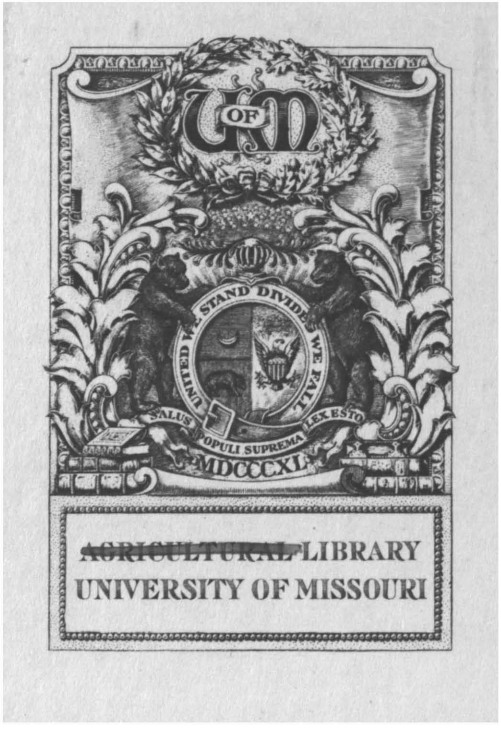

A COMPARISON OF THE ASH OF THE NEW-BORN CALF WITH THAT OF THE FULL-GROWN STEER

by

William Brock Connell, B. S.

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P. F. Trowbridge

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Historical

These analyses of the mineral constituents of bovine feti are a continuation of the work done by Mr. E. E. Vanatta[1] and Mr. A. G. Hogan[2] on a special investigation by the Agricultural College of the University of Missouri. A lengthy discussion of the literature would be a useless duplication. However, a brief review of some of the work previously done would not be amiss. Messrs. Vanatta and Hogan gave the results of investigations on the composition of the ash of dogs, birds, human, horse, cows, and other animals. Of new born animals, work has been done on the human fetus, guinea-pigs, rabbits, etc. All this work, however, can have very little particular bearing upon the composition of the ash of the new born calf, as it has been demonstrated that not only species but also breed effects the composition of the entire animal including the mineral constituents. Following is the analysis of various bones as given by Zalesky[3]:

	Man	Ox	Tortoise	Guinea-pig
Calcium phosphate	83.89	86.09	85.98	87.38
Magnesium "	1.04	1.03	1.36	1.05
Calcium combined with Cl, CO_2, Fe	7.65	7.36	6.32	7.03
Carbon dioxid	5.73	6.20	5.27	----
Chlorine	0.18	0.20	----	0.13
Fluorine	0.23	0.30	0.20	----

To illustrate the varying mineral composition of the muscular tissue the following results of analyses by Hofmann[4] are given:

	Mammals
P_2O_5	0.34-0.48%
K_2O	0.30-0.40%
Na_2O	0.03%
CaO	0.02%
MgO	0.04%
NaCl	0.004-0.01%
Fe_2O_3	0.004-0.01%

Rutherford and Hawk[5] in investigating the sulphur content of human hair found that it was higher in men than in women, and also that red hair contains more sulphur than any other color, irrespective of race and gender. The amount of iron oxide in 1000 grams of the ash of human hair varies between 43.3 grams in bland and 108.7 grams in brown hair (Baudrimont[6]). According to Gautier and Bertrand[7] arsenic also occurs in the hair, nails, etc. Gautier says that arsenic is of importance in the formation and growth of the hair and nails.

Prochownick[8] states that the greatest amount of the solids of amniotic fluid in women consists of salts, the quantity of chlorides (NaCl) being 0.057 to 0.066 per cent.

Experimental

Two calves were used in the analysis. The first, a pure bred Hereford, was carried until two weeks over due and strangled at birth. The weight of the calf was 88 pounds 4 ounces. (The calf was from cow No. 560, Adams Fund Experiment).

The calf was prepared for analysis as soon as possible. One half the body was skinned and the abdominal and thoracic cavities were opened on the median ventral line. The internal organs were removed and weighed separately. All blood and other body fluids were collected as carefully as possible. The solid contents of the large intestines were removed and weighed separately as dung. The flesh was next removed from the bones as nearly as possible. The fat could not be separated, except the kidney fat, as there was so little of it. The various organs separated and weighed are given in the table below.

Division of Animal

Organ	Weight gms.
Brain	218
Gall bladder	10
Spleen	92
Liver	902
Rumen	113
Reticulum	21
Omasum	60
Abomasum	233
Esophagus	91
Kidney	311
Pancreas	41

Large intestine	227
Small intestine	654
Spinal cord	130
Contents large intestine	855
Body fluids	1932
Contents of small intestine	164
Skin 1/2	2295
Flesh 1/2	9590
Bone 1/2	4626
Total	39,176 grams

Calculating back to the total weight the result is 87.9 pounds. The weight before dissection was 88 pounds 4 ounces. The loss in weight was probably due to evaporation, loss of some body fluids, etc. This error amounted to 0.04 per cent. The following samples were prepared for analysis:

Lab. No.	Substance
13-9-5	Flesh and all soft parts
13-9-6	Bone, including hoofs and teeth
13-9-7	Hide and hair
13-9-8	Dung

The second foetus upon which an analysis was run was a pure bred Jersey. The cow (No. 13) was 5 years, 3 months old, and was slaughtered in January 1914. The foetus was 7 months and 24 days old, weighing 30 pounds. The method of dissection was different in that the various organs were not separated.

Except for the dung the entire calf went into one composite sample. Separate samples were made of the dung and amniotic fluid. The following samples were prepared for analysis.

Lab. No.	Substance
14-1-33	Composite of flesh, bone, hair and hide
14-1-33X	Dung
14-1-34	Amniotic fluid

Preparation of Sample

The flesh and soft parts were cut up into strips and passed through the coarsest grinder of the Excelsior sausage mill. This operation was repeated and the sample quartered down. It was then passed twice through the next size grinder. It was mixed and quartered after passing through each size grinder. The bone was ground in the bone mill as fine as possible. All samples were preserved on ice in tightly covered weighing bottles. Each of the samples was analyzed for moisture, fat, nitrogen, ash, phosphorus, total sulphur, and total chlorin, except no total sulphur, phosphorus or total chlorin was run in the case of the amniotic fluid. All determinations of nitrogen, fat, phosphorus, etc., were made in triplicate. The following amounts of sample were preserved for use in the mineral analysis:

13-9-5	Flesh	2000 grams
13-9-6	Bone	1000 "
13-9-7	Hair and hide	1000 "
13-9-8	Dung	865 "
14-1-33	Composite flesh	1000 "

14-1-33X Dung 63

14-1-34 Amniotic fluid 1000 c.c.

Moisture and Fat

The moisture and fat determinations were run in S. & S. paper extraction shells. The shells were first plugged with a liberal amount of fat free cotton and dried in a water oven for 3 to 4 hours at 105° C. They were removed to a vacuum desiccator which was exhausted, when they were quickly transferred to a weighing bottle contained in a desiccator. A counter-balanced weighing bottle was used to weigh after transferring from the bottle in the desiccator.

A large part of the cotton was removed from the tube and spread over a piece of smooth clear glass. A sample of from one to two grams was then weighed from the weighing bottle, and thoroughly incorporated with the cotton. Care was taken to get as little as possible on the glass. A small portion of the cotton was reserved to wipe up any of the sample upon the plate. The entire cotton was replaced in the tube. The tube was placed in a vacuum desiccator containing fresh sulphuric acid. The desiccators were exhausted and rotated at frequent intervals. At the end of 3 days the acid was changed. The tubes remained under vacuum until they had reached constant weight. The weight of tube was already known. The weight of sample plus tube minus the weight of sample plus tube dry gave the loss in weight or moisture. The same samples and tubes were used for fat determination. After the moisture weights had been taken the tubes were extracted for 16 hours in a Soxhlet fat extractor with dry ether.

The loss in weight or ether extract was called fat.

In the case of the bone the sample was weighed out in 100 c.c. evaporating dishes. This was done for the reason that the bone could not be ground fine enough to assure a uniform sample. By taking 50 gram samples this error due to sampling was reduced. The bone was dried in vacuum desiccators to constant weight.

