EFFECT OF ORAL INGESTION OF DIFFERENT FORMS OF SILVER ON TISSUE CONTENT OF SOME ESSENTIAL ELEMENTS IN CHICKS

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ABSTRACT

Silver is ingested in India in the form of varak, Ayurvedic bhasm and water contained in silver utensils, but nobody knows their effects. We have examined the effect of interaction of silver ingested in the form of varak (leaf), bhasm (ash) and water (colloidal solution) on some essential elements (Na, K, Ca, Mg, Cu, Fe and Zn) in blood, liver, spleen and kidneys of chicks. The results showed significant rise of silver in all the tissues and significant fall in copper in the blood. The greatest rise was obtained in blood silver by silver sol while it had the lowest amount of silver. Iron significantly increased in tissues but somewhat decreased in blood. Zinc content increased in all the tissues by leaf and ash but decreased by sol. No consistent pattern was seen in case of other elements.

KEY WORDS

Silver, Bhasm, Chicks, Zinc, Iron, Copper.

INTRODUCTION

Silver is widely used in the form of leaf or foil (*varak*) in decorating sweets and betels in India and cakes and confectionary in the west (1). Silver leaf and *bhasm* (ash) are widely used in Ayurvedic system of medicine which considers it a tonic, stimulant, aphrodisiac and good for heart (2). These are also present in several Ayurvedic preparations, viz; Jayamangala Rasa, Vrihat Vata Gajankusa, Mahalakshmbilas Rasa, Kanchanabhra, Swasa Gajankusa, etc (3). Apart from it, many Indians drink water and milk kept in silverware as it is believed to be good for health and longevity (4).

Thus, silver is ingested by people despite it being a non essential element. Although no estimate of daily intake by Indians is available, an intake of 60 – 80 µgAg / day is reported as human dietary intake in the west. Obviously, the intake in Indians is much greater especially by those on silver therapy in Ayurved.

It is known that excess supply or retention of an inorganic element can displace another element in biological tissue to alter its concentration (5), which can induce metabolic responses in the tissues which, if incorporated, can produce either pathological changes or clinical diseases (6). In the light of this we decided to examine the effect of oral ingestion of silver on tissue content of some essential elements in chicks. The elements analyzed were sodium and potassium (alkali metals), calcium and magnesium (alkaline earth metals), copper, iron and zinc (transition metals) and silver (non-essential transition element). The effect of silver was seen in its three forms – metallic (foil or leaf), colloidal (sol) and complexed (ash or *bhasm*).

MATERIALS AND METHODS

This study was carried out on one month old, male, young chicks (*Gallus serregineus*) weighing about 1 kg and purchased from the local poultry. Chicks were preferred because of ease of handling, easy availability and larger blood volume. They were fed normal "Finisher mash" diet and water *ad libitum* (7).

The chicks were divided into four groups – one control group of 15 chicks and three experimental groups containing 10

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chicks in each group. The chicks of one of the experimental group were given 15 mg silver leaf mixed with about 1 gm of milk cake (*mawa* sweet) another group 2 mg of silver *bhasm* made into a pellet of wheat flour dough, and third group received 2 ml of silver sol containing 0.4 mg silver through a syringe. The details about preparation of these feeds is described in an earlier publication (8). This treatment was given for seven days. On 8th day the chicks were sacrificed, blood collected and liver, spleen and kidneys removed. These were then dry ashed in muffle furnace and ash was dissolved in nitric acid. Silver, copper, iron, zinc, calcium and magnesium were estimated in an atomic absorption spectrophotometer while sodium and potassium were determined in a flame photometer. The leaf, *bhasm* and sol were also assayed. All these details are already published (8).

RESULTS AND DISCUSSION

The effect of silver ingestion on tissue content of essential elements is shown in Table 1 to 8. As can be seen from Table 1, silver ingestion for one week significant increased in silver in blood of all the experimental group chicks as compared to control chicks. In fact, average increase of silver in blood by silver leaf was six times the control, about eleven times by *bhasm* and 24 times by the sol. This indicates that silver was absorbed from these preparations and hence the effect produced on other elements can be ascribed to it. The biological availability of silver from these three silver preparations did not bear any relation to amount of silver ingested, because in one week 105 mg silver was ingested in the leaf, 70 mg of *bhasm* equivalent to 30 mg of silver and only 2.8 mg silver in sol group. Thus sol was most effective and leaf was least effective. The silver contents of liver, kidney and spleen also increased significantly. The maximum rise occurred with the sol and minimum with the leaf.

