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3 **Investigation of Selected Heavy Metals Concentration in**  
4 **Animal Feeds**

5

6 **ABSTRACT**

7 The animal feed materials contaminated with heavy metals, which usually comes from soils to  
8 plant, atmosphere and contaminated of seawater. These metals deposited in animal meat, liver  
9 and milk. The levels of these metals arise from modern agriculture methods, discharge of human  
10 and industrial waste in marine eco system and practice of adding food supplements, to increase  
11 its production. Various animal feed imported by local agents at UAE from different counties,  
12 were subjected for analysis at the National Laboratories Department, Ministry of Climate  
13 Change and Environment, located at Sharjah, UAE. ICP- MS technique used to measure the  
14 concentration of four selected heavy metals, mainly; Arsenic (As), Lead (Pb), Cadmium (Cd),  
15 and mercury (Hg), in imported animal feed, metal concentrations found to range as follows; (As)  
16 (0.06 - 2.63) ppm, Cd (0.02- 0.15) ppm, Hg (0.01- 0.52) ppm and Pb (0.14- 8.35) ppm.

17 **KEYWORDS:** Heavy metals concentration, Animal feed, ICP-MS analysis.

18 **INTRODUCTION**

19 Environmental contamination is a serious problem to animals as well as people's health, these  
20 trace metals found in soil, food, water and livestock organs, tissues and in livestock products  
21 were of great concern [1], studies shows that risk associated due to animal feed residues or  
22 metals in animal feed [2]. In recent years the modern industrialization and new agriculture  
23 techniques were main cause of environmental contamination.[3].

24 The cattle feed products contain heavy metals, such as cadmium, lead, arsenic, mercury and  
25 some metalloids are special concern because these trace metals are quickly transferred through  
26 food chain and cause interruption to important biological function. [4,5]

27 The main cause of environmental pollution was due to modern agricultural and industrial  
28 activities harms to ecological system. [1.5]

29 The entry of heavy metals in soils which include animal manures, sewage sludge, inorganic  
30 fertilizers and atmospheric deposition.[6] transfer of trace metals from the agricultural soils and  
31 farming industrial environment, use of huge amount precipitation and gas absorption methods.  
32 [7] these toxic metals from various sources increasing gradually taken up by plants and  
33 transferred to food chain. The accumulation of heavy metals in plants depends on nature of soil,  
34 type of plants and bioavailability of metals to uptake in soil - system. [8]

35 In recent years Many animal farms are established in china, annually it produces  $32 \times 108$  t of  
36 animal manure. [9] The animal manures were used in agriculture soils to increase the fertility and  
37 organic stock concentration. These practice leads to harmful environmental problems, like  
38 contamination of surface water with phosphate and nitrate.

39 The spreading of content of heavy metals in the atmosphere will transfer through food chain.  
40 the trace metals have high density related to water and available in different forms (Cr, Hg Pb,  
41 Cd), there heavier masses, toxic nature were concerns to heavy metals are harmful even at low  
42 amount. [10-13] Some trace elements are essential for plants, animals and humans. Such as Co,  
43 Cr, Fe, Cu were usually low concentration and called micronutrients. They were found in various  
44 metal concentration (ppm or ppb). [14]

45 The important metals typically found in animal food as nutrients to improve the animal  
46 production (European Union (EU) Reg. 1881/2006). Exposure to higher concentration leads to  
47 cellular disorder and source of contamination. [15] Other metals such as Cd, Pb, As, Hg were  
48 non-essential and toxicants. (Reg. 2002/32/EC). However, these heavy metals harm to humans  
49 and animal health, due to its toxic nature, they can damage the organs, even at lower  
50 concentration, and thus are important to keep under control.

51 The content of heavy metals mainly depends on the soil fertility, nature of climate and area of the  
52 location. Usually soils contain different heavy metals and their concentration can be increased by  
53 adding pesticides or fertilizers, these can be eliminated through animal urination. [16]

54 Our present study related to the investigation of concentration of selected heavy metals in  
55 different animal feed brought from many countries, usually used in UAE. The content of As, Pb,  
56 Cd and Hg of animal feed were analyzed using ICP- MS method.

## 57 **2. METHODS AND MATERIALS**

58 Different varieties of animal feed samples from different countries were collected at the port  
59 point for analysis. Animal feed supplement brought from Belgium and KSA, fish feed (pellets)  
60 from India and KSA, horse feed from UK, wheat bran from Mozambique, poultry feed from  
61 Greece and feed additive- mixed brought from South Korea. The main aim of the study is  
62 focused on the heavy metal content in animal feed in UAE.

63 All the samples were collected and preserved in airtight poly Ethelyn bags and stored at 4°C  
64 until the experimental work is completed. The wet digestion technique used to measure the  
65 concentration of four heavy metals. 1.0 gram of sample was transfer to keddahs flask and 3:1  
66 ratio of HCl and HNO<sub>3</sub> was added to the sample for digestion. The digested sample was heated  
67 to 40°C about half hour and its temperature increased up to 100°C, until a clear solution and  
68 fumes were vanished. It shows the completion of digestion of method.[17]

69 The distilled water was added to the solution and the Whatman filter paper used for filtration.  
70 The polyethylene bottles were filled with digested solution and the heavy metal analysis were  
71 carried out using ICP- MS method.