Moisture

Sample	Weight of Sample	Weight of Moisture	Per cent of Moisture	Average % Moisture
Flesh and soft parts 13-9-5	5.0100	3.8743	77.330	
	2.9238	2.2603	77.307	77.549
	3.8427	2.9977	78.010	
Bone 13-9-6	55.5365	34.2558	61.321	
	58.3011	36.3238	62.030	61.817
	53.0239	32.9278	62.100	
Hair and hide 13-9-7	4.2594	2.9680	72.172*	
	3.8288	2.3774	62.090	63.34
	3.5812	2.3200	64.590	
Composite of animal 14-1-33	3.8535	3.0305	78.600	
	4.0730	3.2122	78.800	78.66
	4.2228	3.3188	78.600	
Amniotic fluid 14-1-34	1004.0000	987.0608	98.22	98.22

Fat

Sample	Weight of Sample	Weight of Fat	Per cent of Fat	Average % Fat
Flesh and soft parts 13-9-5	5.0100	0.2480	4.73	
	2.9238	0.1315	4.50	4.57
	3.8427	0.1892	4.49	
Bone 13-9-6	55.5365	1.5550	2.80	
	58.3011	1.5272	2.75	2.78
	53.0239	1.4899	2.81	
Hair and hide 13-9-7	4.2594	0.0274	0.643	
	3.8288	0.0205	0.535	0.586
	3.5812	0.0207	0.580	
Composite of animal 14-1-33	3.8535	0.0990	2.54	
	4.0730	0.1021	2.50	2.56
	4.2228	0.1116	2.64	

*Thrown out of average.

Ash and Phosphorus

About 10 or 12 grams were weighed out for ash and phosphorus determinations. The samples were heated in porcelain crucibles at first under a very low flame and then raised to a faint red heat. The heating was continued until constant weights were obtained. Care was taken that the organic matter did not froth over the sides. The heat should not be high enough to cause volatilization of salts.

After obtaining the weight of the ash, the phosphorus in each sample was determined as follows. The crucible and ash content were placed in a 150 c.c. beaker, 20 c.c. nitric acid and 10 c.c. hydrochloric acid with 25 c.c. water being added. The beaker was then heated on the hot plate until all the hydrochloric acid had been driven off and the solution was clear. This was then filtered into a 250 c.c. beaker, neutralized with ammonium hydroxid and again made slightly acid with nitric acid. After adding 15 grams of ammonium nitrate the beaker was placed in a water bath at 65° C.; 100 c.c. of acid ammonium molybdate was then added and the beaker was allowed to stand one hour. This was then filtered, the precipitate washed by decantation and on the filter with a 10 per cent solution of ammonium nitrate.

The beaker containing the filtrate was replaced by the beaker in which the original precipitation occurred and the precipitate was dissolved on the funnel and washed into the beaker with 2.5 per cent hot ammonium hydroxid. The solution was made slightly acid with hydrochloric acid and again made slightly alkaline with ammonia. After cooling the phosphorus was precip-

itated by adding magnesia mixture drop by drop. In 15 minutes 12 c.c. of concentrated ammonia were added. After standing over night the precipitate was filtered off, washed with 2.5 per cent ammonia, ignited in a porcelain crucible to $Mg_2P_2O_7$ and weighed. The phosphorus is calculated as P_2O_5.

Ash

Sample	Weight of Sample	Weight of Ash	Per cent of Ash	Average % Ash
Flesh and soft parts 13-9-5	13.3840 15.4135 15.4620	0.1240 0.1323 0.1408	0.927 0.859 0.911	0.899
Bone 13-9-6	55.5365 58.3011 53.0239	7.8861 8.3953 7.5824	14.20 14.40 14.30	14.30 fresh basis 31.13 dry basis
Hair & hide 13-9-7	8.3775 9.2640 8.9353	0.0685 0.0729 0.0729	0.818 0.777 0.815	0.803
Excreta 13-9-8	865.0000	3.2000	0.370	0.370
Composite of animal 14-1-33	18.3814 19.3003 18.5720	0.5790 0.6214 0.5887	3.15 3.22 3.17	3.18
Excreta 14-1-33X	63.0000	0.617	0.980	0.980
Amniotic fluid 14-1-34	1004.0000	5.4970	0.504	0.504

Phosphorus Anhydrides

Sample	Weight of Sample	Weight of $Mg_2P_2O_7$	Weight of P_2O_5	% P_2O_5	Average % P_2O_5
Flesh and soft parts 13-9-5	13.3840	0.0694	0.0445	0.333	
	15.4125	0.0756	0.0485	0.315	0.343
	15.4620	0.0919	0.0589	0.381	
Bone 13-9-6	0.5000	0.1185	0.0760	15.21	15.226 dry basis
	0.5000	0.1179	0.0756	15.12	5.656 fresh "
	0.5000	0.1196	0.0767	15.35	
Hair & hide 13-9-7	8.3775	0.0172	0.0110	0.131	
	9.2640	0.0234	0.0150	0.162	0.149
	8.9353	0.0215	0.0138	0.155	
Composite of animal 14-1-33	18.3814	0.2574	0.1654	0.900	
	19.3003	0.2587	0.1663	0.862	0.887
	18.5720	0.2316	0.1485	0.800	

Nitrogen and Protein

The nitrogen determination was run by the usual Kjeldahl method. From .5 to 1.0 gram of the sample was introduced into a 500 c.c. Kjeldahl flask, 25 c.c. of concentrated sulphuric acid added together with about 0.7 gram of mercury. This was carefully heated at first until frothing ceased. Especial care had to be taken with fatty material. About 10 grams of potassium sulphate were then added and boiling continued until the solution was colorless. The neck of the flask was then washed down with a small amount of nitrogen free water and the boiling was continued for one half hour. The flask was allowed to stand until cool, when a small lump of paraffine and a piece of granulated zinc were added to prevent frothing and bumping. Ninety c.c. of concentrated sodium hydroxid containing potassium sulphid was then added. The flask was immediately connected with the condenser and the ammonia distilled into standard hydrochloric acid. After about 300 c.c. had distilled over the receiving flask together with the

adapter was rinsed with nitrogen free water. The excess acid in the receiver was titrated back against standard ammonium hydroxid, using cochineal as an indicator. The protein was obtained by multiplying the nitrogen per cent by the protein factor, 6.25.

Nitrogen & Protein

Sample	Weight Sample	c.c. HCl used	Wt. Nitrogen	% Nitrogen	Av. % Nitrogen	Av. % Protein
Flesh and soft parts 13-9-5	0.9548	17.37	0.0240	2.51		
	1.7883	13.30	0.01838	----	2.82	17.62
	0.9624	21.86	0.03021	3.13		
Hair and hide 13-9-7	1.6360	61.20	0.08457	5.16		
	1.6022	59.72	0.08253	5.15	5.155	32.218
	1.6064	56.62	0.07794	----		
Composite animal 14-1-33	3.6820	48.48	0.06573	1.78		
	6.9430	110.57	0.14993	2.15	1.96	12.26
	Lost	--- -	----	-----		
Amniotic fluid 14-1-34	15.0739	315.83	0.029166	0.190		
	Lost	------	--------	------	0.192	1.20
	15.0739	316.58	0.029366	0.194		

Recapitulation of Analyses of Fresh Material.