Table 1: Silver Content of Chick Tissues
(Values are mean $\pm$ SD μ g / g wet tissue)

Group (n)	Blood	Liver	Spleen	Kidney
Control (15)	0.05 $\pm$ 0.07	0.19 $\pm$ 0.15	0.13 $\pm$ 0.09	0.09 $\pm$ 0.08
Silver leaf (10)	0.30 $\pm$ 0.14 ^c	0.52 $\pm$ 0.19 ^c	0.61 $\pm$ 0.23 ^c	0.40 $\pm$ 0.16 ^c
Silver Ash (10)	0.54 $\pm$ 0.17 ^c	0.31 $\pm$ 0.13 ^a	0.71 $\pm$ 0.30 ^c	0.31 $\pm$ 0.10 ^c
Silver Sol (10)	1.2 $\pm$ 0.4 ^c	1.9 $\pm$ 0.5 ^c	1.8 $\pm$ 0.7 ^c	2.0 $\pm$ 0.9 ^c

Statistical significance; a) P< 0.05; b) P<0.01; c) P<0.001

The copper content of chicks tissues is presented in Table 2. A statistically significant fall was observed in copper in blood by all the three silver preparations. Similarly, the silver sol caused statistically significant fall in all the four tissues

Table 2: Copper Content of Chick Tissues
(Values are mean $\pm$ SD μ g / g wet tissue)

Group (n)	Blood	Liver	Spleen	Kidney
Control (15)	1.1 $\pm$ 0.5	3.0 $\pm$ 0.7	1.6 $\pm$ 0.5	2.7 $\pm$ 0.5
Silver leaf (10)	0.7 $\pm$ 0.2 ^b	3.4 $\pm$ 0.5	1.7 $\pm$ 0.6	2.8 $\pm$ 0.3
Silver Ash (10)	0.3 $\pm$ 0.2 ^c	2.9 $\pm$ 0.7	1.3 $\pm$ 0.7	2.1 $\pm$ 0.5 ^a
Silver Sol (10)	0.2 $\pm$ 0.1 ^c	1.8 $\pm$ 0.6 ^c	0.4 $\pm$ 0.2 ^c	1.8 $\pm$ 0.8 ^b

Statistical significance; a) P< 0.05; b) P<0.01; c) P<0.001

examined. The *bhasm* also decreased copper in all the tissues but was statistically significant only in blood and kidney. The effect of leaf on copper in other tissues was non-significant.

As copper is in the same group of periodic table as silver, an antagonistic relationship is expected. This was actually observed by us in blood and in other tissues in silver sol group. It may be mentioned that Hirasawa and coworkers found significantly decreased copper in serum after injecting silver nitrate intraperitoneally to the rats (9).

The effect of silver on iron content of chick tissues is shown in Table 3. The blood level was slightly decreased in all the experimental groups but the fall was not significant. However, the tissue level of iron increased significantly in all the groups. A rise in iron in spleen and kidneys was also observed by Hirasawa et al. (9).

Table 3: Iron Content of Chick Tissues
(Values are mean $\pm$ SD μ g / g wet tissue)

Group (n)	Blood	Liver	Spleen	Kidney
Control (15)	76.0 $\pm$ 16.9	38.9 $\pm$ 14.2	50.3 $\pm$ 9.9	33.7 $\pm$ 7.8
Silver leaf (10)	73.8 $\pm$ 21.3	134.1 $\pm$ 18.5 ^c	127.4 $\pm$ 20.3 ^c	65.4 $\pm$ 16.7 ^c
Silver Ash (10)	61.7 $\pm$ 11.3 ^a	65.8 $\pm$ 4.5 ^c	75.8 $\pm$ 13.2 ^c	39.2 $\pm$ 11.1
Silver Sol (10)	71.1 $\pm$ 20.7	70.7 $\pm$ 15.7 ^c	88.9 $\pm$ 19.7 ^c	46.6 $\pm$ 12.3 ^c

Statistical significance; a) P< 0.05; b) P<0.01; c) P<0.001

Table 4: Zinc Content of Chick Tissues
(Values are mean $\pm$ SD μ g / g wet tissue)

Group (n)	Blood	Liver	Spleen	Kidney
Control (15)	3.5 $\pm$ 0.5	9.0 $\pm$ 2.4	9.8 $\pm$ 2.8	9.7 $\pm$ 2.5
Silver leaf (10)	5.2 $\pm$ 1.8 ^a	18.6 $\pm$ 1.6 ^c	15.3 $\pm$ 2.8 ^c	17.9 $\pm$ 2.7 ^c
Silver Ash (10)	7.2 $\pm$ 2.4 ^c	18.3 $\pm$ 3.2 ^c	18.4 $\pm$ 3.2 ^c	18.3 $\pm$ 2.9 ^c
Silver Sol (10)	1.5 $\pm$ 0.3 ^c	12.5 $\pm$ 1.9 ^c	6.4 $\pm$ 1.9 ^b	12.6 $\pm$ 3.6 ^a

Statistical significance; a) P< 0.05; b) P<0.01; c) P<0.001

As can be seen from Table 4, the zinc content of all the tissues increased significantly from control group level except blood and spleen zinc in silver sol group. An increase in zinc in liver, spleen and kidneys was also reported by Hirasawa et al (9).

