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THE ADAPTABILITY OF SIMMENTALER CATTLE IN SOUTH AND SOUTH WEST AFRICA WITH SPECIAL REFERENCE TO THEIR CLAWS

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OPSOMMING: DIE AANPASBAARHEID VAN SIMMENTALER BEESTE IN SUID EN SUIDWES-AFRIKA MET SPESIALE VERWYSING NA HULLE KLOUE

'n Studie om die afslyting van kloue verkry vanaf verskillende rasse het nie die stelling dat donker gepigmenteerde kloue meer weerstand bied as die lig gepigmenteerde kloue bevestig nie. Duidelikheid is verkry oor die feit dat die vogtigheid en die mikrostruktuur van die klouhoring van groter belang is vir die hardheid van kloue as die pigment van die klouhoring.

'n Vergelyking tussen die Simmentaler in Duitsland en die Afrikaner toon dat altwee in die omgewing waaraan hulle gewoond is, lae waardes vir die groei en afslyting van die klouhoring toon, terwyl diere wat na Suid- en Suidwes-Afrika uitgevoer is verhoogde waardes wys. Die evaluasie van die metings oor groei en afslyting van klouhorings — asook die histologiese ondersoek — lewer die bewys dat die aanpasbaarheid van die Simmentaler in Suid- en Suidwes-Afrika 'n voortdurende proses is, maar dat dit onwaarskynlik is dat die vlak van die aanpasbaarheid van die Afrikaner ten volle bereik sal word.

SUMMARY:

A study of the abrasion losses of claws obtained from different breeds did not confirm the hypothesis that dark pigmented claws are more resistant than light pigmented claws. It could be shown that factors such as the moisture and the microstructure of the horny walls of the claw influence the hardness of claws more than the pigmentation of the horny walls of the claws.

A comparison between the Simmentaler from Germany and the Afrikaner, proved that both breeds in the environment to which they have become adapted showed low values for both the growth and the abrasion of the claw horn, while animals exported to South and South West Africa exhibited higher values. Evaluation of the growth and abrasion of the claw horn as well as the histological investigations indicated that adaptation of the Simmentaler in South and South West Africa is a continuous process, but is unlikely that the level of adaptation of the Afrikaner will be equalled.

The Simmentaler breed possesses light pigmented claw horn which in the opinion of many breeders is softer and less resistant than claw horn with a dark pigment. Farmers in South and South West Africa very often also express the opinion that the claws of Simmentalers under hard veld conditions, have a high rate of abrasion and therefore this breed tends to acquire claw injuries resulting in lower performance of the animals.

With these opinions in mind investigation of the adaptability of Simmentaler cattle in South and South West Africa with special reference to their claws was concentrated on:

(1) Abrasion losses of claws with different pigmentation.

(2) Growth and abrasion of claws of Simmentalers, Afrikaner, Brahman and crosses between these three breeds.

(3) Histological investigations of the microstructure of the horny walls of the claws in Simmentaler cattle from South West Africa and Germany as well as in Afrikaner cattle.

Materials and methods

Abrasion losses of claws with different pigmentation

Abrasion losses of claws which differed in pigmentation were investigated using 412 claws of slaughtered female animals of different breeds and crosses, 223 originating from front and 189 from the hind legs. Purebred Simmentalers contributed 36

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claws, while 8 claws were obtained from purebred Afrikaners, the remaining 368 claws having come from crossbred animals all of which were fed in a large feedlot during the last 3 months before slaughter. The age of the animals varied, but most of them were slaughtered at an age of 17 to 19 months with an average mass of 380 kg. Except for 31 claws obtained from the Windhoek abattoir the material was collected at the Pretoria abattoir.