	% H_2O	% Fat	% Ash	% P_2O_5	% Nitrogen	% Protein
Flesh & soft parts 13-9-5	77.549	4.57	0.899	0.343	3.82	17.62
Bone 13-9-6	61.817	3.78	Fresh 14.30 Dry 21.13	Fresh 5.656 Dry 15.226	----	----
Hair & hide 13-9-7	63.340	0.586	8.03	0.149	5.155	32.218
Composite animal 14-1-33	78.660	2.560	3.18	0.887	1.96	12.26
Amniotic fluid 14-1-34	98.220	-----	0.504	-----	0.192	1.200

Total Sulphur

For the determination of total sulphur large samples were weighed out in triplicate in porcelain crucibles, dried for a week in the water oven, powdered in an agate mortar. Portions were then weighed out for the determination of total sulphur by the Osborne method as follows. Ten grams of sodium peroxid were placed in a 250 c.c. nickel crucible and water added slowly until reaction was complete. The crucible was then heated until all water was expelled, as indicated by the formation of a scum at the edges. After cooling to a pasty consistency the sample was

rapidly added and thoroughly mixed with a platinum stirring rod. Heat was then applied until there was little tendency to froth. This required about one half hour. Sodium peroxid was then added in small quantities. Flashing or flaming indicated that there was too much sodium peroxid present and the addition was discontinued. When no more flashing occurred the mixture was heated to red heat and then allowed to cool. The crucible was then placed in a 600 c.c. beaker and hot water added carefully. The contents were acidified with hydrochloric acid and after solution was complete the liquid was boiled to drive off excess chlorine. The solution was filtered hot and the filter paper washed free from chlorides. The filtrate was neutralized with ammonium hydroxid, made acid again with hydrochloric acid (4 c.c.) and evaporated to about 400 c.c. An excess of hot 10 per cent barium chlorid was added drop by drop with stirring. The solution was kept on the hot plate for 30 minutes and then allowed to stand over night. The precipitate was filtered off, washed with hot water until free from chlorids, dried, ignited and weighed as barium sulphate. The results were calculated to per cent sulphur.

Total Sulphur as SO_3

Sample	Weight Sample	Wt. $BaSO_4$	Wt. SO_3	% SO_3	Av. % SO_3
Flesh & soft parts	1.000	0.0235	0.0123	1.23	1.20
13-9-5	1.000	0.0223	0.0117	1.17	
Composite animal	1.000	0.0471	0.0162	1.62	1.58
14-1-33	1.000	0.0448	0.0154	1.54	

1.20% on dry basis is equivalent to 0.33% on fresh basis.
1.58% " " " " " " 0.365% " " "

Total Chlorine

A hard glass tube sealed at one end, about 36 inches long and 1/2 inch in diameter was used in the determination of chlorine. The powdered sample was mixed with about five times its weight of powdered calcium oxide. A little calcium oxide was placed in the bottom of the tube, the sample plus calcium oxide placed on top of this and then more calcium oxide was added. The tube was placed in a combustion furnace tilted at an angle of 15° from the horizontal and ignited. The burners were first lighted under the calcium oxide near the open end of the tube and then under the sample. When carbonization was complete the tube was cooled, the contents transferred to an 800 c.c. beaker, and hot water added. The substance both in the beaker and on the filter was washed by decantation and on the filter with hot water until free from chlorids. The filtrate was acidified with nitric acid and evaporated to about 300 c.c. An excess of silver nitrate was slowly added. The solution was heated to boiling and then allowed to remain over night in a dark cupboard. The precipitate was then filtered through a Gooch crucible, washed with hot water and dried at 120° C. The per cent of chlorine was calculated from the silver chloride.

Below are given the results showing the total amount of chlorine in the soft parts of the new born Hereford calf including the blood (No. 13-9-5) and in the entire body of the 8 months Jersey fetus (No. 14-1-33).

Total Chlorine

Sample	Weight Sample	Weight AgCl	Weight Cl	% Cl	Average % Cl
Flesh & soft parts 13-9-5	1.000	0.0280	0.0070	0.700	0.700
	1.000	0.0280	0.0070	0.700	
Composite animal 14-1-33	1.000	0.0312	0.0078	0.780	0.775
	1.000	0.0308	0.0077	0.770	

0.700% on dry basis is equivalent to 0.190% on fresh basis

0.775% " " " " " " 0.210% " " "

Preparation of Sample

for

Complete Ash Analysis

The following amounts of the fresh ground material were used for the complete ash analysis:

13-9-5	3000 grams	14-1-33	1000 grams
13-9-6	1000 "	14-1-33X	63 "
13-9-7	564 "	14-1-34	1049 "
13-9-8	865 "		

The samples were covered with 95 per cent alcohol for purposes of preservation and dried on the water bath with occasional stirring and additions of alcohol for three or four weeks. Experience having shown that it was impossible to ignite in platinum dishes on account of the phosphorus, sulphur, etc., contained in the material, platinum wire baskets were constructed. These baskets were 7-8 centimeters in diameter and of the same depth. About ten or twelve ribs of platinum wire meet at the

bottom. Platinum wire spirals are also wound around the basket, the wires being closer together at the bottom. A small amount of the material to be ignited was placed in these baskets and exposed to the naked flame. A large porcelain casserole with a layer of the sample in the bottom was placed underneath the basket to catch the drip and unignited portions of the sample. These portions were returned to the basket and ignition proceeded. This plan was carried out until all of the material was thoroughly carbonized and a good part of the carbon was oxidized. The substance was then trituated with hot water, the water extract being saved. This operation was continued until the charred substance was free from chlorids. The insoluble residue was then ignited in a platinum dish and again lixivated. The filtrate from the lixivation was added to the previous filtrate. The ashless filter paper was ignited with the insoluble residue and the whole called the insoluble ash. This was weighed and preserved in weighing bottles. The filtrates were evaporated to dryness in a tared platinum dish. If dark colored they were ignited carefully until white or a light grey. Care was taken not to heat high enough for the volatilization of chlorids. This was dried at 135° C.to constant weight and called the soluble ash. The soluble ash was then made up to volume.

Total Water Insoluble Ash

	Gms.
Flesh and soft parts 13-9-5	3.9031
Bone 13-9-6	138.8897
Hair and hide 13-9-7	4.4420
Dung 13-9-8	3.0975
Composite of animal 14-1-33	24.3708
Dung 14-1-33X	0.1980
Amniotic fluid 14-1-34	1.4378

Total Water Soluble Ash

Flesh and soft parts 13-9-5	1.9350
Bone 13-9-6	4.7940
Hair and hide 13-9-7	3.7838
Dung 13-9-8	3.0488
Composite of animal 14-1-33	5.3990
Dung 14-1-33X	0.4313
Amniotic fluid 14-1-34	6.0107

Analysis of Soluble Ash.

Sodium and Potassium Chlorids.

The aliquot used for the determination of the total solids in the solution of the soluble ash was used for these determinations. The residue was dissolved in 40 c.c. of hot water, an excess of a saturated solution of barium hydroxid added and the solution was warmed on the water bath for one half hour. The precipitate was then filtered out and washed with hot water. A few drops of ammonium hydroxid were added to the filtrate and an excess of ammonium carbonate. After standing on the water bath for some time, the precipitate was filtered out

and washed with hot water. The filtrate was again evaporated, heated for 4 hours at 135° C, then heated to dull redness to expel ammonium salts. The residue was again taken up with hot water, a few drops of ammonium hydroxid, a small amount of ammonium carbonate and a small crystal of ammonium oxalate added. After standing a few minutes on the water bath the solution was filtered, 5 c.c. of concentrated hydrochloric acid added, evaporated on the water bath and the ammonium salts expelled by heating. The residue was weighed as sodium and potassium chlorids.

Total Sodium and Potassium Chlorids.

Sample	Weight Sample	Wt. NaCl & KCl	% of alkali chlorids	Av. % Alkali chlorids
Flesh and soft parts	0.3804	0.1554	40.85	
13-9-5	0.3804	0.1554	40.85	40.85
Bone	0.1382	0.0377	29.40	
13-9-6	0.1382	0.0377	29.40	29.40
Hair and Hide	0.2202	0.0722	32.78	
13-9-7	0.2202	0.0722	32.78	32.78
Excreta	0.0836	0.0506	60.52	
13-9-8	0.0836	0.0506	60.52	60.52
Composite of animal	0.1495	0.0618	41.33	
14-1-33	0.1495	0.0618	41.33	41.33
Excreta	0.0882	0.0239	27.09	
14-1-33X	0.0882	0.0236	26.75	26.92
Amniotic	0.2602	0.1146	44.04	
fluid 14-1-34	0.2602	0.1143	43.92	43.98

The potassium determination was made directly on the mixture of the chlorids. The sodium and potassium chlorids were dissolved in 60 c.c. of hot water and a few c.c. of concentrated

hydrochloric acid were added. An excess of chloroplatinic acid was added to convert the potassium and sodium salts into the respective chloroplatinates. This solution was then evaporated on the water bath to a thick paste, removed and heated with 85 per cent alcohol. After standing for two hours the precipitate of potassium chloroplatinate was filtered off in a Gooch crucible, and washed with 85 per cent alcohol. The crucible was dried in the electric oven at 110° C and weighed.

