10.1071/AN12048_AC

Supplementary Material: *Animal Production Science*, 2013, 53(3), 181–208.

Supplementary Material

Many factors influence the relative bioavailability (R) of elements present in feed including the level, chemical form, particle size, interactions with other feed components, chelators, inhibitors, the physiological status of the animal, age and species of animal as well as the processing conditions the feed or feed ingredient has been exposed to (Miles and Henry 2000). The table below lists indicative values for relative bioavailability of various feed additives and contamination sources relative to the soluble forms used in studies on the transfer of chemical elements to tissues, milk and eggs.

Table of indicative values for relative bioavailability (R), expressed as percentages

Element	Source	Poultry	Swine	Cattle	Sheep	Reference
Antimony (Sb)	Potassium antimonite*		100			Denys 2011
	Mining soils		1-11			Denys 2011
	Soil from steel foundries		5-11			Denys 2011
Arsenic (As)	As_2O_3, Arsenic sulfosalts		≤25			USEPA 2011
	Arsenic phosphate, As(M)oxide where M=Fe, Pb, Mn, Fe, Zn sulphates		25-75			USEPA 2011
	FeAsO		>75			USEPA 2011
	Sodium arsenate ($NaAsO_3$)*		100			USEPA 2011
	Calcine soil		4-23			Wragg et al. 2011
	Iron slag soil		22-43			Wragg et al. 2011
	Aberjona river sediment		37-51			Wragg et al. 2011
	Grossan soils		12-16			Juhasz et al. 2007
	Arsenic herbicide contaminated soil		10-80			Juhasz et al. 2007
	Arsenic pesticide contaminated soil		29-44			Juhasz et al. 2007
	Mine site soil		7-42			Juhasz et al. 2007
	Red ferrosol soil (spiked/aged)		24			Juhasz et al. 2008
	Brown chromosol (spiked/aged)		11-69			Juhasz et al. 2008
	Soil		78			USEPA 1996
	Slag		42			USEPA 1996
	Mining soils		3-15			Denys 2011
	Soil from steel founderies		35-72			Denys 2011
Cadmium (Cd)	Cadmium acetate*, Cadmium chloride*		100			
	Mining soils		12-51			Denys 2011
	Soil from steel founderies		75			Denys 2011
	Soils		10-79			Wragg et al. 2011
Chromium (Cr)	Chromium tripicolinate		100			Lindemann et al 2008
	Chromium propionate		13			Lindemann et al 2008
	Chromium methionine		51			Lindemann et al 2008
	Chromium yeast		23			Lindemann et al 2008
Copper (Cu)	$CuSO_4$•5(H_2O)* Cuprous oxide (Cu_2O)	100	100	100	100	Ammerman et al. 1998
	Copper EDTA	-	-	95	120	Ammerman et al. 1998
	Copper lysine	105	-	100	-	Ammerman et al. 1998
	Copper methionine	90	110	-	-	Ammerman et al. 1998
	Copper proteinate		-	-	130	Ammerman et al. 1998
	Cupric acetate*	100	-	-	-	Ammerman et al. 1998
	Cupric basic carbonate	115	-	-	-	Ammerman et al. 1998
	Cupric carbonate	65	85	-	-	Ammerman et al. 1998
	Cupric chloride	110	-	115	115	Ammerman et al. 1998

Element	Source	Poultry	Swine	Cattle	Sheep	Reference
	Cupric chloride, tribasic	105	-	-	-	Ammerman et al. 1998
	Cupric oxide (CuO)[B]	0	30	15	-	Ammerman et al. 1998
	Cuprous oxide (Cu_2O)	0	30	15	-	Ammerman et al. 1998
	Copper sulphide			25		Ammerman et al. 1998
Fluoride	NaF*	100	100	100	100	Clay and Suttie 1985
	Raw rock phosphate				69	Clay and Suttie 1985
	Dicalcium phosphate				52	Clay and Suttie 1985
	Defluorinated phosphate				20	Clay and Suttie 1985
	Soils			30-41	4.5-23	Wöhlbier et al 1968 (c) Milhaud et al. 1990 (sh)
Lead	Lead acetate*	100	100	100	100	
	Mn(Pb) oxide		>75			Casteel et al 2006
	Cerussite (lead carbonate)		>75			Casteel et al 2006
	Lead phosphate		25-75			Casteel et al 2006
	Lead oxide		25-75			Casteel et al 2006
	Fe/Pb oxide		<25			Casteel et al 2006
	Anglesite		<25			Casteel et al 2006
	Galena		<25			Casteel et al 2006
	Fe/Pb sulphates		<25			Casteel et al 2006
	Pb (M) oxide		<25			Casteel et al 2006
	Australian soils		<25			Juhasz et al. 2009
	Soils		1-87			Marschner et al. 2006, Schroder et al. 2004
	Mining soils		8-59			Denys 2011
	Soil from steel founderies		28-56			Denys 2011
Mercury	Mercuric chloride*		100			
	Cinnabar (HgS)		1.5-3			Schoof and Nielsen 1997
Selenium	Sodium selenite* (Na_2SeO_3), Cobalt selenite* ($CoSeO_3$)	100	100	100	100	Ammerman et al. 1998
	Selenocystine	110	-	-	-	Ammerman et al. 1998
	Selenomethionine	80-115	120-150	245	-	Ammerman et al. 1998
	Selenoyeast	-	-	290	100	Ammerman et al. 1998
	Selenium, elemental	5	-	-	0	Ammerman et al. 1998
Zinc	Zinc sulphate*, zinc chloride*, zinc acetate*	100	100	100	100	Ammerman et al. 1998
	Zinc, chelated	-	-	-	110	Ammerman et al. 1998
	Zinc lysine	-	100	-	-	Ammerman et al. 1998
	Zinc methionine	125	100	-	-	Ammerman et al. 1998
	Zinc proteinate	100				Ammerman et al. 1998
	Zinc sequestered				105	Ammerman et al. 1998
	Zn carbonate	105	-	60		Ammerman et al. 1998
	Zinc oxide	55-100	50	100	70	Ammerman et al. 1998
	Zinc, elemental	100	130	-	-	Ammerman et al. 1998

[A] relative bioavailabilities greater than 100 indicate greater bioavialability than the reference salts, indicated above with an asterix (*)
[B] Cupric oxide needles which are retained for extended periods within the intestinal tract of ruminants have been shown to be an effective source of copper.

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