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**PLASMA PROTEIN LEVELS IN
EAST AFRICANS**

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During the course of two independent investigations it was possible to collect some information on the subject of the protein content of the plasma of East Africans. The first of these was carried out during the war and was the survey referred to by Kekwick, Wright and Raper (1), while the second was the African Labour Efficiency Survey of 1947 (2).

The methods of analysis of the plasma from oxalated blood, drawn with suitable precautions from the arm, were the same in both investigations, namely the precipitation of the globulin fraction by Howe's method (3) and the determination of the total protein and albumin nitrogen by macro-Kjeldahl digestion. The non-protein nitrogen was estimated in each case on the Folin-Wu filtrate by digestion and Nesslerization. Analyses were made in duplicate, those for albumin being on filtrates from duplicate precipitations. The subjects in the first group to be examined numbered 44 and were African army personnel of the King's African Rifles (K.A.R.) and were receiving the standard army rations (4). The second group consisted of 29 employees of the Kenya and Uganda Railways and Harbours Administration and are referred to as K.U.R. Africans. They were volunteers from the population amongst which a dietary survey was being carried out and the results of which have been published by Henry and Grant (2).

The following Table 1 gives the mean values, standard deviation and ranges for the results obtained:—

TABLE 1
PLASMA PROTEINS : G. PER 100ML. PLASMA

	K.A.R.	K.U.R.
Number of subjects	44	29
TOTAL PROTEIN:		
Mean	7.02	7.96
Range	5.92—8.50	7.33—8.63
S.D.	0.60	0.37
ALBUMIN:		
Mean	3.74	4.89
Range	2.63—4.67	4.15—5.84
S.D.	0.50	0.50
GLOBULIN:		
Mean	3.28	3.07
Range	1.96—4.54	2.16—4.27
S.D.	0.49	0.53
A/G RATIO:		
Mean	1.17	1.67
Range	0.74—2.12	1.00—2.70
S.D.	0.27	0.45

It will be noted that the mean value for the total protein content for the army personnel is well below that for the Railway employees and that the difference is accounted for by the higher albumin content found amongst the latter. This is clearly seen in Table 2, which gives the numbers of individuals falling into the range groups.

The differing ranges of values for the two groups can readily be seen. Of the 44 soldiers 28 had total protein values and 31 had albumin values which were below the lowest corresponding values for the Railway employees. The figures for globulin contents were, however, so widely scattered over the range 2.00 to 4.50 g. that no difference appears to exist between them in this respect.

It may, therefore, be concluded that the higher total protein content of the blood plasma from the Railway workers is the result of this higher albumin fraction and this, in turn, is reflected in a higher albumin/globulin ratio.

TABLE 2

Total	Albumin	Globulin	MILITARY			RAILWAY		
			Total	Albu- min	Globu- lin	Globu- lin	Total	Albu- lin
Under 5.50	Under 3.50	Under 2.00	0	11	1	0	0	0
5.50—5.74	3.50—3.74	2.00—2.24	0	10	0	0	0	2
5.75—5.99	3.75—3.99	2.25—2.49	3	10	1	0	0	3
6.00—6.24	4.00—4.24	2.50—2.74	5	9	4	0	4	2
6.25—6.49	4.25—4.49	2.75—2.99	1	3	5	0	4	6
6.50—6.74	4.50—4.74	3.00—3.24	4	1	9	0	3	6
6.75—6.99	4.75—4.99	3.25—3.49	2	0	8	0	6	2
7.00—7.24	5.00—5.24	3.50—3.74	13	0	10	0	6	6
7.25—7.49	5.25—5.49	3.75—3.99	8	0	3	3	1	1
7.50—7.74	5.50—5.74	4.00—4.24	3	0	2	5	3	0
7.75—7.99	5.75—5.99	4.25—4.49	4	0	0	10	2	1
Over 8.0	Over 6.0	Over 4.5	1	0	1	11	0	0

On the subject of the diets consumed by the two groups only generalized information is available but a comparison is possible between the data for the survey findings for the population of 500 Railway employees whose consumption of food was studied (2, p. 103) and the amounts of nutrients estimated to have been supplied to the soldiers in their army rations (4, p. 209). The available information is as given in Table 3:—

TABLE 3
NUTRIENT VALUES OF DIETARIES

	K.A.R.	K.U.R.
Calories	3,113	2,808
Protein g.	119	92
Fat g.	68	53
Carbohydrate g.	557	491
Calcium mg.	654	602
Iron mg.	27	36
Vitamin A i.u.	3,887 i.u.	475
Carotene micro-g.	including carotene	5,724
Aneurin mg.	1.54	2.24
Nicotinic acid mg.	21	16
Ascorbic acid mg.	93	*20

*After allowance for cooking losses.

A close similarity between the diets of the two groups lay in their being based upon the staple cereal maize. The daily ration to the soldiers was one pound of the flour and the survey showed that the Railway workers were consuming nearly the same amount. The marked difference existing between the groups was in the amounts of meat consumed. A regular supply of 8 oz. per day was available for the soldiers but the Railway employees were much more irregular in their use of it and the average daily amount was found to be under 3 oz. Yet these Railway workers showed a total plasma protein content which was significantly greater than that of the military personnel.

If, for comparison, we take the very complete summary of data issued by the Bureau of Nutrition Surveys in 1945 (5) and exclude the results obtained by the refractometric, tyrosine, specific gravity and biuret methods, we find mean values quoted for 19 groups of subjects which are not specifically mentioned as including females and which we have assumed to consist entirely of males. The average, in turn, of these means is 6.96 g. per 100 ml. serum or plasma for total protein content. Similarly for albumin there are quoted in the tables 11 sets of data which give an average of 4.68 g. per cent. It appears that, in comparison with these results, the mean value for the total protein for the K.A.R. is almost identical while that for the K.U.R. Africans is a gram higher. The albumin fraction is, in comparison, nearly a gram lower in the case of the K.A.R. while that of the Railway workers is rather higher.