Directly after slaughter the horny walls of the claws were removed, separated according to front and hind leg, placed in plastic bags and kept in a refrigerator in order to control the moisture content of the horn material. The claws were subdivided into 5 groups, whereby the light horn was classified as "1" and the completely pigmented black horn as "5" (Pflug, 1978). From the tip of the toe of the horny wall, beginning at the sole border *(margo solearis)* as close as possible to the tip itself, a strip of claw horn 6 cm long and 3 cm wide was sawn with a fine-tooth metal saw. The strip was trimmed exactly with a grinding machine to a length of 5 cm, width of 2,5 cm and thickness of 0,5 cm. Particular care was taken to ensure natural surface remained and that the strip was ground in such a way as to retain its natural curvature. This is an essential part of the procedure because the pigment is deposited only to a depth of 0,2 mm in the surface layer of the horn.

The influence of the moisture content of the claws on the hardness or resistance to abrasion was tested according to methods described by Sassen (1938) and Kovacs (1977) : Five horn strips each of the pigment classes "1" and "5" were treated as follows:

Group 1 : Two hours in distilled water

Group 2 : Two hours in the drying oven at a temperature of 105° C

Group 3 : 1½ hours in the drying oven at a temperature of 105° C

Group 4 : One hour in the drying oven at a temperature of 105° C

Group 5 : Half an hour in the drying oven at a temperature of 105° C

The abrasion loss of each strip was measured by a method similar to that of Sassen (1938) and Koppenhöfer (1940) and described in detail by Pflug (1978). The horn strip is fastened on a structure which moves the strip rectangularly towards a sanding or grinding disk. The principle of the method is the maintenance of a constant pressure (1 kg) of the horn strip against the grinding disk which rotates at 2 400 rpm. The grinding disk was replaced by a new one for every new sample. The loss of horn material was established by weighing the horn strip before and after the abrasion process.

In trimming the strip of 6 cm length to one of 5 cm length the distal 1 cm tip of the strip was ground to a powder. The moisture content of the horn strip was determined by weighing before and after drying for 20 hours in a drying oven.

Growth and abrasion of claws of Simmentaler, Afrikaner, Brahman and crosses between these three breeds

Measurements were made on 138 female animals obtained from 9 farms with different soil types and climatic conditions. In Germany the claws of a group of 10 female Simmentalers were measured for comparison.

The length of the claws was measured in each case, and the method for the determination of growth and abrasion was basically the same as that described by Prentice (1973) for Ayrshire cattle. The growth was measured by the increase in distance between a marked point on the horn surface of the claw and the coronary border *(margo coronalis)*, while the abrasion was given by the decrease in distance from the said point to the sole border *(margo solearis)*. The marked point on the horny surface was obtained in the following way: The distance between the coronary border and the sole border was measured on the lateral and medial claw of the right front and hind leg at the tip of the claw, in the middle of the claw and at the heel of the claw (Fig. 1). At midpoint between A and B, C and D as well as E and F the mark was sawn slightly into the horn surface.

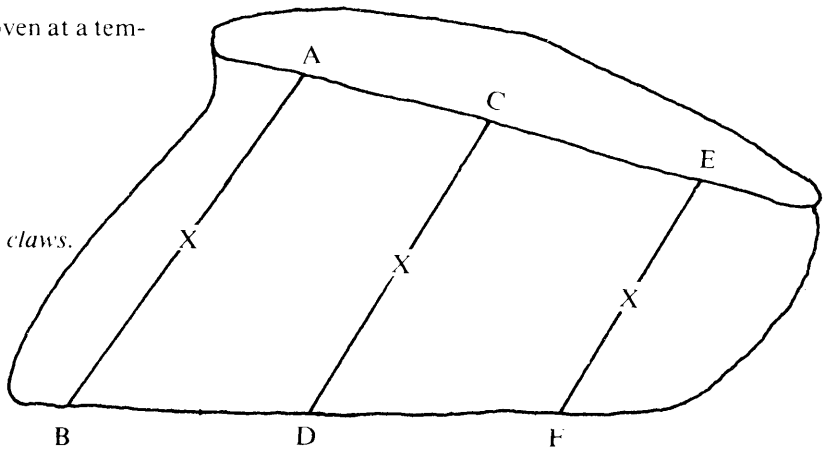

Fig. 1 The three measuring points of the claws.

In this way 12 values were obtained from each animal. Growth and abrasion were measured 80 to 90 days following the marking of claws.

