

Minerals, trace-elements and toxic metals in lyophilized tissues

In an almost biased manner the analysis of biological preparations made in the last decade has focused on the detection of organic compounds. The active substances or compounds sought in biochemical substrates and enzymes were proteins, lipids, carbohydrates, poly- and oligopeptides. In clinical terms, quantities that can be measured or weighed have priority over qualitative estimations. Here, the amount of substances found is sometimes relevant to their biological significance.

The fact that there cannot be any complex functioning compound without an inorganic nucleus is being slowly real-

ized. There can be no hemoglobin without a Fe atom and no chlorophyll without an Mg atom. The red coloured material in the blood of mammals is dependent upon the presence and level of the iron atom, in the same way that the green colouring matter in plants depends upon magnesium. The bivalent ions particularly, magnesium, zinc and copper – represent an indispensable ingredient for the functioning of most enzymes. This significance of the trace elements in the functioning of biological systems encourages you to examine a number of the lyophilizates used in cell therapy with regard to their inorganic content.

Material and method

Minerals were analyzed from 19 different tissues of lyophilized commercial preparations of the «Siccacell-Series». In order to eliminate coincidences, such as seasonal and nutritional factors, each 400 mg of lyophilizate consisted of 4 different batches. Samples of the lyophilizates were numerically numbered and the laboratory conducting the analysis did not know the origin of the tissues.

The analyses were done at the Anamol Laboratories, 105 Scarsdale Road, Don Mills, ON, M3B 2R5. This laboratory, under the management of Dr. Tamari, has long years of experience in the analysis of elements, trace elements and toxic metals – in particular hair analysis. Results and their evaluation are computerized the same way as the results from nutritional analysis.

Results

Results of the analysis have been compiled in 3 tables –

Table 5 – elemental composition of the examined tissues

Table 6 – differences in element distribution in the tissues

Table 7 – differences in mineral or trace element content of female and male tissues – endocrine tissues primarily examined.

On the whole, at first sight the big differences in mineral content of fetal and juvenile tissue lyophilizates are striking. The second finding worth pointing out is the fact that individual elements are only present in specific tissues and missing in others. A third and remarkable finding was the unexpectedly great difference in mineral content between tissues of male and female origin.

Tab. 5: Content of 21 elements, trace-elements and toxic metals in fetal and juvenile tissues. Values in ppm (pars per mille)

	Ca	Cr	Co	Cu	Fe	Li	Mg	Mn	Mo	Ni	P	K	Se	Na	V	Zn	Al	As	Cd	Pb	Hg
Cerebrum	502	0,99	0	12,9	124	1,0	694	1,66	0,05	1,42	12330	17890	2,75	12990	0,01	51,9	20,9	5,30	0,46	1,4	12,3
Cerebellum	496	3,12	0,01	35,6	216,8	1,05	1007	2,76	0,16	0,76	13250	21970	0,77	13240	0,20	79,1	67,4	0,53	0,08	0	1,34
Diencephalon	445	2,31	0	25,4	161	0,80	888,8	2,08	0,15	1,10	14030	21010	0,29	12040	0,11	59,2	23,5	0	0,09	0,50	0
Lung	872	1,99	0	23,9	415	1,43	1062	1,77	0,22	0,65	14040	23880	0,14	28280	0,11	96,7	317,4	0,72	0,16	0	1,53
Liver	437	1,34	0	155,1	5293	1,02	954,2	16,11	1,35	1,22	11860	16590	0	8051	0,78	603,3	98,6	0	0,16	0,41	0,76
Spleen	527	1,93	0	24,6	1339	1,20	944,5	1,32	0,18	2,10	12830	18430	0	5892	0,38	70,1	139,1	0	0,17	1,07	0,18
Thymus	597,9	1,99	0	26,6	173,4	0,79	1163	1,97	0,18	0,75	13290	28400	0,22	7895	0,12	83,3	60,2	0,08	0,10	0	1,26
Adrenals ♂	613	1,10	0	13,4	301,9	0,51	587,1	2,94	0,07	0,56	10000	11970	0,20	5289	0	40,1	39,1	0	0,21	0	0
Adrenals ♀	658	17,8	0	19,2	537	0,99	833,9	4,67	0,86	9,27	12910	13830	0,88	5452	0,16	65,9	59,3	0,09	0,60	0	0
Placenta ♂	1150	1,30	0	16,9	651,1	0,88	979,6	1,89	0,17	0,65	13040	16170	0,67	13390	0,15	85,9	36,0	0	0,14	0	0,65
Placenta ♀	770,1	1,40	0	101,9	527,8	0,85	972,9	2,23	0,26	0,60	12230	14490	0,51	14510	0,13	115,1	24,4	0	0,60	0,11	0,35
Testis	919,8	1,59	0	15,7	288,9	0,86	1121	2,90	0,28	1,76	13890	32440	2,20	11700	0,14	131,5	74,7	0	0,21	0	0
Ovary	1077	6,11	0	21,4	345,1	0,84	755,1	2,66	0,33	5,42	11890	18920	1,41	28520	0,04	54,7	616,9	0,63	0,11	0	2,20
Thyroidgland	851	5,08	0	28,1	281,4	1,31	1027	5,98	0,20	1,35	5653	10420	0,69	11730	0	73,8	111,0	0,50	0,11	0	2,17
Pankreas	3006	12,1	0	102,0	510,6	0,98	1290	5,90	0,63	1,42	13310	18630	0	13430	0,18	198,1	573,7	0,18	0,05	0	0,11
Connective Tissue	3238	5,34	0	41,8	295,3	2,22	1114	2,79	0,22	2,27	6395	9897	0,20	18830	0,15	72,3	74,0	0,20	0,26	0	1,42
Cartilage	13960	3,1	0	111,8	90,1	1,8	2458	2,1	0,1	2,4	13240	5593	0	20350	0,2	93,3	26,6	0	0,1	0	0