## 72 **3- RESULTS AND DISCUSSION**

73 The heavy metal content of different animal feed samples was tabulated in Table 1. The four  
74 heavy metal concentration As, Cd, Hg, Pb were analyzed using ICP- MS technique. The mean  
75 values of metals concentration in (As, Cd, Hg, Pb) as follows 0.47ppm, 0.08ppm, 0.09ppm,  
76 2.02ppm respectively.

Table (1). Heavy metal concentration of animal feed

sample type	physical texture	origin of country	Ppm concent.			
			As (ppm)	Cd (ppm)	Hg (ppm)	Pb (ppm)
fish feed	sinking pellets	KSA	1.05	0.20	0.02	0.14
fish feed	small pellets	India	0.37	0.07	0.26	3.20
fish feed	small pellets	India	0.39	0.04	0.24	2.75
fish feed	small pellets	India	1.25	0.10	0.18	4.11
fish feed	small pellets	India	0.42	0.06	0.12	5.27
fish feed	small pellets	India	0.82	0.06	0.14	5.28
fish feed	small pellets	India	0.43	0.07	0.05	3.38
fish feed	small pellets	KSA	1.13	0.13	0.33	0.32
fish feed	small pellets	KSA	1.55	0.14	0.10	0.24
fish feed	small pellets	KSA	2.02	0.49	0.07	0.33
fish feed	small pellets	KSA	0.29	0.15	0.05	0.19
Animal feed supplement	pellets	KSA	0.37	0.09	0.01	0.52
Animal feed supplement	pellets	KSA	0.17	0.06	0.01	0.30
Animal feed supplement (Gastroguts)	crumbles	Belgium	2.63	0.05	0.52	8.35
wheat bran	light fluffy texture	Mozambique	0.07	0.08	0.05	0.17
poultry feed	crumbles	Greece	0.06	0.04	0.02	2.17
feed additive-sugar beet pellet	pellets	Egypt	0.06	0.04	0.00	0.87
feed additive- mixed hay	grassy	South Korea	0.09	0.02	(0.00)	0.23
feed additive-growth rabbit feed	chunk	Egypt	0.12	0.07	(0.00)	0.46
horse feed	mixed grain-chunks	UK	0.20	0.10	0.06	0.23
horse feed	pellets	UK	0.13	0.04	(0.02)	0.27
horse feed	pellets	UK	0.06	0.08	(0.02)	0.18
horse feed	mixed grain-chunks	Australia	0.25	0.03	0.06	0.34
horse feed	mixed grain-chunks	UK	0.21	0.06	0.07	0.39
camel racing diet -mixed feed	pellets	UK	0.17	0.15	0.01	0.58

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Comment [gc1]: These data refer to the same food. They can be described by the general average.

Comment [gc2]: This is the highest value?

Comment [gc3]:

Comment [gc4]: Describe the value you are referring to.

Comment [gc5]: This value (0.15ppm) does not correspond to the highest.

77 The content of As in animal feed supplement (Gastroguts) from Belgium is higher (2.63ppm),  
 78 the amount of Cd was higher in horse feed, and camel racing diet -mixed feed from UK, the  
 79 content of Hg was higher in Gastroguts from Belgium used as animal feed supplement  
 80 (0.52ppm), and concentration of Pb was higher in Animal feed supplement from Belgium, and  
 81 fish feed from India (8.35ppm and 5.28ppm) were compared to other samples used for our  
 82 analysis, as shows the toxic metal concentrations of animal feed and supplements of our study  
 83 compared with other animal feed and manures of various countries.

84 **Arsenic (As):**

85 The more poisonous organ arsenic found in animal feed and livestock's due to modern farming  
86 activities. Usually As is present in liquids sprayers to control ectoparasites of animals and animal  
87 feed. Its chronic toxicity results in weight loss, mouth infection, decrease the milk yield. The  
88 acute toxicity effects were abdominal pain electrocardiogram. [18]

89 The content of Arsenic (As) in different animal feed and its supplements ranged from 0.06-2.63  
90 ppm. While the As values were lower compared to other countries. like fish feed from Thailand,  
91 Denmark were 7 ppm, 6.9 ppm, horse feed from Germany 6.7- 8.7 ppm and mineral feed as 12  
92 ppm. Dairy cattle field, animal manure of England and wales as 3.03 ppm and 9.01 ppm  
93 respectively contain high amount of Arsenic. [19]

#### 94 **Cadmium (Cd):**

95 Cadmium is toxic to both humans and animals. it accumulates in liver and kidney for long time  
96 exposure.[20] Usually Cd is not added in animal feed, but it is present in mineral supplement like  
97 zinc sulfate, phosphate and zinc oxide like impurity's and enters animal forms causes  
98 contamination. [21]

