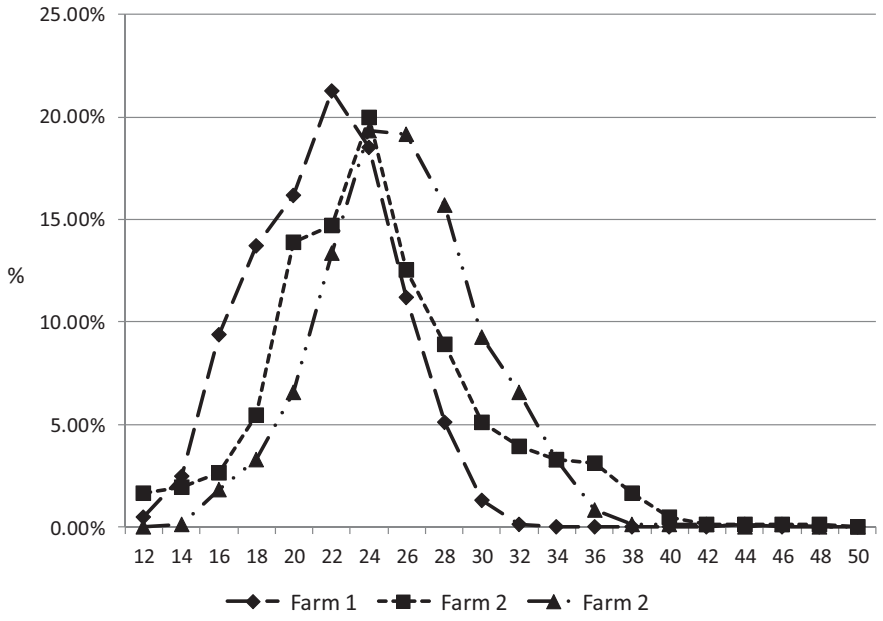

FIGURE 1. The variation of fibre diameter in alpaca wool from studied farms

The level of medullation in the wool samples from alpacas kept in Australia, Africa and Europe was similar ($P \geq 0.05$) – Table 1. The share of no-medullated fibres, with partial medulla and with continuous medulla in all tested flocks, remained at a similar level (Fig. 2). The most common type of medullation was partially medullated fibres, which accounted for about 40% of all fibres in the tested samples. Occurrence of the medullation in this species may be due to adaptation to the conditions of the South American continent, which is the place of origin of these animals. The high daily temperature in the mountains could have contributed to the development of a defense mechanism in the form of a medulla even in thin fibres, which supports the thermoregulation in alpacas. Although the amount of fibres with the medulla increased with their thickness, its presence has already been recorded in fibres with a diameter of 14–20 μm (Fig. 3). The medulla in very thin fibres, were also found by Radzik-Rant et al. (1994) in the wool of native Indian breeds of sheep kept in the Thar desert area.

In presented study, more than 50% of medullated fibres were found in 67% of examined alpacas. A detailed analysis of the medullation level indicated a high individual variability of this feature. Some fleeces were characterized by more than 70% and even 85% of no-medullated fibres, as well as fleeces with the medullation measuring more than 96%. Large individual variability of the medullation in alpacas wool has also been reported by Lupton et al. (2006). The most common type of fibres within the partial medullated fibres, were those with a regular partial medulla (Fig. 4). In addition, within this fibre type, the fibres with almost continuous medulla and with

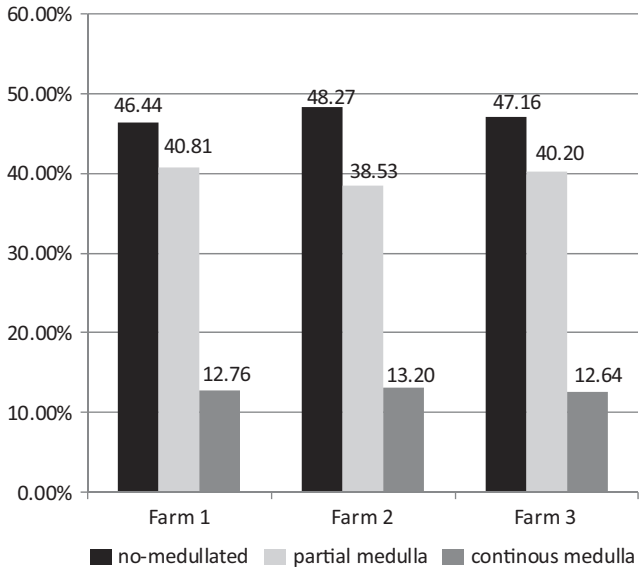

FIGURE 2. The distribution of different types of fibres in alpaca wool from studied farms

