Table IV. Results of Use of Duncan's Multiple Range Test of Significance

Vegetable	Form of Soil Selenium	Mean[a] Selenium Content, P.P.M.		Vegetable	Form of Soil Selenium	Mean[a] Selenium Content, P.P.M.	
Cabbage	Selenate	159.7	a	Bean (dry)	Selenate	47.0	f g h i j
Broccoli	Selenate	155.0	a	Pea (L.M.)	Selenate	46.5	f g h i j
Cabbage	Organic	150.3	a	Eggplant	Organic	45.0	f g h i j
Spinach	Organic	114.0	b	Rutabaga	Organic	43.0	g h i j
Onion	Organic	103.0	b c	Cucumber	Organic	41.0	g h i j k
Pea (L.M.)	Organic	101.0	b c	Tomato	Organic	40.0	g h i j k
Swiss chard	Organic	100.0	b c	Rutabaga	Selenate	37.0	g h i j k l
Bean (green)	Organic	95.5	c	Tomato	Selenate	36.0	h i j k l
Radish	Organic	93.0	c	Radish	Selenate	36.0	h i j k l
Spinach	Selenate	89.0	c d	Potatoes	Organic	35.0	h i j k l
Broccoli	Organic	81.7	d e	Parsnip	Selenate	35.0	h i j k l
Swiss chard	Selenate	76.0	d e	Beets	Selenate	33.0	i j k l
Okra	Organic	73.0	e	Eggplant	Selenate	32.0	i j k l
Bean (green)	Selenate	72.5	e	Carrots	Organic	32.0	i j k l
Onion	Selenate	58.0	f	Beets	Organic	28.0	j k l
Pea (L.P.)	Organic	58.0	f	Lettuce	Selenate	23.5	k l
	Selenate	52.5	f g	Carrots	Selenate	23.0	k l
Beans (dry)	Organic	51.0	f g h	Parsnip	Organic	21.0	k l
Okra	Selenate	50.0	f g h i	Potatoes	Selenate	19.0	l
Lettuce	Organic	48.0	f g h i	Cucumbers	Selenate	18.0	l

[a] Any means indicated by the same letter are not significantly different ($P < 0.05$).

it into organic selenium compounds. They appear capable of absorbing selenium that was a part of organic compounds when added to the soil. The exact chemical nature of the selenium at the time of absorption is not known; however, selenium is readily absorbed, metabolized, and stored in the plant tissues as a part of organic and inorganic compounds. The ability of vegetables to absorb, metabolize, and store selenium in their tissues emphasizes the need for location of the vegetable garden or field on soil that is free of available selenium.

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GAME ANIMALS AS MEAT SOURCES

Vitamin Content and Amino Acid Composition of Some African Game Animals

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During the symposium on the Conservation of Nature and Natural Resources in Modern African States held in Arusha in September, 1961, great interest was shown in the possibility of game ranching and cropping as a source of valuable protein for human nutrition. Many papers gave figures on the efficiency of wild life compared to domestic animals in the utilization of vegetation in the semiarid, unimproved areas. Quoted yields of meat per beast and the ratio of meat to fat and moisture were given much thought (*4–7, 12*). In view of the possibility of game becoming a marketable meat supply, research work was organized to determine the amino acid and vitamin composition of the four species of animals likely to be cropped in East Africa. These are the Elephant (*Loxodonta Africana*), Wildebeeste (*Gorgon taurinus*), Zebra (*Equus burchelli*), and Kongoni (*Alcelaphus cokei*). For purposes of comparison, an analysis of the indigenous African zebu, grazing in the same area as the wild animals, was also made.

Experimental Procedure

Collection of Specimens. To ensure accurate results, almost all animals were

The vitamin and amino acid content of five species of African animals (elephant, wildebeeste, zebra, kongoni, and zebu cattle) was determined, and comparison made within the group as well as with American beef, mutton, and pork. While the results cannot be considered conclusive since only one specimen of each species was analyzed, all five species showed an amino acid composition similar to beef, mutton, or pork, but a much higher vitamin content than meat from animals living in temperate zones. Within the group, the elephant and zebu cattle showed a higher content of essential amino acids than the kongoni, wildebeeste, and zebra. These findings are believed to be the first of their kind ever published.