Potassium Chloride (and oxide)

Sample	Weight Sample	Wt. $K_2Pt_2Cl_6$	Wt. KCl	Wt. K_2O	% K_2O	Av. % K_2O
Flesh and soft parts 13-9-5	0.3804	0.7316	0.08040	0.1032	27.15	
	0.3804	0.7298	0.08020	0.1029	27.05	27.10
Bone 13-9-6	0.1282	0.1774	0.01950	0.0250	19.50	
	0.1282	0.1778	0.01954	0.02506	19.55	19.52
Hair and hide 13-9-7	0.2202	0.3712	0.04079	0.0523	23.78	
	0.2202	0.3705	0.04071	0.0522	23.74	23.76
Excreta 13-9-8	0.0836	0.1944	0.02137	0.0274	32.87	
	0.0836	0.1946	0.02139	0.0275	32.94	32.90
Composite of animal 14-1-33	0.1495	0.2959	0.03252	0.0417	27.93	
	0.1495	0.2959	0.03252	0.0417	27.93	27.93
Excreta 14-1-33A	0.0882	0.1196	0.01315	0.01687	19.13	
	0.0882	0.1193	0.01312	0.01683	19.09	19.11
Amniotic fluid 14-1-34	0.2602	0.4154	0.0457	0.0586	22.52	
	0.2602	0.4163	0.0458	0.0587	22.59	22.55

Sodium Chlorid (and Oxide)

Sample	Weight Sample	Wt.KCl & NaCl	Wt. KCl	Wt. NaCl	Wt. Na_2O	% Na_2O	Av. % Na_2O
Flesh & soft parts 13-9-5	0.3804	0.1554	0.08040	0.0750	0.08068	21.21	
	0.3804	0.1554	0.08020	0.0752	0.08094	21.28	21.24
Bone 13-9-6	0.1282	0.0377	0.01950	0.0182	0.01956	15.42	
	0.1282	0.0377	0.01954	0.0183	0.01967	15.52	15.47
Hair & hide 13-9-7	0.2202	0.0722	0.04079	0.0314	0.03382	15.36	
	0.2202	0.0772	0.04071	0.0315	0.03391	15.40	15.38
Excreta 13-9-8	0.0836	0.0506	0.02137	0.0177	0.01887	22.58	
	0.0836	0.0506	0.02139	0.0176	0.01891	22.63	22.60
Composite animal 14-1-33	0.1495	0.0618	0.03252	0.0293	0.03157	21.12	
	0.1495	0.0618	0.03252	0.0292	0.03139	21.00	21.06
Excreta 14-1-33X	0.0882	0.0239	0.01315	0.0108	0.01162	13.18	
	0.0882	0.0236	0.01312	0.0105	0.01132	12.84	13.02
Amniotic Fluid 14-1-34	0.2602	0.1146	0.0457	0.0561	0.0604	23.22	
	0.2602	0.1143	0.0458	0.0566	0.05989	23.02	23.12

Chlorine

For this determination the samples were treated as follows: an aliquot was transferred to a 250 c.c. beaker, and barely acidified with nitric acid. An excess of standard silver nitrate was added and the solution was brought to boiling. The excess of silver nitrate was then titrated with ammonium sulphocyanate solution, using 1 c.c. of a saturated solution of iron alum as an indicator. One c.c. of the ammonium sulphocyanate solution was equivalent to 1.102 c.c. of the silver nitrate solution, 1 c.c. of which was equivalent to 0.003216 grams of chlorine.

Chlorine

Sample	Weight Sample	c.c. $AgNO_3$ used	Gms. of Chlorine	% Chlorine	Av. % Chlorine
Flesh & soft parts	0.1835	4.1	0.013185	14.10	
13-9-5	0.1835	4.1	0.013185	14.10	14.10
Bone	0.1439	5.27	0.016948	23.00	
13-9-6	0.1439	5.38	0.017296	23.18	23.09
Hair & hide	0.1437	4.99	0.016047	13.72	
13-9-7	0.1437	4.55	0.014572	13.58	13.65
Excreta	0.4297	39.7	0.1277	25.08	
13-9-8	0.4297	39.6	0.1274	25.00	25.04
Composite animal	0.1202	5.9	0.0192	16.00	
14-1-33	0.1202	5.9	0.0192	16.00	16.00
Excreta	0.0168	0.65	0.02209	13.14	
14-1-33X	0.0168	0.60	0.02209	13.14	13.14
Amniotic fluid	0.1804	5.60	0.018009	9.98	
14-1-34	0.1804	5.60	0.018009	9.98	9.98

Carbon Dioxid

The carbon dioxid was determined by means of a Gomberg potash bulb in train with sulphuric acid drying towers. One hundred c.c. of the solution was heated with dilute sulphuric acid in a flask having a dry current of air passing into it. The carbon dioxid was sucked through the potash bulb. The increase in weight gave the weight of the carbon dioxid.

Carbon Dioxid

Sample	Weight Sample	Weight CO_2	% CO_2	Av. % CO_2
Flesh and soft parts 13-9-5	0.7353	0.0612	8.33	
	0.7353	0.0606	8.25	8.29
Bone 13-9-6	0.9588	0.0752	7.85	
	0.9588	0.0752	7.85	7.85
Hair & hide 13-9-7	0.9567	0.1427	14.92	
	0.9567	0.1419	14.84	14.88
Excreta 13-9-8	0.8595	0.0526	6.12	
	0.8595	0.0506	5.96	6.04
Composite animal 14-1-33	0.6010	0.0448	7.46	
	0.6010	0.0450	7.50	7.48
Excreta 14-1-33X	0.1685	0.0495	29.42	
	0.1685	0.0495	29.42	29.42
Amniotic fluid 14-1-34	1.0598	0.0675	6.37	
	1.0598	0.0673	6.45	6.41

Sulphates

The sulphate was determined as barium sulphate. Ten c.c. of the solution was drawn, transferred to a 200 c.c. beaker and diluted to 100 c.c. The solution was strongly acidified with concentrated hydrochloric acid, heated to boiling, and an excess of ten per cent barium chlorid added drop by drop with constant stirring. The boiling was continued for thirty minutes and the beaker was allowed to stand over night. The precipitate was washed on the filter and by decantation with hot water. The precipitate was dried, ignited and weighed as barium sulphate.

Sulphates

Sample	Weight Sample	Wt. of $BaSO_4$	Wt. SO_3	% of SO_3	Av. % SO_3
Flesh and soft parts 13-9-5	0.0735	0.0104	0.00635	8.64	
	0.0735	0.0103	0.00632	8.61	8.62
Bone 13-9-6	0.0958	0.0195	0.01184	12.36	
	0.0958	0.0196	0.01187	12.40	12.38
Hair and hide 13-9-7	0.9560	0.1171	0.07103	7.43	
	0.9560	0.1176	0.07131	7.46	7.44
Excreta 13-9-8	0.8995	0.1147	0.06953	7.73	
	0.8995	0.1156	0.07006	7.79	7.71
Excreta 14-1-33X	0.00168	0.0095	0.00325	19.345	
	0.00168	0.0100	0.00343	20.416	19.88
Amniotic fluid 14-1-34	0.1059	0.1122	0.0384	36.355	
	0.1059	0.1064	0.0364	34.466	35.41
Composite animal 14-1-33	0.0601	0.0135	0.00614	10.22	
	0.0601	0.0134	0.00611	10.18	10.20

Phosphorus as P_2O_5

Aliquots were taken for the phosphorus determinations and transferred to 350 c.c. beakers. They were then diluted to 50 c.c.. The liquid was slightly acidified with nitric acid and 15 grams of ammonium citrate added. The solution was warmed on a water bath to 65° C and 50 c.c. of ammonium molybdate solution added. This temperature was maintained for one hour, when the yellow precipitate of ammonium phospho-molybdate was filtered

off. It was washed both by decanting and on the filter 4 to 5 times with 10 per cent ammonium nitrate solution. The filtrate was tested for more phosphates by the addition of more ammonium molybdate and warming. If phosphates were absent in the filtrate it was replaced by the beaker in which the precipitation was made, and the precipitate dissolved into the beaker with hot 2.5 per cent ammonium hydroxid. This solution was made slightly acid with hydrochloric acid and then faintly alkaline with ammonium hydroxid. After cooling 12 c.c. of magnesia mixture was added drop by drop with constant stirring; in fifteen minutes 4 c.c. of strong ammonia was added and the beaker allowed to stand over night. The precipitate was filtered off, washed by decantation and on the filter with 2.5 per cent ammonium hydroxid. Care was taken to remove all precipitate from sides of the beaker. The magnesium ammonium phosphate was dried, ignited and weighed as $Mg_2P_2O_7$.