The silver leaf ingestion did not alter calcium level of tissues but bhasm ingestion significantly raised calcium level in all tissues and sol in all tissues except blood (Table 5) On the

Table 5: Calcium Content of Chick Tissues
(Values are mean $\pm$ SD μ g / g wet tissue)

Group (n)	Blood	Liver	Spleen	Kidney
Control (15)	19.1 $\pm$ 4.5	4.6 $\pm$ 1.8	3.0 $\pm$ 1.6	8.6 $\pm$ 2.8
Silver leaf (10)	19.0 $\pm$ 2.9	4.5 $\pm$ 1.1	3.3 $\pm$ 0.7	8.6 $\pm$ 2.0
Silver Ash (10)	32.0 $\pm$ 4.0 ^c	8.8 $\pm$ 2.7 ^c	4.3 $\pm$ 1.3 ^a	14.2 $\pm$ 2.2 ^c
Silver Sol (10)	19.0 $\pm$ 5.2	7.9 $\pm$ 3.7 ^a	7.6 $\pm$ 3.8 ^b	19.4 $\pm$ 8.0 ^c

Statistical significance; a) P< 0.05; b) P<0.01; c) P<0.001

Table 6: Magnesium Content of Chick Tissues
(Values are mean $\pm$ SD μ g / g wet tissue)

Group (n)	Blood	Liver	Spleen	Kidney
Control (15)	32.1 $\pm$ 10.6	99.1 $\pm$ 17.0	113.0 $\pm$ 18.8	108.2 $\pm$ 18.1
Silver leaf (10)	35.5 $\pm$ 7.8	72.6 $\pm$ 7.1 ^c	70.1 $\pm$ 9.7 ^c	73.3 $\pm$ 9.7 ^c
Silver Ash (10)	47.7 $\pm$ 12.5 ^b	110.7 $\pm$ 10.6 ^a	125.7 $\pm$ 18.8	118.4 $\pm$ 9.6
Silver Sol (10)	63.7 $\pm$ 16.8 ^c	86.4 $\pm$ 5.9 ^a	96.7 $\pm$ 16.4 ^a	125.9 $\pm$ 21.3 ^a

Statistical significance; a) P< 0.05; b) P<0.01; c) P<0.001

Table 7: Sodium Content of Chick Tissues
(Values are mean $\pm$ SD μ g / g wet tissue)

Group (n)	Blood	Liver	Spleen	Kidney
Control (15)	1946 $\pm$ 74	1760 $\pm$ 176	1920 $\pm$ 467	2100 $\pm$ 300
Silver leaf (10)	1850 $\pm$ 97 ^a	1690 $\pm$ 213	1610 $\pm$ 202 ^a	2060 $\pm$ 316
Silver Ash (10)	1950 $\pm$ 52	1750 $\pm$ 108	2120 $\pm$ 555	2070 $\pm$ 125
Silver Sol (10)	1900 $\pm$ 47	1530 $\pm$ 105 ^c	1620 $\pm$ 229 ^a	2350 $\pm$ 359

Statistical significance; a) P< 0.05; b) P<0.01; c) P<0.001

Table 8: Potassium Content of Chick Tissues
(Values are mean $\pm$ SD μ g/g wet tissue)

Group (n)	Blood	Liver	Spleen	Kidney
Control (15)	2186 $\pm$ 665	5826 $\pm$ 778	6573 $\pm$ 1055	4706 $\pm$ 1039
Silver leaf (10)	540 $\pm$ 189 ^c	5430 $\pm$ 878	5530 $\pm$ 956 ^a	4330 $\pm$ 994
Silver Ash (10)	1000 $\pm$ 625 ^c	5490 $\pm$ 964	5090 $\pm$ 1185 ^b	6220 $\pm$ 1855 ^a
Silver Sol (10)	910 $\pm$ 119 ^c	6150 $\pm$ 869	7980 $\pm$ 1432 ^a	5710 $\pm$ 955 ^a

Statistical significance; a) P< 0.05; b) P<0.01; c) P<0.001

other hand, a similar element - magnesium showed erratic distribution in tissues after silver administration (Table 6). Similarly no consistent changes were observed in the tissue level of sodium (Table 7) and potassium (Table 8).

This study showed that silver ingested in any form affects tissue level of essential elements in a period as short as a week. The metabolic consequences of decrease in tissue copper and increased iron, zinc and calcium is hitherto unknown and may be interesting to investigate; because copper is essential for the activity of many oxidative enzymes, excess iron is toxic to the tissues, zinc plays a role in functioning of enzymes involved in free radical removal and calcium in functioning of nerves and muscles (1, 10).

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