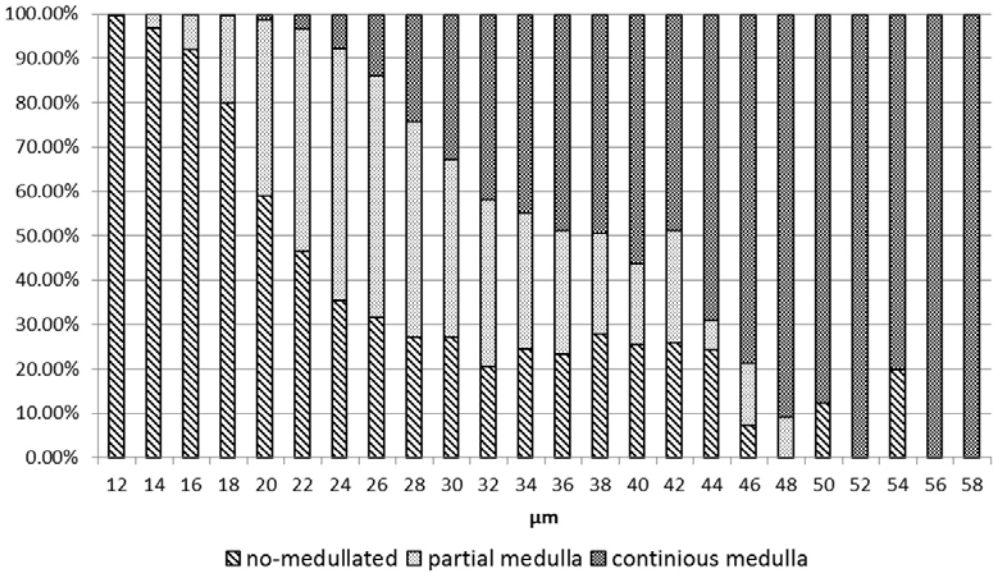

FIGURE 3. The diameter of different fibre types

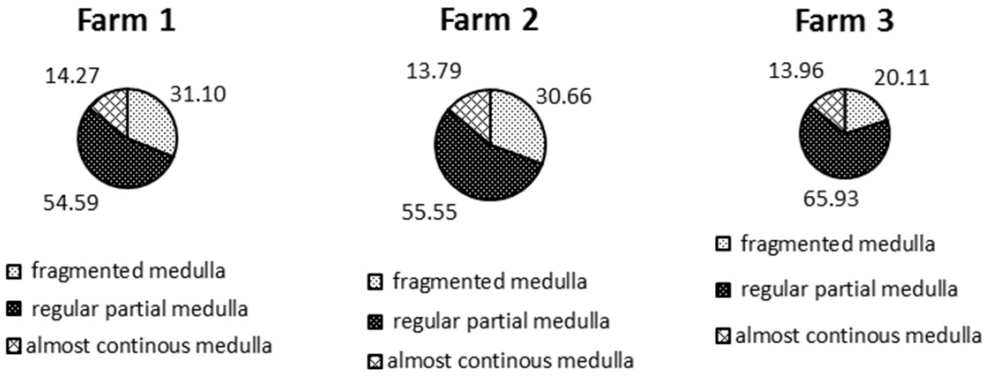

FIGURE 4. The percentage of fibres with different types of partial medulla in alpaca wool from studied farms (%)

fragmented medulla have also been identified. The latter were among the least common. Attention should be drawn to the high convergence of the distribution of the different types of medulla in all tested flocks, despite the differences resulting from the geographical location of the farms.

Although differences in the level of medullation depending on the sex were not confirmed statistically, more medullated fibres were recorded in the male fleeces as compared to the examined females (Table 2).

The wool of the tested alpacas did not differ ($P \geq 0.05$) in terms of staple length

despite the different environmental conditions connected with farms location on different continents (Table 1). Large similarity in this feature was shown by the alpacas kept in Europe and Australia, while alpaca staples from Africa were slightly shorter, with an average length of 9.27 cm. The results are consistent with the results obtained by Wuliji et al. (2000) and McGregor (2002) in New Zealand alpacas. The length interval for the tested samples ranged from 6.1 to 15.1 cm and did not exceed the range determined for alpaca wool (5–16 cm) by Hoffman (2006). Value less than 7.6 cm, which excludes processing worsted system, was noted only for two samples, which accounted for only 6% of the material tested. In the study on Australian alpaca wool, conducted by McGregor (2006), the number of too short fleeces was about 13%.

In the examined males, the staple length showed (statistically insignificant) higher values than in females (Table 2). Lupton et al. (2006) also indicated that males usually produce longer wool compared to females.

CONCLUSION

In summary, it can be concluded that the wool of the examined alpacas did not differ by average fibre diameter, coefficient of variation of fibre diameter as well as length of staples despite the different located of the farms. Extremely interesting are the results of the analysis of the medullation level, which showed similarity even with regard to the distribution of the type of medullated fibres in the tested flocks. The medullation of these wools seems to be independent of the breeding work, climatic conditions and thus nutritional conditions.

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Streszczenie: *Charakterystyka porównawcza wybranych cech wełny alpak pochodzących z farm położonych na różnych kontynentach*. Zainteresowanie hodowlą alpak na całym świecie jest związane z pozyskiwaniem od tych zwierząt cennego włókna. Na cechy wełny alpak mają wpływ zarówno czynniki genetyczne, jak i warunki środowiskowe. Celem przeprowadzonych badań było porównanie wybranych cech wełny alpak rasy huacaya pochodzących z trzech farm położonych w Australii, Afryce i Europie. Próby wełny pobrano od 30 alpak, po 10 z każdej fermy. Określono w nich grubość włókien, długość zespołów oraz stopień rdzenistości. Grubość włókien mierzono metodą mikroprojekcyjną. Jednocześnie z pomiarem grubości określono zawartość włókien z obecnością rdzenia. Identyfikowano włókna z ciągłym i przerywanym rdzeniem oraz włókna bezrdzeniowe. Uzyskano podobne rezultaty we wszystkich badanych fermach w odniesieniu do grubości wełny, jej długości, jak i przede wszystkim stopnia rdzenistości, a nawet rozkładu rodzaju włókien rdzeniowych.

Słowa kluczowe: wełna alpak, grubość włókien, rdzenistość, położenie geograficzne

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