

## PESTICIDES AND TOXIC METALS RESIDUES IN MUSCLE AND LIVER TISSUES OF SHEEP, CATTLE AND DROMEDARY CAMEL IN SAUDI ARABIA

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**Abstract:** Data regarding determination of pesticide residues and toxic elements in edible tissues of different animals particularly in the camels in Eastern region of Saudi Arabia are scarce. Therefore, current study aimed to evaluate levels of forty-five pesticides and heavy metals (lead (Pb); cadmium (Cd); Arsenic (As)) in muscle and liver tissue samples that collected from forty-two animals; sheep (n=21), cattle (n=11) and dromedary camels (n=10) admitted to Al-Ahsa abattoir, Eastern province, Saudi Arabia. Seven of forty-five pesticides residues were detected in tissues by gas chromatographic mass spectrometry (GC/MS). The detected pesticides were organophosphorus (diazinon, profenofos and coumaphos), pyrethroid (cypermethrin, permethrin and lambda-cyhalothrin) and acaricide (amitraz). Diazinon has been detected in both muscle and liver tissues of all examined carcasses. However, other detected residues distributed according to species. All toxic metals have been detected in both muscle and liver tissues of all tested animals. The heavy metal loads were species independent. The concentrations of Pb and As in liver tissues were comparable to that of muscle tissues of all tested animals. However, the concentrations of Cd in liver were significantly higher than that in muscles of all tested animals. All values of detected pesticide residues and heavy metals were below the maximum residue limits (MRLs). In conclusion, pesticide residues and toxic metals were detected in meat and liver tissues of sheep, cattle and dromedary camels that admitted to Al-Ahsa abattoir, Saudi Arabia. The detected pesticides residues and toxic metals were well below MRLs; thereby no risks are associated with its human consumption.

**Key words:** chromatography; residues; toxic elements; meat; pesticides; animals

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### Introduction

The use of pesticide increased steadily during 1996-2013 in Saudi Arabia (1). In 2013, the

total usage of insecticide was 3130.5 tons of active ingredients compare to that during 2012 (2889 tons of active ingredients). The organophosphate ranked first of pesticide used during this period (1). The Date Palme still represents the most important crop cultivated in Al-Ahsa, Eastern Province, Saudi Arabia and an element contributing in economy of the beautiful oasis, Al-Ahsa. Pesticides used in Al-Ahsa to fight the red date Palme weevil (2) and other pests that attack different varieties of vegetable crops cultivated in Al-Ahsa region (1). Contamination of the environment with pesticide residues has been documented earlier (3). Based on the reports of the toxicity and detrimental effects of pesticides, their use has been restricted worldwide. Although the use of most of pesticides has been restricted, its residues in food were detected (4). Water, plants and grasses that contaminated by pesticides residues may ingested by herbivorous animals and secreted in meat and/or milk (4). Pesticides residues contamination has been reported in processed food (5, 6) and eggs (7, 8). In addition, organochlorine pesticides have been detected in edible tissues of camel, cattle and sheep carcasses slaughtered in Sharkia Province of Egypt (9), in meat of sheep slaughtered in Jaipur area of India (10) and in fish and poultry meat in India (11). The dromedary camels are one of the important sources of meat in the semiarid and arid areas of Asia and Africa (12). Camel meat characters are near to that of other red meat animal species (12). In Al-Ahsa region, camel meat is preferable along with the other meats of sheep and cattle. However, data reporting the detection of pesticides residues in edible tissues of these animals reared in Al-Ahsa region of eastern province of Saudi Arabia are scarce. The inorganic arsenic is more toxic than organic one. However, it is reported in literatures as total arsenic (13). The exposure of animal to lead increased when feed materials mixed with contaminated soil (14). Regarding lead toxicity, cattle and sheep are the most sensitive animal species. The elimination of lead is incomplete and slow. Its half-life is approximately 250 days in ewes, between 95 and 760 days in cattle (15, 16), and 2 to 18 years in humans (17, 18). Like lead, animal exposed

to cadmium through plants mixed with contaminated soil (19). Cadmium classified as a human carcinogen (Group 1) by International Agency of Cancer Research particularly cancer in lungs, endometrial tissue, bladder, and breast (20). Only one report (21) originated from our laboratory demonstrated the detection of metal contents in the edible tissues of camel and sheep slaughtered in Saudi Arabia. However, in this report (21), cattle meat and liver tissues were not investigated. GC-MS used for high speed, excellent separation and quantitative analysis of many volatile pesticides (22-29). The current study aimed to evaluate levels of forty-five pesticides and heavy metals (lead (Pb); cadmium (Cd); Arsenic (As)) in muscle and liver tissue samples that collected from forty-two animals; sheep (n=21), cattle (n=11) and dromedary camels (n=10) admitted to Al-Ahsa abattoir, Eastern province, Saudi Arabia.