Table I. Vitamin Content per 100 Grams of Product

Samples	Thiamine B_1, Mg.	Riboflavin B_2, Mg.	Vitamin B_6, Mg.	Nicotinic Acid, Mg.	Pantothenic Acid, Mg.	B_{12}, μg.
Zebra	0.15	0.8	3.3	32	1.25	4
Kongoni	0.24	1.5	2.1	25.5	2.70	9
Wildebeeste	0.40	1.35	2.75	31	2.95	10
Zebu	0.15	0.9	1.7	25.5	2.10	11.3
Elephant	0.12	0.6	1.3	17	...	3.8
Beef (round) on dry matter (*1*)	0.27	0.57	1.23	15.7	3.33	6.67

Table II. Amino Acid Composition of Game Meats Compared with Beef Mutton, and Pork

Amino acids expressed as grams per 16 grams N

	Elephant	Kongoni	Wildebeeste	Zebra	Zebu	Beef[a]	Mutton[a]	Pork[a]
Protein (N × 6.25) %	81.00	83.44	81.88	80.50	74.06			
AMINO ACIDS ESSENTIAL TO ADULT MAN								
Isoleucine	5.33	4.50	4.54	4.53	5.24	5.23	5.18	5.14
Leucine	8.31	7.67	7.34	6.20	8.67	8.19	7.74	7.36
Lysine	10.44	8.28	8.45	8.43	10.02	8.74	8.10	8.21
"Available" lysine	9.6	8.3	7.6	9.3	8.9			
Methionine	2.74	2.04	2.26	2.03	2.96	2.48	2.40	2.50
Phenylalanine	4.55	4.32	4.11	4.50	4.98	4.11	4.06	3.94
Threonine	4.45	4.16	3.80	4.19	4.33	4.42	4.58	4.64
Tryptophan	1.04	1.05	1.07	1.08	1.07	1.17	1.30	1.30
Valine	5.47	2.38	4.46	4.73	5.26	5.55	4.93	5.20
ADDITIONAL AMINO ACIDS PROBABLY ESSENTIAL TO CHILDREN								
Arginine	6.85	7.02	5.73	6.84	6.96	6.45	6.51	6.13
Histidine	4.14	4.02	3.37	5.15	4.34	3.47	2.78	3.46
NONESSENTIAL AMINO ACIDS								
Alanine	6.60	6.74	6.03	7.11	6.66	5.78	5.58	4.64
Ammonia	2.29	2.07	2.35	2.04	2.41			
Aspartic acid	8.94	9.54	8.13	8.59	9.24	9.33	9.22	9.47
Cysteine (calculated as cysteic acid)	1.93	1.78	1.44	1.24	2.31	1.26	1.32	1.17
Glutamic acid	16.05	16.26	13.03	15.47	15.79	15.15	15.17	15.30
Glycine	5.49	7.20	5.26	6.12	4.19	6.19	5.84	4.96
Hydroxyproline	...	...	...	...	...			
Proline	4.84	4.44	3.75	4.26	3.81	4.93	4.62	4.42
Serine	3.98	4.32	3.43	4.12	3.99	4.19	4.00	4.06
Tyrosine	3.78	3.33	3.28	3.75	4.06	3.39	3.47	3.57

[a] Taken from "Amino Acid Content of Foods," Home Economics Research Report No. 4, U.S. Dept. of Agriculture, 1957.

shot on the same day, at a time when luscious grazing was available after the long rainy season. With the exception of the elephant, which was shot near Voi, some 200 miles east of Nairobi, the animals were all shot in Masailand, within a radius of 50 miles of Nairobi. Great care was taken to deliver the meat as soon (and, therefore, as fresh) as possible to the Veterinary Research Laboratory.

Soon after being shot, each animal was bled, after which its skin was slit open and a specimen weighing about 2 pounds was cut from the gluteal region. Each specimen was wrapped in polyethylene sheeting and placed in a large vacuum flask on a layer of dry ice. With the exception of the elephant meat which was delivered to the laboratory by air, the specimens were brought there by car for freeze-drying.

Lyophilization of the Game Meat Samples. Approximately 1-pound samples of the meats were cut into slivers and minced in a sterile household mincer. They were then freeze-dried in Edwards High Vacuum Ltd. 30 PI machines, the minced samples being loaded to a minimum depth in the aluminum foil-lined carriage plates. The machines were evacuated with the refrigerated coil condensers operating at −50° C. Pirani gauge readings were taken at intervals, no heat input being used and the external temperature of the chamber being 22° to 25° C; after 24 hours the Hg reading was 0.07 mm., and after 30 hours 0.068 mm.

After freeze-drying, each sample was divided in half and packed as quickly as possible into two wide-mouthed, screw-capped jars. The necks were sealed by dipping in molten paraffin wax. One jar of each specimen was dispatched by air to the Tropical Products Institute in London for amino acid estimation, and the other to Afico S.A. of Vevey, Switzerland, for vitamin analysis.