Phosphorus

Sample	Weight Sample	Wt. $Mg_2P_2O_7$	Wt. P_2O_5	% P_2O_5	Av. % P_2O_5
Flesh and soft parts	0.0735	0.0386	0.01758	23.92	
13-9-5	0.0735	0.0391	0.01781	24.24	24.08
Bone	0.0958	0.0566	0.02574	26.87	
13-9-6	0.0958	0.0567	0.02580	26.94	26.90
Hair & hide	0.0956	0.0596	0.02712	28.37	
13-9-7	0.0956	0.0597	0.02717	28.43	28.41
Excreta	0.0859	0.0142	0.00648	7.54	
13-9-8	0.0859	0.0144	0.00657	7.64	7.59
Composite animal	0.0601	0.0286	0.01301	21.65	
14-1-33	0.0601	0.0287	0.01304	21.70	21.67
Excreta	0.1680	0.0342	0.01555	9.26	
14-1-33X	0.1680	0.0344	0.01564	9.31	9.28
Amniotic fluid	0.1052	0.0056	0.00253	2.41	
14-1-34	0.1052	0.0054	0.00248	2.36	2.38

Recapitulation of Water Soluble Ash

	13-9-5	13-9-6	13-9-7	13-9-8	14-1-33	14-1-33½	14-1-34
K_2O	27.10	19.52	23.76	32.90	27.93	19.11	22.55
Na_2O	21.24	15.47	15.38	22.60	21.06	13.02	23.12
Cl	14.10	23.09	13.65	25.04	16.00	13.14	9.98
CO_2	8.29	7.85	14.88	6.04	7.48	29.42	6.41
SO_3	8.62	12.38	7.44	7.71	10.20	19.88	35.41
P_2O_5	24.08	26.90	28.41	7.71	21.67	9.28	2.38
Sum	103.43	105.21	103.52	102.00	104.34	103.85	99.85
Deduct O=Cl	3.22	5.27	3.12	5.72	3.65	3.00	2.29
Total	100.21	99.94	100.40	96.28	100.69	100.85	97.57

Insoluble Ash.

The following constituents were determined in the insoluble ash: calcium, magnesium, iron, phosphorus, and sulphates. When the entire sample of insoluble ash did not exceed 5 grams, all of it was placed in solution. In those samples weighing over 5 grams, 5 grams was put into solution. The samples were boiled for about three hours in dilute hydrochloric acid. A small portion was insoluble. This was filtered off, ignited and fused with

a mixture of sodium and potassium carbonates. The fusion mixture was dissolved in hot water and added to the filtrate.

Phosphorus

An aliquot was transferred to a 250 c.c. beaker and an equal volume of strong nitric acid added. This was left on the hot plate until all the hydrochloric acid had been driven off. The solution was allowed to cool, made alkaline with ammonium hydroxid, slightly acidified again with nitric acid, 15 grams of ammonium nitrate added and kept on the water bath at 65° C for one hour. The remainder of the determination corresponds to the determination of phosphorus in the soluble ash.

Phosphorus as P_2O_5

Sample	Weight Sample	Wt. $Mg_2P_2O_7$	Wt. P_2O_5	% P_2O_5	Av. % P_2O_5
Flesh and soft parts	0.0580	0.0404	0.02589	43.26	
13-9-5	0.0580	0.0380	0.02500	43.20	43.23
Bone	0.1000	0.0884	0.04421	44.21	
13-9-6	0.1000	0.0888	0.04444	44.44	44.32
Hair & hide	0.0488	0.0381	0.01729	35.44	
13-9-7	0.0488	0.0380	0.01734	35.54	35.50
Excreta	0.0439	0.0387	0.01762	40.14	
13-9-8	0.0439	0.0387	0.01762	40.14	40.14
Composite animal	0.1000	0.0862	0.03920	39.20	
14-1-33	0.1000	0.0858	0.03904	39.04	39.12
Excreta	0.0078	0.0052	0.00332	42.82	
14-1-33X	0.0078	0.0052	0.00332	42.82	42.82
Amniotic Fluid	0.0537	0.0382	0.02451	45.66	
14-1-34	0.0537	0.0380	0.02440	45.45	45.55

Iron

Aliquots were drawn and transferred to 250 c.c. Erlenmeyer flasks. One c.c. of concentrated sulphuric acid was added, the flasks placed on the hot plate and allowed to remain until the white fumes of the acid appeared. After cooling about 25 c.c. of water was added together with 0.5 gram of powdered zinc. The flasks were fitted with rubber stoppers and bunsen valves. The flasks were then placed on the hot plate and boiled until all the zinc had dissolved. The solution was immediately titrated with a standard solution of potassium permanganate.

Iron as Fe_2O_3

Sample	Weight Sample	c.c. $KMnO_4$	Factor $KMnO_4$	Weight Fe_2O_3	% Fe_2O_3	Av. % Fe_2O_3
Flesh and soft parts	0.0580	0.71	0.001	0.00071	1.23	
13-9-5	0.0580	0.75		0.00075	1.30	1.26
Bone	0.1000	0.11		0.00011	0.11	
13-9-6	0.1000	0.11		0.00011	0.11	0.11
Hair & hide	0.0488	4.49		0.00449	9.22	
13-9-7	0.0488	4.67		0.00467	9.57	9.35
Excreta	0.0439	0.71		0.00071	1.62	
13-9-8	0.0439	0.75		0.00075	1.71	1.66
Composite animal	0.1000	1.70		0.00170	1.70	
14-1-33	0.1000	1.60		0.00160	1.60	1.65
Excreta	0.0396	1.13		0.00113	2.87	
14-1-33X	0.0396	1.12		0.00112	2.84	2.85
Amniotic fluid	0.0718	0.68		0.00068	0.95	
14-1-34	0.0718	0.68		0.00068	0.95	0.95

Calcium

A 25 c.c. sample was drawn and tranferred to a 250 c.c. beaker. It was rendered slightly alkaline with an excess of ammonium hydroxid. About 2 grams of ammonium acetate and a large excess of strong acetic acid were added, then the solution was allowed to stand one hour. The precipitate was filtered off and washed on the filter paper with acetic acid (1-3). The filtrate was set aside and the beaker in which the precipitation occurred was placed under the funnel and the precipitate dissolved and washed into the beaker with hot dilute hydrochloric acid. The hydrochloric acid solution was again made alkaline with ammonium hydroxid, acidified with acetic acid, filtered and washed. The filtrates were combined and the precipitate rejected. The filtrates were heated to boiling and a hot saturated solution of ammonium oxalate added slowly in excess. This was kept boiling on the hot plate for one hour. The precipitate was allowed to settle and it was filtered. The filtrate was replaced by the beaker in which the original precipitation occurred and the precipitate of calcium oxalate washed into this with hot dilute hydrochloric acid. The calcium solution was again made alkaline with ammonium hydroxid, acidified with acetic acid, and a few drops of ammonium oxalate added. The precipitate was digested and filtered as before, taking care that the filter paper was alkaline. The filtrates were combined for the determination of magnesium.

A 250 c.c. Erlenmeyer flask was placed under the funnel, the calcium oxalate precipitate was washed into it with hot dilute (1-1) sulphuric acid. After cooling they were titrated with potassium permanganate.