Because these measurements were taken on the lateral and medial claws of the right front and hind legs, the animals were pulled down onto the left side and the extremities tied up.

The distance between farms is large and it was not possible to standardize the intervals between measurements; this was mostly overcome by the use of correction factors to obtain the results of growth or abrasion per 30 days.

Histological investigations on the microstructure of the horny walls of the claws

The collection of material for the comparative histological investigations was similar to that for the studies on abrasion losses of claws. The claws of slaughtered female cattle from the Afrikaner and Simmentaler breeds were collected at the Windhoek abattoir and those from the Simmentaler (Fleckvieh) breed in Germany at the Münich abattoir.

A small piece of the claw horn of 1 cm × 2 cm × 2 cm from the sole border of the tip of the claw was sawn out and immersed in 10 per cent formalin for two days. Thereafter the pieces were kept overnight in a solution of 70 parts formic acid and 30 parts 10 per cent formalin and eventually sectioned with a cryotome. Since the resistance of the claw horn is determined not only by the number of horn tubules per surface unit, but also the diameter of the tubules (Kind, 1961) measurements of the latter were included in the investigation. The medullae of the tubules are not involved in any mechanical function — they contain decaying medullary cell masses which fall out in the distal portion of the tubules and leave a hollow medullary cavity (Nickel, 1938). The investigations of Tscherne (1910) and Kind (1961) led to the conclusion that in the more resistant horn wall a thicker cortex of the tubules with a narrow medulla will give additional strength compared to the less resistant horn wall with a thinner cortical substance of the tubules and a wider medullary cavity. For a comparison between 3 groups of animals with different numbers of tubules and differences in tubular and intertubular horn, the portion of cortical substances per mm^2 measured surface, was calculated.

Results and discussion

Abrasion losses of claws with different pigmentation

The abrasion losses of Simmentalers in South West Africa with light pigment (class "1") both on claws of the front as well as hind legs were lower ($P < 0{,}001$) than those on claws of animals of South Africa (Table 1). All the claws from South West Africa originated from purebred Simmentalers, while those from South Africa with light pigment came mainly from crossbred animals (55 from crossbred and 5 from purebred Simmentalers).

It was interesting to note that in the animals from South Africa the claws with pigment "2" presented the lowest abrasion losses at the front leg, while claws with pigment "3" showed the lowest losses in the hind leg. None of the other differences between pigment classes or front- and hind legs were significant.

The uneven numbers of claws from the front and hind legs was due to the difficulty of collecting material from the abattoirs and also because claws which could not easily be classified into the pigment classes were discarded.

Table 1

Abrasion percentages of claw horn in female cattle from South and South West Africa

Pigment class	Origin	Front leg			Hind leg		
		n	$\bar{x}$	s	n	$\bar{x}$	s
1	SWA	13	13,1	3,2	18	13,0	2,9
1	SA	31	17,1	2,1	29	16,6	1,8
2	SA	30	16,1	2,8	30	15,5	2,4
3	SA	34	16,5	2,1	16	15,2	2,7
4	SA	54	16,8	2,7	52	16,3	2,6
5	SA	56	16,6	3,7	49	16,3	2,8

Table 2

Abrasion losses and moisture estimations in five treated groups

Group	Pigment class	Abrasion (per cent)			Moisture (per cent)		
		n	$\bar{x}$	s	n	$\bar{x}$	s
1	1	5	38,7	4,4	5	45,0	0,0
	5	5	40,3	5,4	5	45,3	1,3
2	1	5	36,8	1,2	5	6,2	0,0
	5	5	37,8	1,4	5	5,4	0,7
3	1	5	29,0	4,5	5	8,6	0,5
	5	5	30,1	2,3	5	9,0	0,4
4	1	5	20,3	2,9	5	10,0	0,3
	5	5	21,7	2,4	5	9,2	0,7
5	1	5	18,7	1,9	5	13,3	0,0
	5	5	20,2	2,9	5	12,4	0,7

The highest abrasion values were obtained both in the very low and very high regions of moisture percentages of the claw horn. The abrasion decreased with increasing moisture percentage from 5% in group 2 to 13% in group 5. However, in view of the absence of data for moisture percentages from 13% to 45% the minimum abrasion, as related to moisture content, could not be established. These results are in agreement with Kovacs (1977) and Dewes (1978), who showed that both very high, as well as very low moisture percentages had a detrimental effect on the abrasion resistance of the claw horn.

