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Studies on the Basic Characteristics of South African Merino Wool.—II. Specific Gravity.

By C. M. VAN WYK and HESTER A. M. NEL, Wool Research Section, Onderstepoort.

INTRODUCTION.

RESEARCH workers are inclined to believe that the variability of the specific gravity of wool is so small as to be of no practical significance. King (1926) asserted that "the values indicate that the specific gravity is substantially the same for all qualities which are medulla-free". Speakman, Stott and Chang (1933) found the extreme values of 1·304 for Wensleydale and 1·309 for Merino wool at 25° C. Notwithstanding these results practical sheep and woolmen believe that there are marked differences in the specific gravities of different types of wool and even in the differnt typs within the Merino. Provision is also made for this contention in some wool score cards. As a result of these divergent viewpoints, a study of the variation in specific gravity of South African Merino wool was undertaken.

METHOD.

The bulk of the grease and dirt of the selected wool samples was removed by a preliminary washing in benzene at 50° C., after which adhering foreign matter was removed with the aid of forceps. Further purification was effected by successive extraction with benzene, alcohol and ether in a soxhlet apparatus. Finally the wool was washed in a 0·1 per cent. solution of saponin at 50° C. for 10 minutes and repeatedly rinsed in distilled water.

Four specific gravity bottles, each containing approximately two grams of wool, were placed above a shallow dish containing phosphorus pentoxide in a Witts filtering appartus from which the funnel had been removed and a ground-in joint inserted (Fig. 1). A glass tube passing through the ground-in joint was joined to four narrower tubes each of which projected into a specific gravity bottle. On the outside of the apparatus the tube was bent downwards, drawn to a point and sealed off.

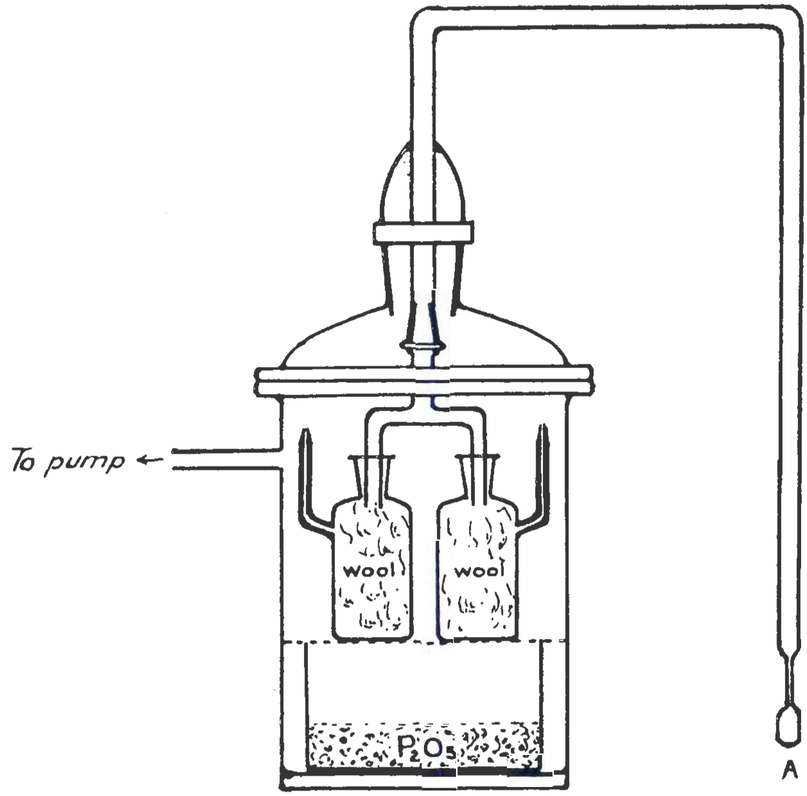

FIGURE 1.

The apparatus was evacuated through the side tube to a pressure of 0·003 mm. of mercury by means of a mercury vapour pump backed by a Hyvac pump, evacuation being continued for a fortnight. At the end of this period the tip of the tube leading from the apparatus was broken under benzene, which had been freshly distilled over sodium after a preliminary drying over calcium chloride and phosphorus pentoxide.

The bottles containing wool and benzene were weighed after immersion at various temperatures between 15° C. and 30° C. in a thermostatically controlled waterbath, the temperature of which was kept constant within 0·1° C.

The wool was then removed and the bottles were filled from the same batch of benzene and weighed over the same range of temperatures as before. Since the relation between the weights of the bottles filled with benzene and temperature could be regarded as linear over this range of temperature, a linear equation was fitted to the results by the method of least squares. The weights of the bottles filled with benzene were then calculated for the same temperatures at which the bottles had been weighed when containing both wool and benzene.

The bottles had to be calibrated anew with benzene after each determination since the relation between the weight of the bottle filled with benzene and temperature varied with time.

The bottles were then filled with water and weighed and the specific gravity of the benzene calculated. In all cases the value of the specific gravity of the benzene agreed to within 0·02 per cent. of the values given in the International Critical Tables.