The following organs (tissues) were analyzed:

Cerebrum	Hypophysis, male	Thyroid	Lung
Cerebellum	Hypophysis, female	Pancreas	Liver
Diencephalon	Suprarenal gland, male	Thymus	Spleen
	Suprarenal gland, female		Connective tissue
	Testis		Cartilage
	Ovaries		
	Placenta, male fetus		
	Placenta, female fetus		

Comment on the various elements

As shown in Tables 5 and 6, the concentration gradient of elements indicated in parts per mille is surprisingly great, as we are concerned here with a purely quantitative evaluation.

Calcium (Ca) – The tissues examined which are richest in calcium are cartilage, connective tissues and pancreas. The tissues with the least amount of calcium are the cerebellum, diencephalon and liver (cartilage 13.960 ppm – liver 437 ppm).

Chromium (Cr) – High concentrations of chromium are found in the female suprarenal glands (17.8), pancreas and ovaries, with the lowest values in the liver, male suprarenal and the cerebrum (0.99). It is worth noting the tremendous difference between the female and male suprarenal glands, i.e. 17.8 vs. 1.10, a ratio also reflected between the ovaries and testes at 6.11 to 1.59.

Cobalt (Co) – Not found in fetal tissues, with the exception of a trace in the cerebellum (0.01).

Copper (Cu) – Also shows a marked difference between the copper-rich organs, liver (155.1), pancreas (102), fe-

male placenta (101.9) and the tissues poor in copper, namely male suprarenal glands (13.4), cerebrum (12.9) and cartilage (11.8).

Iron (Fe) – The highest concentration is in the liver (5.293), spleen and male placenta and the lowest concentration in the diencephalon, cerebrum and cartilage (90.1).

Lithium (Li) – Found in connective tissue (2.22), cartilage and lung at relatively high concentrations. Levels are relatively low in the diencephalon, thymus and male suprarenal glands (0.51). Here the ratio is small because of the low initial values.

Magnesium (Mg) – Cartilage (2.458), pancreas and thymus show the highest levels, and the ovaries, cerebrum and male suprarenal glands (587.1) the lowest values.

Manganese (Mn) – Liver (16.11), thyroid and pancreas are at the top, whereas lung, cerebrum and spleen (1.32) are at the low end of the scale.

Molybdenum (Mo) – is found mainly in the liver (1.35), female suprarenal

Tab. 6: Content- and Concentrationgraduation of 21 elements, trace-elements and toxic metals in 17 fetal or juvenile tissues. Values in ppm (pars per mille).