The results obtained also show that there was almost no difference between the pigment classes "1" and "5" in moisture content, abrasion and the relationship between the 2 characteristics. Because of the fact that the pigment had no significant influence on the abrasion losses and because different moisture percentages led to different abrasion values, the influence of moisture independent of that due to pigment was investigated using the total material available.

The moisture content in 379 claws investigated varied from 22,9 per cent to 32,5 per cent and all the claws were divided into three classes of moisture content (Table 3).

Table 3

The influence of moisture on the abrasion of claws

Moisture	Abrasion losses (per cent)		
	n	$\bar{x}$	s
$\leqq$ 25%	95	15,9	2,2
$\leqq$ 30%	246	16,5	2,8
> 30%	38	17,1	2,3

These results continued the trend shown in Table 2 viz., the abrasion of claw horn was directly related to the moisture content — with increased moisture content, an increased abrasion of claw horn took place. In Fig. 2 the values of table 2 and 3 are depicted together, the differences between the 3 moisture groups being statistically significant ($P < 0{,}001$).

It could be seen that the abrasion values increased in claws that had a moisture content below 15 per cent, whereas they also increased in claws containing a moisture content above 25 per cent. In other words, the lowest abrasion took place in claws with a moisture content between 15 and 25 per cent.

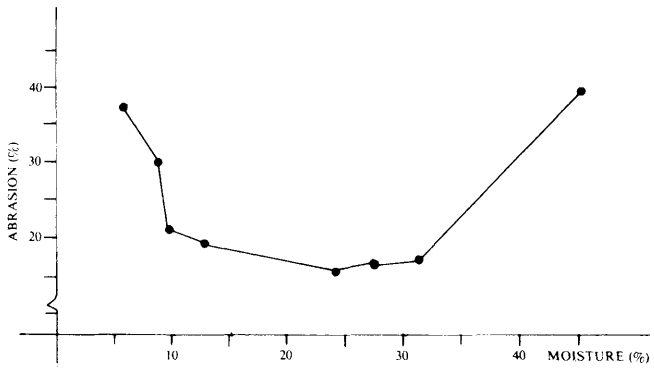

Fig. 2 The abrasion losses of claw horn in relation to the moisture content

Growth and abrasion of claws of Simmentaler, Afrikaner, Brahman and crosses between these three breeds

The growth and abrasion were measured on the lateral and medial claw of the right front and hind leg at the tip of the claw, in the middle of the claw and at the heel of the claw. On the claw toe, the horn grows more slowly than in the mid-wall regions. The horn of the posterior wall of the medial claws of the forelegs and the lateral claws of the hindlegs grow somewhat faster than the horn of the mid-wall region. However, these differences were very small and not statistically significant. Only 1,3 per cent of the total variance in growth and 0,7 per cent in abrasion were due to differences between fore- and hindlegs.

The abrasion rate at the toe was significantly higher than that of the mid-wall, while posterior wall exhibited an intermediate rate of abrasion.

Because of the small differences between fore- and hindlegs an average value for all claws was calculated in the following elaborations. The differences between the regions of the claws were larger; as much as 19,2% of the total variance in growth and 3,5% in abrasion were due to claw region differences (Table 4).

In studying the influence of body mass, age, soil types and rainfall it was shown that mass and age of the animals were of lesser importance, while the soil types and rainfall played a great role in the growth and abrasion of claws (Pflug, 1978). Animals on sandy soils had lower growth and abrasion values than animals on stony grounds, and in areas with lower rainfall higher growth and abrasion values were found than in areas with higher rainfall.

In Table 5 breed differences in the growth and abrasion of claw horn on the 3 measured areas are depicted.