The dry weight of the wool was subsequently determined by heating to a temperature of 100° C. at 5 cm. Hg. pressure in the presence of concentrated sulphuric acid. An Abderhalden drying apparatus was used for this purpose.

Extreme care was exercised to ensure that the benzene used was pure and dry since the observed specific gravity would be the apparent and not the true specific gravity if traces of water or other liquids present in the benzene were adsorbed by the wool. The sorptive effect was found by King (1926) to be a minimum with benzene, toluene, nitrobenzene, olive oil and oleic acid.

Owing to the large variations in air density experienced, it was found necessary to apply a correction for buoyancy at each weighing. This was accomplished by taking a reading of the pressure, temperature and relative humidity of the air at each weighing and calculating the air density (Watson 1922), while the external volumes of the bottles were determined by an immersion method.

In order to ensure that inadequate drying of a particular batch of benzene or a possible error in the calibration of a particular bottle should not influence the result, determinations were carried out on duplicate samples, using a different batch of benzene and a different bottle each time.

A determination of the specific gravity of 50 samples in duplicate gave $\pm 0{\cdot}00116$ for the standard error of the means of duplicates, a value small enougb to demonstrate such differences between samples as have a practical value.

The results are all expressed as the specific gravity at 25° C. relative to water at 4° C.

Experimental Results.

The specific gravity of a series of samples drawn from the various wool-growing areas was determined. These samples differed considerably in regard to other physical properties and consequently were expected to show differences in specific gravity, if such differences existed.

The results are given in Table 1.

TABLE 1.

Sample.	Specific Gravity at 25°/ Water at 4° C.	Mean Fineness. (μ).	Origin.
1	1·303	20·7	Karroo.
2	1·306	19·2	,,
3	1·302	21·6	,,
4	1·304	24·4	,, (Ram).
5	1·311	25·1	,, ,,
6	1·303	27·3	Karroo (Ram).
7	1·305	22·0	Karroo (Ram).
8	1·305	22·4	Karroo (Ram).
9	1·303	23·4	Karroo (Ram).
10	1·300	22·8	Karroo (Ram).
11	1·301	—	Karroo (Ram).
12	1·301	—	Karroo (Ram).
13	1·303	—	Karroo (Ram).
14	1·301	—	Karroo (Ram).
15	1·303	—	Grassveld (Eastern Province).
16	1·303	—	Grassveld (Eastern Province).
17	1·298	—	Grassveld (Eastern Province).
18	1·301	—	Grassveld (Eastern Province).
19	1·301	19·4	Grassveld (Eastern Province).
20	1·304	—	Sour Grassveld (Orange Free State) (Ram).
21	1·305	—	Sour Grassveld (Orange Free State) (Ram).
22	1·309	—	Sour Grassveld (Orange Free State) (Ram).
23	1·309	—	Sour Grassveld (Orange Free State) (Ram).
24	1·310	—	Sour Grassveld (Orange Free State) (Ram).
25	1·313	—	Sour Grassveld (Orange Free State) (Ram).
26	1·311	—	Sour Grassveld (Orange Free State) (Ram).
27	1·313	—	Sour Grassveld (Orange Free State) (Ram).
28	1·298	17·6	Grassveld (Transvaal Highveld).
29	1·304	19·9	Grassveld (Transvaal Highveld).
30	1·302	19·8	Grassveld (Transvaal Highveld).
31	1·301	20·6	Grassveld (Transvaal Highveld) (Lamb's Wool).
32	1·308	19·4	Western Cape Province.
33	1·308	19·8	Western Cape Province ("Wild Wool").
34	1·303	19·0	Western Cape Province ("Cotton-fibred Wool").
35	1·305	20·5	Experimental Wool (Well-fed).
36	1·304	23·1	Experimental Wool (Well-fed).
37	1·307	23·7	Experimental Wool (Well-fed).
38	1·304	26·2	Experimental Wool (Well-fed).
39	1·308	22·1	Experimental Wool (Well-fed).
40	1·307	19·4	Experimental Wool (Well-fed).
41	1·312	23·7	Experimental Wool (Well-fed).
42	1·306	22·8	Experimental Wool (Well-fed).
43	1·308	25·7	Experimental Wool (Well-fed).
44	1·307	26·7	Experimental Wool (Well-fed).
45	1·304	15·7	Experimental Wool (Underfed).
46	1·307	15·6	Experimental Wool (Underfed).
47	1·306	19·9	Experimental Wool (Underfed).
48	1·307	16·1	Experimental Wool (Underfed).
49	1·308	12·9	Experimental Wool (Underfed).
50	1·306	19·1	Experimental Wool (Underfed).
51	1·305	16·5	Experimental Wool (Underfed).
52	1·308	17·7	Experimental Wool (Underfed).
53	1·306	15·8	Experimental Wool (Underfed).
54	1·304	15·6	Experimental Wool (Underfed).

Mean.................................. = 1·3052/water at 4° C.
Standard Deviation...................... = ± 0·0035.
Coefficient of Variability............... = 0·27 per cent.
Standard error of a determination (mean of duplicates)......................... = ± 0·0012.