Vitamin Analysis. Thiamine was determined by the method of McIntire *et al.* (*9*) and the Association of Vitamin Chemists (*10*); Riboflavin by the method of McIntire *et al.* (*8*) and Snell and Strong (*13*); vitamin B_6 by the method of Atkin *et al.* (*3*) and Rabinowitz and Snell (*11*); nicotinic acid by the method of McIntire *et al.* (*8*) and Snell and Wright (*14*); pantothenic acid by the method of Toepfer *et al.* (*15*); and vitamin B_{12} by the method of the Analytical Methods Committee (*2*) and Ledger (*6*).

Results and Discussion

The findings shown in Tables I and II are believed to be the first of their kind ever to be published. While they will not affect any game policy, they do contribute to our knowledge of the meat composition of these different species, which have not hitherto been studied from this point of view.

Vitamin Content. From Table I it is possible to assume that the levels of most vitamins in the meat of the game and the idigenous cattle are higher than in American beef (*1*). Caution must be

used in interpretation as these samples were immediately frozen and freeze-dried, while the figures of meat are from samples whose pretreatment prior to analysis is unknown.

Amino Acids. In general, none of the game meats tested differs significantly from beef, mutton, and pork in the levels of essential (and nonessential) amino acids; i.e., the nutritional value, as far as the protein is concerned, of any of these meats is at least as high.

The same cautionary remarks regarding pretreatment of samples prior to analysis must be applied when comparing these figures with those of beef, mutton, or pork. However, comparison within the group, elephant, kongoni, wildebeeste, zebra, and zebu, where the samples were treated exactly the same, is more valid. This shows that elephant and zebu cattle have higher content of essential amino acids than kongoni and wildebeeste.

In addition, lysine levels in elephant and zebu meat are unusually high. This may be an asset from the nutritional point of view, especially where lysine is comparatively low in the staple foods.

The level of available lysine in elephant meat, 9.6, is a higher value than anything previously encountered in meat protein.

Admittedly only one sample of each was analyzed, but the figures are suggestive that both elephant and zebu cattle are superior to the other ungulate animals and also may be superior to the domesticated animals in supplying essential amino acids. Further research is required to confirm the results.

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COFFEE CONSTITUENTS

Isolation and Characterization of Cellulose in the Coffee Bean

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The main polysaccharide of the green coffee bean is an insoluble, hard (1 → 4)-β-D-mannan. If this is removed by formic acid hydrolysis, there is left a glucan which is shown to be cellulose in an amount equal to 5% of the green coffee bean (dry basis). Proof for cellulose was solubility in cuprammonia, hydrolysis to glucose, and acetolysis to β-cellobiose octaacetate. The procedure for the last, as a test for cellulose, has been improved.

THE first publication from this laboratory on the carbohydrates of green coffee (*8*) reported that there was little, if any, cellulose present in the bean. The authors now wish to report the results of definitive experiments which prove conclusively the presence of cellulose in significant amounts. The previous failure to establish cellulose was based upon its apparent lack of cuprammonium solubility, due, it is believed, to interference by the encrusting β-D-(1 → 4)-mannan (*6*).

Crude Cellulose Fraction Isolation

As previously described (*8*), ground green coffee beans (Santos 4's) were extracted with ethanol-water (80 to 20). The insoluble residue was extracted successively at room temperature with benzene-ethanol (2 to 1) and thrice with water, then twice at 90° C. with 0.5% ammonium oxalate, to yield 48% of a gray residue. The holocellulose was prepared from this residue, essentially according to the modification by Whistler and associates (*4*) of the procedure of Wise and coworkers (*5*) by treatment with aqueous, acidified sodium chlorite (pH 4.5 to 5.0) under nitrogen at 75° C. for 1.5 hours; yield 42% (dry basis). This material, after extraction with 10% potassium hydroxide, was previously (*8*) reported to contain the following amounts of constituent sugars: D-glucose, 17.8%; D-mannose, 48.5%; D-galactose, 14.8%; L-arabinose, 6.0%, all as determined by acid hydrolysis and quantitative papergram densitometry.

An amount of 40 grams of this material (the holocellulose) was extracted for 4 days with hot formic acid (90%) in a Soxhlet extractor fitted with a coarse, sintered-glass funnel. The formic acid was removed from the residual "holocellulose" by evaporation under reduced pressure, followed by the addition and removal of water by distillation under reduced pressure. A colorless solid was obtained on freeze-drying; yield 9.0 grams (22.5%), ash (sulfate) <1%. Treatment of cotton linters in the same manner for 4 days resulted in a weight loss of ~20%.

Assay of Glucose in Formic Acid Residue

A 0.500-gram sample of the formic acid residue was added to 75 ml. of