Ca	Cartilage 13960	Conn. tiss. 3238	Pankreas 3006	Pankreas 1150	Placenta ♂ 1150	Ovary 1077	Testis 919,8	Lung 872	Thyroid 851	Thyroid 851	Placenta ♀ 770,1	Adrenal ♀ 658	Adrenal ♂ 613	Thymus 597,9	Spleen 527	Cerebrum 502	Cerebrum 496	Dienceph. 445	Liver 437
Cr	17,8	Pankreas 12,1	Ovary 6,11	Conn. tiss. 5,34	Conn. tiss. 5,34	Thyroid 5,08	Cerebellum 3,12	Cartilage 3,1	Cartilage 2,31	Dienceph. 2,31	Thymus 1,99	Lung 1,99	Spleen 1,93	Testis 1,59	Placenta ♂ 1,40	Liver 1,34	Placenta ♀ 1,30	Adrenal ♂ 1,10	Cerebrum 0,99
Co	0,01	Cerebellum																	
Cu	155,1	Pankreas 102,0	Pankreas 101,9	Conn. tiss. 41,8	Conn. tiss. 41,8	Cerebellum 35,6	Thyroid 28,1	Thymus 26,6	Dienceph. 25,4	Dienceph. 25,4	Spleen 24,4	Lung 23,9	Ovary 21,4	Adrenal ♀ 19,2	Placenta ♂ 16,9	Testis 15,7	Adrenal ♂ 13,4	Cerebrum 12,9	Cartilage 11,8
Fe	5293	Spleen 1339	Placenta ♂ 651	Placenta ♀ 537	Placenta ♀ 537	Adrenals ♀ 527,8	Pankreas 510,6	Lung 415	Ovary 345,1	Ovary 345,1	Adrenals ♂ 301,9	Conn. tiss. 295,3	Testis 288,5	Thyroid 281,4	Cerebellum 216,8	Thymus 173,4	Dienceph. 161	Cerebrum 124	Cartilage 90,1
Li	Conn. tiss.	Cartilage	Lung	Thyroid	Thyroid	Spleen	Cerebellum	Liver	Cerebrum	Cerebrum	Pankreas	Adrenals ♀	Placenta ♂	Testis	Placenta ♀	Ovary	Dienceph.	Thymus	Adrenals ♂
Mg	2458	Pankreas 1290	Thymus 1163	Testis 1121	Testis 1121	Conn. tiss. 1114	Lung 1062	Thyroid 1027	Cerebellum 1007	Cerebellum 1007	Placenta ♂ 979,6	Placenta ♀ 972,9	Liver 954,2	Spleen 944,5	Dienceph. 888,8	Adrenals ♀ 833,9	Ovary 795	Cerebrum 694	Adrenals ♂ 587,1
Mn	16,11	Thyroid	Pankreas 590	Adrenals ♀ 4,67	Adrenals ♀ 4,67	Adrenals ♂ 2,94	Testis 2,90	Conn. tiss. 2,79	Cerebellum 2,76	Cerebellum 2,76	Ovary 2,66	Placenta ♂ 2,23	Cartilage 2,1	Thymus 2,08	Placenta ♂ 1,97	Placenta ♂ 1,89	Lung 1,77	Cerebrum 1,66	Spleen 1,32
Mo	135	Adrenals ♀ 5,42	Pankreas 0,63	Ovary 0,33	Ovary 0,33	Testis 0,28	Placenta ♀ 0,26	Lung 0,22	Cerebrum 0,22	Cerebrum 0,22	Thyroid 0,20	Spleen 0,18	Thymus 0,18	Placenta ♂ 0,17	Cerebellum 0,16	Lung 0,15	Adrenals ♂ 0,1	Placenta ♂ 0,07	Cerebrum 0,05
Ni	9,27	Ovary	Cartilage	Conn. tiss.	Conn. tiss.	Spleen	Testis	Pankreas	Cerebrum	Cerebrum	Thyroid	Liver	Dienceph.	Dienceph.	Thymus	Lung	Placenta ♂	Placenta ♀	Adrenals ♂
P	14040	Thymus 14030	Testis 13890	Pankreas 13310	Pankreas 13310	Thymus 13290	Cerebellum 13250	Cartilage 13240	Placenta ♂ 13040	Placenta ♂ 13040	Adrenals ♂ 12910	Spleen 12830	Cerebrum 12330	Placenta ♂ 12230	Ovary 11890	Liver 11860	Adrenals ♂ 10000	Conn. tiss. 6395	Thyroid 5653