Calcium as CaO

Sample	Weight Sample	c.c $KMnO_4$	Factor $KMnO_4$	Wt. CaO	% CaO	Av. % CaO
Flesh and soft parts	0.1251	67.67	0.001	0.06767	54.10	
13-9-5	0.1251	67.50		0.06750	53.96	54.03
Bone	0.2500	137.80		0.13780	55.15	
13-9-6	0.2500	138.17		0.13817	55.27	55.21
Hair and	0.1221	64.18		0.0641	52.57	
hide 13-9-7	0.1221	64.18		0.0641	52.57	52.57
Excreta	0.1097	61.56		0.0615	56.12	
13-9-8	0.1097	61.42		0.0614	55.99	56.05
Composite animal	0.2500	146.90		0.1469	58.76	
14-1-33	0.2500	147.12		0.1471	58.85	58.80
Excreta	0.0198	9.95		0.00959	48.44	
14-1-33X	0.0198	9.39		0.00939	48.33	48.38
Amniotic fluid	0.0717	36.96		0.03696	51.55	
14-1-34	0.0717	36.65		0.03665	51.40	51.47

Magnesium

The filtrates from the calcium determination were evaporated down to a small volume. Ammonium hydroxid was added in slight excess together with a saturated solution of di-sodium phosphate until precipitation was complete. One-third the volume of ammonium hydroxid was added and after standing over night the clear liquid was decanted through a filter paper and the precipitate washed by decantation and on the filter paper with dilute ammonium hydroxid. The filtrate was replaced by the beaker in which precipitation took place and the precipitate dissolved and washed into the beaker with hot dilute hydrochloric acid and then washed

with hot water. After adding 3 c.c. of the di-sodium phosphate solution, the solution was made slightly alkaline with ammonium hydroxid and allowed to stand fifteen minutes. One-third the volume of ammonium hydroxid was then added and the precipitate allowed to stand over night. The precipitate was filtered off on an ashless filter paper, dried, ignited, and weighed as magnesium pyrophosphate. The magnesium oxid was calculated from the pyrophosphate.

Magnesium

Sample	Weight Sample	Wt. $Mg_2P_2O_7$	Wt. MgO	% MgO	Av. % MgO
Flesh and soft parts 13-9-5	0.1251	0.0354	0.00638	5.10	
	0.1251	0.0357	0.00643	5.14	5.12
Bone 13-9-6	0.2500	0.0381	0.00687	2.75	
	0.2500	0.0374	0.00675	2.70	2.72
Hide and hair 13-9-7	0.1221	0.0145	0.00262	2.15	
	0.1221	0.0145	0.00262	2.15	2.15
Excreta 13-9-8	0.1097	0.0388	0.00699	6.38	
	0.1097	0.0385	0.00694	6.33	6.35
Composite animal 14-1-33	0.2500	0.0563	0.01015	4.06	
	0.2500	0.0574	0.01035	4.14	4.10
Excreta 14-1-33X	0.0198	0.0072	0.00131	6.63	
	0.0198	0.0072	0.00131	6.63	6.63
Amniotic fluid 14-1-34	0.0717	0.0085	0.00154	2.15	
	0.0717	0.0080	0.00145	2.02	2.08

Recapitulation of the Insoluble Ash

	13-9-5	13-9-6	13-9-7	13-9-8	14-1-33	14-1-33X	14-1-34
P_2O_5	43.23	44.32	35.50	40.14	39.12	42.82	45.55
CaO	54.03	55.21	52.57	56.05	58.18	48.38	51.47
Fe_2O_3	1.26	0.11	9.35	1.66	1.65	2.85	0.92
MgO	2.40	0.79	0.93	3.31	2.10	6.67	2.16
SO_3	----	----	1.90	----	----	----	----
Total	100.92	100.43	100.25	101.16	101.05	100.72	100.10

Recapitulation of Total Ash

	Total Ash of Flesh 13-9-5			Total Ash of Bone 13-9-6		
	% Sol. Ash in terms of Total Ash	% Insol. Ash in terms of Total Ash	% Constituents in Total Ash	% Sol. Ash in terms of Total Ash	% Insol. Ash in terms of Total Ash	% Constituents in Total Ash
K_2O	10.03	none	10.03	0.82	none	0.82
Na_2O	8.06	"	8.06	0.65	"	0.65
Cl	5.22	"	5.22	0.97	"	0.97
CO_2	3.07	"	3.07	0.33	"	0.33
SO_3	3.19	"	3.19	0.52	"	0.52
P_2O_5	8.91	26.23	35.14	1.13	42.55	43.68
Fe_2O_3	none	0.76	0.76	none	0.11	0.11
CaO	"	32.42	32.42	"	53.01	53.01
MgO	"	1.44	1.44	"	0.76	0.76
Total	38.48	60.85	99.33	4.42	96.43	100.85
Deduct O=Cl	1.19		1.19	0.22		0.22
Total	37.29		98.14	4.20		100.63

Recapitulation of Total Ash

	Total Ash of Hide & Hair 13-9-7			Total Ash of Excreta 13-9-8		
	% Sol. Ash in terms of Total Ash	% Insol. Ash in terms of Total Ash	% Constituents in Total Ash	% Sol. Ash in terms of Total Ash	% Insol- Ash in. terms of Total Ash	% Constituents in Total Ash
K_2O	8.08	none	8.08	15.17	none	15.17
Na_2O	5.23	"	5.23	10.17	"	10.17
Cl	4.78	"	4.78	11.37	"	11.37
CO_2	5.06	"	5.06	2.72	"	2.72
SO_3	2.53	1.22	3.75	3.47	"	3.47
P_2O_5	9.66	23.07	32.73	5.44	21.68	27.12
Fe_2O_3	none	6.08	6.08	none	0.90	0.90
CaO	"	34.17	34.17	"	30.27	30.27
MgO	"	0.61	0.61	"	1.79	1.79
Total	35.34	65.15	100.49	48.24	54.64	102.88
Deduct O=Cl	1.09		1.09	2.57		2.57
Total	34.23		99.40	45.67		100.31

Recapitulation of Total Ash

	Total Ash of Composite Animal 14-1-33			Total Ash of Excreta 14-1-33X		
	% Sol. Ash in terms of Total Ash	% Insol. Ash in terms of Total Ash	% Constituents in Total Ash	% Sol. Ash in terms of Total Ash	% Insol. Ash in terms of Total Ash	% Constituents in Total Ash
K_2O	12.00	none	12.00	13.00	none	13.00
Na_2O	9.27	"	9.27	9.13	"	9.13
Cl	6.88	"	6.88	9.42	"	9.42
CO_2	3.22	"	3.22	20.60	"	20.60
SO_3	4.39	"	4.39	14.25	"	14.25
P_2O_5	9.32	21.52	30.84	6.50	12.12	18.62
Fe_2O_3	none	0.91	0.91	none	0.82	0.82
CaO	"	32.00	32.00	"	13.69	13.69
MgO	"	1.16	1.16	"	1.87	1.87
Total	45.08	55.59	100.67	72.89	28.60	101.49
Deduct O=Cl	1.57		1.57	2.15		2.15
Total	43.51		99.10	70.74		99.34

Recapitulation of Total Ash

Total Ash of Amniotic Fluid
14-1-34

	% Sol. Ash in terms of Total Ash	% Insol. Ash in terms of Total Ash	% Constituents in Total Ash
K_2O	17.59	none	17.59
Na_2O	16.85	"	16.85
Cl	7.15	"	7.15
CO_2	4.68	"	4.68
SO_3	25.39	"	25.39
P_2O_5	1.74	12.89	14.63
Fe_2O_3	none	0.26	0.26
CaO	"	14.56	14.56
MgO	"	0.58	0.58
Total	73.40	28.29	101.69
Deduct O=Cl	1.63		1.63
Total	71.77		100.06