An anlysis of variance was made of the results, as shown in Table 2.

TABLE 2.

Analysis of Variance (Specific Gravity of 50 Samples).

Variance.	D.F.	Standard Deviation.	z.
Between samples....................	49	·004993	1·112.
Within samples......................	50	·001643	$n_1 = 49$, $n_2 = 50$.

The value of z is highly significant at the 0·1 per cent. probability level, showing that definite differences in specific gravity exist among the samples.

Owing to the small range of temperature, (15° C.-30° C.), over which determinations were made, the coefficient of expansion could not be estimated with any degree of accuracy. The mean value obtained was $(1{\cdot}5 \pm 0{\cdot}27) \times 10^{-4}$, which is of the same order as that obtained for 60's Merino wool by Speakman, Stott and Chang (1933).

The correlation coefficient between specific gravity and fibre fineness was $+0{\cdot}0049 \pm 0{\cdot}16$, an insignificant value.

The next point investigated was the assertion that wools could be selected according to specific gravity.

A series of samples from stud rams was specially selected in pairs by a leading sheep and wool expert, who presumed that the samples of a pair were similar except for differences in specific gravity. The samples were all grown on the same pasturage.

The results of the determinations are given in Table 3.

TABLE 3.

Pairs.	Presumed of Lower S.G.	Presumed of Higher S.G.	Difference.
1...........................	1·304	*	—
2...........................	*	1·305	—
3...........................	1·309	1·309	0
4...........................	1·310	1·313	+ ·003
5...........................	1·311	1·313	+ ·002

* Samples submitted were to small for a determination.

Only in the case of the fourth pair do the results definitely agree with a view that the samples of a pair have been selected according to specific gravity.

A further set of four samples was selected from another area, all being from the same flock and grown under identical conditions. These were numbered from one to four in decreasing values of specific gravity (i.e. No. 1 highest and No. 4 lowest). The results are given in Table 4.

TABLE 4.

Sample.	Specific Gravity.
Presumed higher 1	1·301
,, ,, 2	1·301
,, ,, 3	1·303
Presumed lower 4	1·301

Table 4 does not support the view that the samples were correctly chosen.

Four more samples were selected and numbered one to four in decreasing values of specific gravity. The results are given in Table 5.

TABLE 5.

Samples.	Specific Gravity.
Presumed higher 1	1·303
,, ,, 2	1·303
,, ,, 3	1·298
Presumed lower 4	1·301

The results of Table 5 show a tendency to support the view that the samples were correctly chosen.

DISCUSSION.

The determination of the specific gravity of fifty-four samples of South African Merino wool showed that real differences in specific gravity occurred. The values varied from 1·298 to 1·313 but the small coefficient of variability shows that specific gravity may be regarded as one of the least variable attributes of Merino wool. As will be seen from Table 1 the samples represented most of the wool-growing areas and even the wool from the experimental animals may be regarded as typical cases occurring in practice. The standard error of the mean of all the samples was $\pm 0 \cdot 0005$, which was so small as to suggest that a fair average for South African Merino wool had been determined.

With regard to the suggestion made by Speakman, Stott and Chang (1933) that the differences in the specific gravity obtained by them for Australian 60's Merino wool and that found by King (1926) may have been due to a difference in the methods of evacuation, it may be pointed out that both values lie within the range obtained for South African Merino wool in this investigation.

It will be noted that the results of Table 3 are all higher than those given in Tables 4 and 5. The samples within each group were grown under identical conditions but the groups themselves represented different areas, so that it is reasonable to suppose that environment or breeding had influenced the specific gravity of the wool. Until further results are available no conclusions can be drawn.

Evidence regarding the assertion that wools can be selected according to specific gravity is inconclusive, and while a larger number of samples is necessary in order to prove or disprove the theory, it appears probable at this stage that the samples had been selected for some other property mistakenly assumed to be specific gravity. This point is now being further investigated.

The specific gravity of clean wool enters into the estimation of fibre fineness in the weight-length method, and has been assumed to have a value of 1·30 (Roberts 1930). By this method the fineness of a sample having a specific gravity of 1·313 will be estimated too low by $\frac{1}{2}$ per cent. or $0 \cdot 1\mu$ in the case of a medium merino wool. Since this error is small compared to that found in the length measurements for the method employed by Roberts, it is evident that variations in the specific gravity are not a serious source of possible error.

Summary and Conclusions.

1. The specific gravity of 54 samples of South African Merino wool from various wool-growing areas was determined. Significant differences occurred among these samples.

2. The mean value was 1·3052 at 25°C., water at 4°C. with a standard deviation of $\pm \cdot 0035$ and a coefficient of variability of $\pm 0 \cdot 27$ per cent.

3. A series of samples presumed to have been selected for differences in specific gravity were analysed. The results were inconclusive.

4. No correlation between the specific gravity and the fibre fineness of the samples was obtained.

5. The influence of variations in specific gravity on the determination of fibre fineness by the weight-length method is discussed.

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