In view of the influence of live mass, feeding/grazing, soil type and rainfall, the influence of breed on growth and abrasion of claw horn (Table 5) was difficult to measure. Nevertheless, after correction for soil, differences were exhibited between the different breeds (F-test). The Simmentaler from Germany (Group 1) showed the lowest values which differed significantly from the other groups. These animals were included in the table although a direct comparison is possibly not acceptable.

The comparison of the groups in South Africa could be summarized as follows: The imported Simmentaler (Group 2) were significantly different to those generations of Simmentalers bred in South Africa (Groups 3-5). Group 2 differed significantly also from the crossed animals (Group 6), as regards the growth of claw horn. No significant differences were obtained for the growth and abrasion of claw horn when the imported Simmentalers were compared with the indigenous Afrikaner or Brahman breeds and there were also no differences between the latter two breeds. Further work here would be of great interest.

Table 4

Growth and abrasion (mm/30 days)

Claw region	Growth			Abrasion		
	n	x	s	n	x	s
Tip of claw	138	4,9	1,7	138	5,4 [b]	1,5
Middle of claw	138	6,2 [a]	1,9	138	5,7 [b]	1,8
Heel of claw	138	6,8 [a]	2,3	138	5,2 [b]	1,9

[a,b] Values with the same superscript do not differ significantly.

Table 5

Breed differences in the growth and abrasion of claw horn (mm/30 days) on the tip, the middle region and the heel

Breed	n	Growth						Abrasion					
		Tip		Middle		Heel		Tip		Middle		Heel	
		$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
1	10	2,9	0,2	3,3	0,2	3,7	0,3	2,3	0,2	2,6	0,3	2,5	0,2
2	40	3,6	1,1	4,9	1,2	5,9	1,9	5,0	1,7	4,9	1,6	5,5	1,8
3	39	5,1	1,8	6,4	2,0	6,8	2,3	5,6	2,3	5,3	1,5	5,5	1,8
4	17	6,3	1,2	7,4	1,4	8,4	1,7	6,8	1,6	6,4	1,0	6,7	1,2
5	6	6,3	0,8	7,9	0,9	9,1	1,7	6,7	1,8	5,9	0,7	6,5	0,7
6	23	5,6	1,6	6,7	1,9	7,0	2,2	5,9	1,8	5,6	1,5	5,7	1,7
7	13	4,4	1,0	5,3	1,1	5,8	1,2	4,8	1,3	5,0	1,2	4,7	1,6

1 = Simmentaler Germany
2 = Simmentaler imported, two years or longer in the country
3 = Simmentaler, first generation out of 2
4 = Simmentaler, second generation out of 2
5 = Simmentaler, third generation out of 2
6 = Crosses of Simmentaler with Afrikaner or Brahman
7 = Afrikaner, Brahman

Histological investigation on the microstructure of the horny walls of the claws

Highly significant differences (t -Test) existed between breeds ($P < 0,001$) in the number of tubules per 12,5 mm², in the total diameter of tubules and in the cortical substance per mm² measured surface (Table 6). number of tubules per unit surface area and a greater average total diameter of the tubules than the Simmentaler. In contrast, the average diameter of the medullary cavity of the Simmentaler in South West Africa was significantly higher than that of the Afrikaner and of the Simmentaler from Germany. Furthermore, the cortical substance per mm² measured

Table 6

Characteristic parameters of the microstructure of the horny walls

Breed	n	Number of tubules per 12,5 mm²		Total Diameter (mm)		Diameter of medullary cavity (mm)		Cortical substance per mm² measured surface (mm²)	
		$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Afrikaner	50	52,1	3,1	0,260	0,008	0,068	0,004	0,208	0,019
Simmentaler SWA	50	44,5	6,1	0,252	0,007	0,078	0,010	0,161	0,023
Simmentaler Germany	50	34,3	5,1	0,194	0,013	0,067	0,012	0,071	0,015

Comparing the microstructure of the horny wall of the claw of Simmentaler from South West Africa and Germany and of the Afrikaner cattle it was noted that the Afrikaner possessed the significantly higher surface for the Afrikaner was significantly greater than that for the Simmentaler from South West Africa and Germany. All these differences were highly significant ($P < 0,001$).

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