Mineral Constituents Calculated on Fresh Material

Sample	Wt. Fresh Material gms.	% Ash	Wt. Ash gms.	% K_2O in Ash	Wt. K_2O in Fresh Material gms.	% K_2O in Entire Calf No. I	% CaO in Ash	Wt. CaO in Total Ash Gms.	% CaO in Entire Calf	% MgO in Ash	Wt. MgO in Total Ash Gms.	% MgO in Entire Calf
Flesh and soft parts 13-9-5	19,180	0.899	172.62	10.03	17.313		32.42	55.95		1.44	2.48	
Bone 13-9-6	9,252	14.300	1323.036	0.82	10.840		53.01	665.61		0.76	10.05	
Hide and hair 13-9-7	4,580	0.803	36.777	8.080	2.971	0.064	34.17	125.65	2.50	0.61	2.24	0.043
Excreta 13-9-8	865	0.370	3.200	15.170	0.485		30.27	0.96		1.79	0.05	
Composite animal 14-1-33	14,000	3.180	445.200	12.00	53.420		32.00	142.46		1.16	5.16	
Excreta 14-1-33X	63	0.980	0.617	13.00	0.080	0.380	13.69	0.08	1.01	1.87	0.01	0.036
Amniotic fluid 14-1-34	5,454	0.504	27.480	17.59	4.830	0.088	14.56	4.00	0.073	0.58	0.15	0.002

Wt. 21.853
Wt. 847.17
Wt. 14.82
Wt. 53.50
Wt. 142.54
Wt. 5.17

Mineral Constituents Calculated on Fresh Material

Sample	Wt. Fresh Material gms.	% Ash	Wt. Ash gms.	% P_2O_5 in Ash	Wt. P_2O_5 in Total Ash gms.	% P_2O_5 in Entire Calf	% Fe_2O_3 in Ash	Wt. Fe_2O_3 in Total Ash Gms	% Fe_2O_3 in Entire Calf	% Na_2O in Ash	Wt. Na_2O in Fresh material gms.	% Na_2O in Entire Calf
Flesh and soft parts 13-9-5	19,180	0.899	172.620	35.14	60.65		0.76	1.31		8.06	13.91	
Bone 13-9-6	9,252	14.300	1323.036	43.68	577.89		0.11	1.45		0.65	8.59	
Hide and hair 13-9-7	4,580	0.803	36.777	32.73	120.34	3.34	6.08	22.34	0.074	5.23	19.23	0.124
Excreta 13-9-8	865	0.370	3.200	27.12	0.86		0.90	0.02		10.17	0.32	
Composite animal 14-1-33	14,000	3.180	445.200	30.84	137.30		0.91	4.05		9.27	41.27	
Excreta 14-1-33X	63	0.980	0.617	18.62	0.11	0.98	0.82	0.005	0.028	9.12	0.05	0.390
Amniotic fluid 14-1-34	5,454	0.504	27.480	14.63	4.02	0.073	0.26	0.07	0.001	16.85	4.63	0.084

Wt. 759.74 Wt. 137.41 Wt. 25.12 Wt. 4.05 Wt. Na_2O = 42.05 Wt. 41.32

Mineral Constituents of the Entire Animals

	Calf No. I Full period	Calf No. II 8 Mo. fetus	Amniotic Fluid
K_2O	0.172	0.380	0.088
Na_2O	0.124	0.290	0.084
Cl	0.190	0.210	----
SO_3	0.330	0.365	----
P_2O_5	3.24	0.98	0.073
Fe_2O_3	0.074	0.038	0.001
CaO	3.50	1.010	0.073
MgO	0.043	0.036	0.002

Loss of Sulphur and Chlorine During Ignition

The percentage of sulphur as found in the fresh material of the flesh and soft parts (13-9-5) is 0.132 per cent; of the composite animal (14-1-33) is 0.146 per cent. Calculating the weight of sulphur in the entire animals there are 51.48 grams in the full term calf and 30.10 grams in the eight months fetus. However, the amount found in the ash is far below these percentages. Below is given a table showing the per cent of loss of the sulphur during ignition.

	Grams sulphur in body	Grams sulphur according to ash analysis	Loss sulphur on ignition	% Loss of sulphur on ignition
Full Term	51.48	10.48	41.00	79.64
Eight Months	30.10	7.84	12.26	60.99

The percentage of chlorine in the fresh sample of the full term calf is 0.190 per cent; in the 8 month fetus the percentage of chlorine is 0.210 per cent. The body of the full term calf would then contain 74.10 grams of chlorine; the body of the eight month fetus would contain 39.4 grams of chlorine. Below is given a table showing the loss of chlorine during ignition.

	Grams Chlorine in body	Grams Chlorine according to ash analysis	Loss of Chlorine on ignition	% Loss of Chlorine on ignition
Full Term	74.10	39.65	34.45	46.49
Eight Months	39.40	30.29	9.11	31.00

Discussion

Comparison with Analyses of other New Born Calves

Analyses have previously been made in this laboratory of the ash of the new born calf, the work being done by Messrs. Vanatta and Hogan. It would perhaps be well to make some comparisons with their work and also with the work of other investigators on other material. The figures are based on fresh material.

	Connell		Vanatta	Hogan
Constituents	8 Months Jersey Fetus	Full Term Hereford Calf	Full Term Jersey Calf	Full Term Jersey Calf
K_2O	0.380	0.172	0.189	0.2031
Na_2O	0.290	0.124	0.253	0.2117
Cl	0.210	0.190	0.210	0.169
SO_3	0.365	0.330	0.359	0.238
P_2O_5	0.980	2.24	1.6028	1.3669
Fe_2O_3	0.028	0.74	0.040	0.0343
CaO	1.010	2.50	1.7547	1.4597
MgO	0.036	0.043	0.0844	0.0622
SiO_2	----	----	0.0260	0.3030

As in the above table there are two breeds or types of animals to be considered, it is necessary to make a comparison of the eight months Jersey fetus with the full term Jersey calves and a comparison of the full term Hereford calf with the full term Jersey calves.

Comparing the calcium oxide and phosphoric anhydride content of the eight months Jersey fetus with that of the full term Jersey calves it will be noted that the percentage of calcium oxide and phosphoric anhydride is decidedly higher in the full term calves. There is a higher soda and potash content in the eight months Jersey fetus. No material difference is noted in the chlorine or sulphur content though the chlorine and sulphur are somewhat higher in the eight months than in the full term Jersey calves.

A comparison of the last two columns does not show any material difference in the mineral composition of the full term Jersey calves. The calves being from the same cow and from the same sire no difference was expected. Upon making a comparison of the full term Hereford calf with the full term Jersey calves a material difference will be noted. The per cent of calcium oxide in the body is higher as is also the phosphoric anhydride. There is a decrease in the percentage of potash and soda. The higher calcium oxide and phosphoric anhydrid can be accounted for by the fact that the percentage of bone to the entire body is greater in the new born calves of the Hereford breed than in those of the Jersey breed. The proportion of bone to the entire body in the Herefore is 26.2 per cent; that of the Jersey breed at birth 24.1 per cent. The iron is also appreciably higher in the Hereford calf. This is probably due to the hair which was red (see citation, Rutherford and Hawk). The magnesium oxide following the calcium oxide is higher than in the Jersey calves. No great difference is noted in the sulphur or chlorine content, but it appears to follow the decreasing potash content.

The writer could find no silica in either the soluble or insoluble ash. The alkaline soluble ash did not come in contact with glass (all determinations being carried out in platinum, when possible) until the samples were made up to volume. The aliquot for all determinations was immediately drawn, transferred to beakers and acidified.

If the assumption is made that the weight of the eight months Jersey fetus at time of birth would be sixty pounds, approximately the weight of the Jersey calves analyzed by Vanatta and Hogan, it can be shown that the greatest amount of calcium oxide and phosphoric anhydride is obtained by the body during the last month of fetus development. The body of the fetus at eight months contained, by actual analysis, 0.303 pounds of calcium oxide together with 0.294 pounds of phosphoric anhydride. Assuming that it would weigh 100 per cent more at birth the figures for calcium oxide would be 0.606 pound and for phosphoric acid 0.588 pounds. By Vanatta's and Hogan's work we have seen, however, that at birth the weight of calcium oxide in a sixty pound calf was 0.964 pound and that the weight of the phosphoric anhydride was 0.890 pound. Then there must be a greater gain in the weight of the calcium oxide and phosphoric anhydride than in the weight of the total fetus. It can readily be seen that the gain in calcium oxide is 160 per cent; the gain in phosphoric anhydride is 150 per cent, while the gain in body weight is only 100 per cent. A comparison with the full term Hereford shows a still more striking difference. The weight of calcium oxide in the Hereford

calf is 2.2 pounds; the weight of the phosphoric anhydride is 1.97 pounds, or there is 330 per cent more calcium oxide and 320 per cent more phosphoric acid in the Hereford calf than in the Jersey calves. There is not only a higher per cent of calcium oxide and phosphoric annydride but by weight there is over twice as much in the body of the Hereford as in the body of the Jersey calves.