K	32440	Thymus 28400	Lung 23880	Cerebellum 21970	Cerebellum 21970	Dienceph. 21010	Ovary 18920	Pankreas 18630	Spleen 18630	Spleen 18630	Cerebrum 17890	Liver 16590	Placenta ♂ 16170	Thyroid 14900	Adrenals ♀ 13830	Adrenals ♀ 11970	Thyroid 10420	Conn. tiss. 9897	Cartilage 5593
Sc	2,75	Testis	Ovary	Adrenals ♀	Adrenals ♀	Cerebellum	Thyroid	Placenta ♂	Placenta ♂	Placenta ♂	Dienceph.	Thymus	Adrenals ♂	Conn. tiss.	Lung	Liver	Spleen	Cartilage	Pankreas
Na	28520	Lung 28280	Cartilage 20350	Conn. tiss. 18830	Conn. tiss. 18830	Placenta ♀ 14510	Pankreas 13430	Placenta ♂ 13390	Placenta ♂ 13390	Placenta ♂ 13390	Cerebrum 12990	Dienceph. 12040	Thyroid 11730	Thyroid 11700	Testis 8051	Thymus 7895	Spleen 5892	Adrenals ♀ 5452	Adrenals ♂ 5289
V	0,78	Spleen	Cartilage	Cerebellum	Cerebellum	Pankreas	0,16	0,15	0,15	0,15	0,14	0,13	0,12	Lung	0,11	Ovary	Cerebrum	Adrenals ♂	Thyroid
Zn	603,3	Pankreas 198,1	Testis 131,5	Placenta 115,1	Placenta 115,1	Lung 96,7	Cartilage 93,3	Placenta ♂ 85,9	Thymus 83,3	Thymus 83,3	Cerebellum 79,1	Thyroid 73,8	Conn. tiss. 72,3	Spleen 70,1	Adrenals ♀ 65,9	Dienceph. 59,2	Ovary 54,7	Cerebrum 51,9	Adrenals ♂ 40,1
Al	616,9	Pankreas 573,7	Lung 317,4	Spleen 139,1	Spleen 139,1	Thyroid 111,0	Liver 98,6	Thymus 74,7	Conn. tiss. 74,0	Conn. tiss. 74,0	Cerebellum 67,4	Thymus 60,2	Liver 59,3	Adrenals ♀ 39,1	Placenta ♂ 36,0	Cartilage 26,6	Placenta ♀ 24,4	Dienceph. 23,5	Cerebrum 20,9
As	5,30	Lung 5,72	Ovary 0,63	Conn. tiss. 0,53	Conn. tiss. 0,53	Thyroid 0,50	Testis 0,20	Pankreas 0,18	0,09	0,09	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Cd	0,60	Placenta ♀ 0,60	Cerebrum 0,46	Conn. tiss. 0,26	Conn. tiss. 0,26	Adrenals ♂ 0,21	Testis 0,21	Spleen 0,17	Liver 0,16	Liver 0,16	Lung 0,16	Placenta ♂ 0,14	Ovary 0,11	Thyroid 0,11	Thymus 0,1	Cartilage 0,1	Dienceph. 0,09	Cerebellum 0,08	Pankreas 0,05
Pb	1,4	Cerebrum 1,07	Dienceph. 0,50	Liver 0,41	Liver 0,41	Placenta ♀ 0,1	Cerebellum 0	Lung 0	Thymus 0	Thymus 0	Adrenals ♂ 0	Adrenals ♀ 0	Placenta ♂ 0	Testis 0	Ovary 0	Thyroid 0	Pankreas 0	Conn. tiss. 0	Cartilage 0
Hg	12,3	Cerebrum 2,20	Thyroid 2,17	Lung 1,53	Lung 1,53	Conn. tiss. 1,42	Cerebellum 1,34	Thymus 1,26	Liver 0,76	Liver 0,76	Placenta ♂ 0,65	Placenta ♀ 0,35	Spleen 0,18	Pankreas 0,11	Dienceph. 0	Adrenals ♂ 0	Adrenals ♀ 0	Testis 0	Cartilage 0