99 The amount of Cd in our present study ranged from 0.02-0.20 ppm. The values are low  
100 compared to different countries, such as dairy cattle fields, animal manures and poultry of  
101 England and wales as 1.79 ppm, 1.06 ppm and 0.19 ppm respectively.[22] Whereas in Netherland  
102 from year between 2001-2013 the Cd levels in dairy cattle feed, beef cattle feed was 3.77ppm  
103 and 5.1 ppm respectively. [19]

#### 104 **Mercury (Hg):**

105 Mercury is more toxic even at low content. The main source of mercury pollution is due to  
106 sewage water and waste from industries. It is hazards to humans and as well as animals, the  
107 toxicity in animals leads to visual deviation and decrease of awareness. The Hg content in fish is  
108 more than 0.4ppm they cause harm to humans. The animal cattle consume more amount of Hg  
109 leads to disorders such as visual, neuropathy and gastrointestinal.[23]

110 The quantity of Hg ranged from 0-0.52 ppm. Mercury concentration of present study shows little  
111 higher when compared to Czech Republic in poultry farms as 0.344 ppm. [19]

112 **Lead (Pb):**

113 The main source of lead contamination is due to industrial wastes, which may spread through  
114 soil, water and food. Lead poisoning widely found in animals, these lead to more attention on  
115 animal health and environment. It deposited in bone, kidney and other tissues. Lead ingestion  
116 increase the lead levels in blood and causes blood lead burden.[24]

117 The lead values ranged from 0.14-8.35 ppm. The high levels of Pb were reported in the current  
118 study .In which Animal feed supplement (crumbles) from Belgium and fish feed from India  
119 contains significantly higher amount of Pb as 8.32ppm,3.20ppm and 4.11ppm respectively, these  
120 results were compared to other nations such as England , wales and Germany ,shows that higher  
121 content of Hg was present in animal manure from England and wales as 7.07ppm,3.62ppm and  
122 8.37ppm respectively whereas in Germany the horse feed contain significantly high amount of  
123 Hg as 52ppm.[22]

124 The heavy metal concentration of different animal feed and supplements were analyzed in this  
125 work. Metals concentration of As, Cd and Hg were low compared to other animal food products  
126 of various countries, the content of Pb is a little higher in animal feed supplement from Belgium  
127 and fish feed from India. These significant results shows that the animal feed products used in  
128 UAE contain normal levels of heavy metals. monitoring of the heavy metal's concentration must  
129 be carried out on random samples to avoid health risk problems associated to animals as well as  
130 humans.

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**Table (2).** Heavy metal concentration of animal feed from different countries

type of animal feed	country of origin	AS(ppm)	Cd(ppm)	Hg(ppm)	Pb(ppm)	reference
Dairy cattle feed	England and Wales	0.37	0.19		2	24
Dairy cattle feed	England and Wales	0.13	0.12		2.07	24
Dairy cattle feed	England and Wales	0.2	0.29		2.24	24
Dairy cattle feed	England and Wales	1.6	1.79		5.5	24
Dairy cattle feed	England and Wales	3.03	0.16		1.88	24

	Wales				
beef cattle feed	England and Wales	0.49	0.27	<1.00	24
beef cattle feed	England and Wales	0.24-1.16	0.10-0.79		24
beef cattle feed	England and Wales	<0.10	0.11	3.64	24
beef cattle feed	England and Wales	<0.10	0.1	<1.00	24
beef cattle feed	England and Wales				24
poultry cattle	England and Wales	0.23	0.19	<1.00	24
poultry cattle	England and Wales	0.25	0.16	<1.00	24
poultry cattle	England and Wales	0.15	0.12	<1.00	24
poultry cattle	England and Wales	0.35	0.15	<1.00	24
poultry cattle	England and Wales	0.28	0.14	<1.00	24
animal manures	England and Wales	1.63	0.38	3.61	24
animal manures	England and Wales	2.6	0.26	7.07	24
animal manures	England and Wales	9.01	0.42	3.62	24
animal manures	England and Wales	0.46	1.06	8.37	24
fish feed	Thailand	7			21
fish feed	Denmark	6.9			21
HORSE	Germany	8.7			21
HORSE	Germany			52	21
HORSE	Czech Republic		0.344		21
Dairy cattle feed			5.1		21
Dairy cattle feed			3.77		21
fish feed			0.5		21
fish feed			0.087-		21
fish shrimp	Belgium		0.012		21

131

#### 132 4. CONCLUSION

133 Investigation of heavy metals contaminations in different animals feed is very important issue in  
 134 every country as major health and safety requirements. In this study, ICP- MS technique used to

135 measure the concentration of four selected heavy metals, including; Arsenic (As), Lead (Pb),  
136 Cadmium (Cd), and Mercury (Hg), in recently imported different sources animal feed.

137 The results of this investigation of the selected metal concentrations was in the following range,  
138 (As) (0.06 - 2.63) ppm, Cd (0.02- 0.15) ppm, Hg (0.01- 0.52) ppm and Pb (0.14- 8.35) ppm.

139 While these results are in agreeable range at international level in most cases, the lead (Pb)  
140 concentration needs to look at and control.

#### 141 **COMPETING INTERESTS**

142 Authors have declared that no competing interest exist.

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