The weight of potash in the eight months fetus is 0.114 pound, that of the full term Jersey calves 0.118 pound. There is then very little gain in the amount of potash during the last month of development.

This condition would indicate that the greater part of the calcium oxide in the body of a fetus is obtained during the last month of fetal development. Voit[9], investigating the mineral composition of the bones of dogs, and Brubacher[10], the bones of children, substantiate the above assumption.

Comparison of the New-Born Calf with Mature Animals

The results of analyses of ash by Lawes and Gilbert[11] compared with results obtained by the writer may also prove interesting and instructive.

Composition of Ash

Constituents	Connell		Lawes & Gilbert	
	8 Months Jersey Fetus	Full Term Hereford Calf	Fat Calf	Half Fat Ox
K_2O	8.52	12.50	5.40	4.41
Na_2O	6.02	9.19	3.82	3.08
Cl	4.81	6.12	1.55	1.24
CO_2	5.59	11.91	1.34	1.97
SiO_2	---	---	0.12	0.24
SO_3	4.03	5.14	1.08	0.86
P_2O_5	34.67	24.73	40.37	40.32
Fe_2O_3	1.96	0.86	0.53	0.97
CaO	37.71	22.84	43.95	45.26
MgO	1.15	1.51	2.20	2.03

It will be noted that the calcium and phosphorus are much higher in Lawes and Gilbert's work. The percentages of calcium oxides increase with the age of the animal until calcification of the bones is practically complete in the half-fat ox. The potash and soda are decidedly lower than in the new born animal. The sulphur, chlorine, and carbonates appear to have the tendency to follow the decreasing potash and soda percentage. It will be

Noted that the iron is higher in the new born calf than in any other of the animals. This bears out the statement of Bunge[13] that the quantity of iron in the body is greatest at birth.

Unpublished data on hand in this laboratory will enable us to make a further comparison of the percentage of ash and phosphorus in the bodies of new born animals and the bodies of mature animals.

Ash

	Eight months Jersey Fetus	Full Term Hereford Calf	Full Term Jersey Calf	No.505 1 yr. fairly fat	No.121 fat mature	No.500 4 yr. thin	No.501 4 yr. very fat
Flesh		0.899	0.904	0.853	0.781	0.947	0.702
Bone		14.30	14.281	23.852	27.108	23.526	26.316
Hair & hide		0.803	0.787	0.696	0.758	1.072	1.522
Total animal	3.18	4.070	3.550	3.9889	4.189	5.020	3.219

Phosphorus

Flesh		0.147	0.160	0.173	0.154	0.168	0.130
Bone		3.244	3.431	4.403	4.806	4.175	4.802
Hair & Hide		0.064	0.067	0.066	0.056	0.044	0.049
Total animal	0.421	0.963	0.364	0.740	0.748	0.875	0.567

A study of the above table shows that the percentage of ash in the entire animal is greatest in the thin mature animal (No. 500). Although the per cent of ash in the bone of the very fat mature animal (No. 501) is the highest, the proportion of bone

to the entire body is higher in the thin animal. The full term Hereford calf contains a higher per cent of ash in the entire body than some of the more mature animals for the reason that the proportion of bone to the entire animal is greater. This is not true, however, of No. 505, a fairly fat yearling. The ossification of the bones has been counterbalanced by the animal putting on fat. In No. 501 the ossification of the bones has been more than balanced by the great increase in fat.

A study of the phosphorus content shows that the phosphorus is higher in the new born Hereford calf than in any other of the animals. This is the result of the large proportion of bone to the entire animal. The phosphorus in the flesh is highest in the medium fat steer. The per cent of phosphorus diminishes as the weight of the animal increases, provided the animal is in a fairly fat condition. The percentage of phosphorus in the hair and hide is fairly constant. Ossification of the bone is nearly complete in No. 121 and No. 501. Thus the higher phosphorus percentage in the bone.

Relation between the Milk and the New Born Animal

As milk is the only form of food during a certain period of life of both man and mammals, it must contain all the elements necessary for life. Under this head is included the inorganic constituents. Bunge[12] claims that the composition of the ash of the suckling young of various mammals is nearly the same, but that the ash of the milk differs from the ash of the young in

so far as the slower the young grows the richer the milk is in alkali chlorids and relatively poorer in phosphates and lime salts. The following tables showing the analyses of ashes of new born animals and the corresponding milk should prove interesting. The tables are of the ash of the dog (fast growing animal); the ash of the new born calf (a moderately slow growing animal); and the ash of the new born infant (a very slow growing animal). Bunge found the following results: (A representing the ash of the milk from the bitch and B the ash of the new born dog.)

	A	B
K_2O	14.98%	11.42%
Na_2O	8.80	10.06
CaO	27.24	29.52
MgO	1.54	1.82
Fe_2O_3	0.12	0.72
P_2O_5	34.22	39.42
Cl	16.90	8.35

Bunge[13] gives also the following determination of the ash of milk. The first column, A, is his analysis of the ash of milk, the second column, B, the average composition of the ash of the three full term calves which have before been under discussion.

	A	B
K_2O	31.34%	6.29%
Na_2O	13.91	6.06
CaO	20.05	40.63
MgO	2.63	1.65
Fe_2O_3	0.04	1.03
P_2O_5	24.75	37.50
Cl	31.27	3.24
Total	104.79	
Deduct O=Cl	4.79	
Total	100.00	

Camerer and Söldner[14] upon making an analysis of the mother's milk and that of the new born infant obtained the following results: (A being the ash of the milk and B the ash of the new born infant).

	A	B
K_2O	31.40%	7.80
Na_2O	11.90	9.10
CaO	16.40	36.10
MgO	2.60	0.90
Fe_2O_3	0.60	0.80
P_2O_5	13.50	38.90
Cl	20.00	7.70

From a study of the tables it appears that Bunge's statement in regard to the tendency of an increase in the calcium oxide

and phosphoric acid content of the milk from slow to fast growing animals is correct. A comparison of the ash of the milk from the bitch and the ash of the new born dog shows that the percentage of a constituent of each of the ashes is approximately the same. A comparison, however, of the ash of cow's milk and the ash of the new born calf shows that as the percentage of lime and phosphoric acid increases there is no such relationship. It will be noted that the proportion of potash in the milk to the potash in the new born is decidedly less. This diminishing proportion is emphasized still further in looking at the table of the infant.

A comparison of the analyses of the ash of milk shows that in the rapid growing animals the percentage of calcium and phosphorus is greater than in the slower maturing animals. This abundant supply of calcium oxide and phosphoric anhydride is needed to supply the demand which the skeleton of a rapid growing animal puts upon its food. In the slower growing animals the percentage of sodium and potassium is greater than in the quick maturing animals.

We cannot therefore state that the composition of the ash of the young and the ash of the corresponding milk coincide. Proscher and Pages[15] state that the amount of calcium and phosphoric anhydride stand in close relation to the rapidity of growth as the amount of these constituents is greater in the milk of animals which grow and develop rapidly.

Conclusion

In investigations of this character no general conclusions can be drawn from the results of a small number of analyses, but the following tentative conclusions might well be named.

1. The undeveloped young contain more soda and potash than older animals.

2. An increase in the percentage of calcium oxide and phosphoric anhydride means a decrease in the percentage of potash and soda.

3. The proportion of bone to the entire body is greater in the Hereford breed at birth than in the Jersey breed at the same time.

4. At birth there is a greater weight and a higher percentage of calcium oxide and phosphoric anhydride in the entire body of the Hereford than in the body of the Jersey. No conclusions can be drawn from the material at hand as to the difference between the calcium and phosphoric acid content in the two breeds on account of the age and the fatness of the animals.

5. There is very little gain in the amount of potash during the last month of fetal development.

6. The greater part of the calcium oxide and phosphoric anhydride of the body is obtained during the last month of development.

7. The mother's milk of rapidly developing animals contains a higher percentage of calcium oxide and phosphoric acid than the mother's milk of slow growing animals.

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