If we carry this comparison a step further and use the means for the sets of data where both total protein and albumin values are given in the Bureau's tables we find for the 11 sets an average total protein of 7.10 g. corresponding with the albumin of 4.68 g. per cent. These give, by difference, a globulin value of 2.42 g. and an A/G ratio of 1.93. Both the K.A.R. and the K.U.R. groups had mean globulin values which were in excess of this value of 2.42 g. and their resulting ratios, 1.17 and 1.67 respectively, are lower than that of 1.93 arrived at by this calculation.

Reports on the protein content of the plasma of Africans are not very numerous. Quinton and Barnes (6) studied 68 healthy adult Bantu labourers in the Witwatersrand goldfields and found minimum, mean and maximum figures for total protein of 5.6, 7.3 and 9.1 g., for albumin 2.8, 4.5 and 6.0 g., and for globulin 1.6, 2.8 and 4.9 g. per cent. In West Africa Mohun (7) examined sera from 30 young adult Africans who were serving with the forces in the Gold Coast and obtained corresponding values 6.0, 7.21 and 8.2 g. for total protein, 2.1, 3.45 and 4.4 g. for albumin, and 2.9, 3.76 and 4.8 g. for globulin, and the outstanding result appeared to be the excess of globulin over albumin with an albumin/globulin ratio of less than one. This author gives no indication of his subjects' periods of service. Other workers in that same region have been Stephen (8) and Barakat and Smith (9), who have dealt with West Africans, the former also in the Gold Coast and the latter in Gambia, but who have examined only the total protein content of the plasma. Stephen included recruits with six weeks' service as well as older soldiers of six to eight months' and two or more years' standing but drew no conclusion with regard to the effects of length of service. His means were 7.8, 7.4 and 7.2 g. and ranges 6.8-9.2, 6.1-8.6 and 6.1-8.3 g. for these three groups respectively, and it is of interest, in view of the work of Hynes, Ishaq and Morris (10), to note that the recruits in West Africa showed the highest mean. On the basis of their work in India with recruits who had been receiving army rations for from one to four weeks, these latter authors have shown that "the recruit, fresh from a life of extreme poverty on a grossly protein-deficient diet, has a serum protein level higher than that of the trained soldier". For his civilian group, however, Stephen found a range from 6.3-8.6 g. and a mean of 7.5 g., neither differing to any appreciable extent from the corresponding figures for his military personnel. Villagers in two places in Gambia have been reported by Barakat and Smith (*loc. cit.*) to have higher mean values of 7.70 and 7.94 g. per cent total protein.

For Africans in Belgian Congo two sets of data have been published but comparison of our results with them is difficult because of the system of recording which has been used in the first investigation and the method of sampling employed in a part of the second. Van den Berghe and Vander Borgh (11) in their earlier communication give the number of cases with a plasma level above 7.7 g. as 45 in a series of 511 or 8.8 per cent of the total while, in their later publication (12), they state that 97 of a total of 511 or 19 per cent of their cases were above a normal range 6.5-8.0 g. per cent. The second set of data from

Belgian Congo is given by Symul (13) who, however, worked with two batches of material, the one being ten lots of pooled sera and the other individual samples from policemen. His mean figures for these two sets were, for total protein 6.365 and 6.144 g., for albumin 2.755 and 2.754 g., and for globulin 3.611 and 3.389 g. per cent. Twenty selected policemen, chosen as having normal liver function, protein not less than 5 g. and an albumin/globulin ratio greater than 0.75 gave mean values of 5.977 g. for total protein, 2.934 g. for albumin and 3.043 g. for globulin. For these subjects in Belgian Congo the mean albumin/globulin ratio in each group was less than one, a finding similar to that of Mohun (loc. cit.) in the Gold Coast.

Nearer to Kenya Lehmann (14), working in Uganda, found a mean of 7.17 g. for total protein, 4.97 g. for albumin and 2.20 g. for globulin in plasma from 34 well-to-do Africans.

Comparing these sets of data with our own, even although they have been obtained by a variety of analytical procedures, we find that our mean figure of 7.02 g. for total protein in the K.A.R. is similar to, but slightly lower than, first of all that for West African soldiers (Mohun and Stephen for long-service men), secondly that of the South African Bantu living on an institutional dietary (Quinton and Barnes) and, in the third place, Uganda Africans who were living well (Lehmann). It is not as low, however, as the mean for selected policemen whose feeding was under supervision but who were living in an unaccustomed environment in Belgian Congo (Symul). Our civilian Railway workers' mean of 7.96 g. is comparable with that of West African villagers in Gambia (Barakat and Smith). The difference between the levels of albumin in our two groups is marked, that of the soldiers being the lower, but in neither does the mean albumin/globulin ratio fall below one as has been reported in West Africa (Mohun) and in Belgian Congo (Symul). Of the 44 soldiers whose plasma we examined 13 did show a ratio less than one while none of the K.U.R. civilians did so. While we may only speculate upon the various changes that take place in the African's mode of life when he exchanges his village existence for institutional conditions and so long as the evidence of change, such as it is, can be regarded only as circumstantial since it refers to different groups of Africans and not to individuals who have served both as control and as experimental subjects, the need appears to be for more information collected under suitably controlled conditions.

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