glands and the pancreas. Only traces are found in the diencephalon, male suprarenal glands and the cerebrum (0.05).

Nickel (Ni) – The most surprising distribution pattern of all elements. The highest concentrations are in the generating tissues of the female fetus, female suprarenal glands (9.27) and ovaries (5.92). These are paralleled by 10 times lower levels in the lung and placenta (0.60). A certain similarity can be identified with chromium.

Phosphorus. Highest phosphorus concentrations (P) are found in the lung (14.040), diencephalon and testes, with the lowest in the male suprarenal glands, connective tissue and thyroid (5.653).

Potassium (K) – Shows a steep gradient between the tissues rich in potassium, such as testes (32.440), thymus and lung, and the tissues with very little potassium, namely thyroid, connective tissue and cartilage (5.593).

Selenium (Se) – Tissues rich in selenium are the cerebrum (2.75), testes and ovaries; tissues low in selenium or free from selenium are cartilage, spleen, liver and placenta, with a 0-value.

Sodium (Na) – Represents the second largest quantitative share of the intracellular elements after potassium. The high values in the ovaries (28.520), lung and cartilage are paralleled by low values in the spleen and the suprarenal glands (5.289).

Vanadium (V) – Does not reach the 1.0 ppm in any tissue, with liver (0.78),

spleen and cartilage showing the highest values. Thyroid and male suprarenal glands do not contain any vanadium.

Zinc (Zn) – Found in large quantities in the liver (603.3), pancreas and testes. The concentration is lowest in the ovaries, cerebrum and the male suprarenal glands (40.1). There is also an interesting ratio between the testes (131.5) and ovaries (54.7).

Aluminium (Al) – Shows the highest concentrations in the ovaries (616.9), pancreas and lung, and the lowest concentrations in the cerebrum, female placenta, fetus and diencephalon (23.5).

Arsenic (As) – The cerebral hemispheres are alone at the top with 5.30, followed by the lung (0.72) and the ovary (0.63). Most fetal organs do not contain arsenic.

Cadmium (Cd) – Found in the female suprarenal glands and female placenta at 0.60 ppm and in the brain at 0.46 in measurable ranges. In most tissues its values are around or below 0.1 ppm.

Lead (Pb) – Found in the cerebrum (1.4), spleen (1.07) and diencephalon (0.50). Most fetal and juvenile tissues do not contain any lead.

Mercury (Hg) – Found, as for most heavy metals, in the cerebral hemispheres (12.3) but in lower concentrations in the ovaries (2.20) and the thyroid (2.17). Five organs, among them surprisingly the diencephalon, do not contain any trace of lead.

Tab. 7: Differences in the content on minerals, trace-elements and toxic metals in hormonproducing tissues of males and female origin. Noticable are the following differences: In pituary gland: Calcium, Chromium, Copper, Iron, Lithium. In testis and ovary: Magnesium, Chromium, Nickel, Sodium, Potassium. In adrenals: Chromium, Iron, Molybden, Nickel, Selenium. In placenta: Calcium, Copper, Zinc, Aluminium, Cadmium.

	Ca	Cr	Co	Cu	Fe	Li	Mg	Mn	Mo	Ni	P	K	Se	Na	V	Zn	Al	As	Cd	Pb	Hg
Adrenals ♂	613	1,10	0	13,4	301,9	0,51	587,1	2,94	0,07	0,56	10000	11970	0,20	5289	0	40,1	39,1	0	0,21	0	0
Adrenals ♀	658	17,80	0	19,2	537	0,99	833,9	4,67	0,86	9,27	12910	13830	0,88	5452	0,16	65,9	59,3	0,09	0,60	0	0
Placenta ♂	1150	1,30	0	16,9	651,1	0,88	979,6	1,89	0,17	0,65	13040	16170	0,67	13390	0,15	85,9	36,0	0	0,14	0	0,65
Placenta ♀	770,1	1,40	0	101,9	527,8	0,85	972,9	2,23	0,26	0,60	12230	14490	0,51	14510	0,13	115,1	24,4	0	0,60	0,11	0,35
Testis	919,8	1,59	0	15,7	288,9	0,86	1121	2,90	0,28	1,76	13890	32440	2,20	11700	0,14	131,5	74,7	0	0,21	0	0
Ovary	1077	6,11	0	21,7	345,1	0,84	755,1	2,66	0,33	5,42	11890	18920	1,41	28520	0,04	54,7	616,9	0,63	0,11	0	2,20
Pituary ♂	972	0,53	0	21	17	0,28	57	2,15	0,27	4,9	6398	9701	0,11	7317	0,34	49	21,6	0	0,25	1,24	0
Pituary ♀	1304	0,71	0	70	20	0,11	63	2,49	0,22	3,5	6409	11240	0,04	8146	0,14	74	17,9	0	0,24	5,14	0