## Material and methods

### *Animals and samples*

Specimens of muscle (n=42) and liver (n=42) tissues have been collected from 42 animals of three species namely sheep (n=21), cattle (n=11) and dromedary camels (n=10) that have been admitted to Al-Ahsa abattoir, Eastern province, Saudi Arabia (25°22'18.1"N 49°26'21.1"E) directly after slaughter. Age of animals was determined by visual examination of teeth during the ante-mortem inspection (25). The average age of the slaughtered camel and cattle was estimated to be  $5 \pm 2$  years, respectively while for sheep was and  $8 \pm 3$  months. All animals were apparently healthy, active, and free from any disease. Sampled tissues for pesticide and heavy metal residues analysis were stored in plastic falcon tubes and stored at  $-20^{\circ}\text{C}$  until the time of extraction and measurement of 45 pesticide and heavy metal residues. The experiments and procedures were done according to the regulations and guidelines of ethical research committee, King Faisal University, Saudi Arabia. All chemicals were purchased from Merck, Darmstadt, Germany and were of HPLC grade or the highest quality available. Specifications for pesticides standards used in the study are illustrated at Table 1.

*Analytical procedure for pesticide residues*

The QuEChERS EN 15662 method for pesticide residue extraction was used (30) and the obtained extracts were transferred to an auto sampler vial of GC-MS for analysis of pesticide residues. Pesticides residues have been detected by GC/MS system (Shimadzu GC/MS-QP2010 Plus, Japan) equipped with a capillary column DB-5MS (30m length, 0.25 mm thickness, 0.25m diameter). The temperature of injector was 250°C. The temperature program of oven started with 60°C. Hold 6 min at 7°C/min to 200 °C, at 5 °C/min to 280 °C. Hold 20 min; carrier gas, helium; purity,  $\geq 99.999\%$ ; flow rate, 1.2 ml/min; injection port temperature, 250 °C; injection volume, 1 $\mu$ l; injection mode, splitless, purge on after 1.5 min; ionization voltage, 70 eV; ion source temperature, 220 °C; GC/MS interface temperature, 250°C. The analyses were done at two modes, Selective Ion Monitoring (SIM mode) and full Scan mode for enhanced sensitivity and selectivity. The limits of detection (LOD) and limit of quantification (LOQ) for all pesticides are shown in Table 2.

*Analysis of heavy metals (Pb, Cd and As)*

The digestion of muscle and liver samples and the GFA-EX7 graphite furnace atomic absorption spectrophotometric (Shimadzu, Kyoto, Japan) determination of Pb, Cd and As were done as described earlier (31, 32). Preparation of standard stock solutions of Cd, Pb and As and calibration procedures were the same of that discussed in our previous works (31, 32). The LOD for the three investigated heavy metals was 1  $\mu$ g/kg. The absorbance was obtained by adjusting the hollow cathode lamps at the operation conditions shown in Table 3.

*Analytical quality control*

In the present study, to check the efficiency of digestion procedures and the subsequent recovery of the pesticides and metals, homogeneous mixtures of three samples of each of muscle and liver were spiked with multi-elements and multi-pesticides solutions that contain standard solutions of all pesticides and metals considered in the present study. Solutions were spiked in a manner to attain final concentrations of 3 $\mu$ g/g. A mixture without any pesticides and metals was used as control. All mixtures were

then subjected to the digestion procedure. The resulting solutions were analyzed three times for pesticides and metal concentrations according to the same procedures as the samples to establish confidence in the accuracy and reliability of data generated. The amount of spiked pesticides and metals recovered after the digestion of the spiked samples were used to calculate percentage recovery as described earlier (33). The pesticide recovered from both tissues in a percentage over 89% as indicated at Table 2. All heavy metals recovered in a percentage ranged between (89.6-94.2 %) and (85-89.4 %) in liver and muscle tissues, respectively (Table 4).

*Specificity*

The specificity was confirmed based on the presence of the transition ions (quantifier and qualifier) at the correct retention times (that was defined formerly by using one sample from each type that spiked at 10ng/g to check the retention time of pesticides) corresponding to that of the precursor ion presented in Table 1. The measured peak area ratios of qualifier/quantifier were within the range defined in EU Commission Decision 2002/657/EC when compared to the standards.

*Statistical analysis*

The statistical analysis was performed using the SPSS 6.1.3 software package (SAS, Cary, NC, USA). All data were analyzed for variance using ANOVA test.

**Results and discussion**

Data summarized in Table 1 and Figure 1 indicated that, the total number of investigated pesticides standards were 45 standards. However, gas chromatographic analysis indicated the existence of only 7 types of pesticides residues (Diazinon, Lambda-Cyhalothrin-II, Profenofos, Cis-Permethrin, Cypermethrin, Amitraz, coumaphos). The aim behind the screening of large number of pesticides was to cover all existing chemical classes that includes, organophosphates, organo-chlorine, carbamates, synthetic pyrethroids, triazines, pyrimidines, triazoles, dicarboximides, bezimid-

azole, dithiocarbamates, nicotinoids, dinitrophenol, pesticides aliphatic nitrogen, pesticides morpholine, pesticides from natural product derivatives, and pesticides of substituted urea class. However, only seven of screened pesticides have been detected in muscle and liver tissues of all tested animals (Table 1). The detected pesticides residues are of listed pesticides residues monitored in Saudi agricultural soils (34). Diazinon has been detected in muscle and liver tissues of all examined carcasses. This may attributed to the extensive use of diazinon for eradication of Ticks that affected animals related to all areas of Al-Ahsa governorate as said by the habitants of that region. Other detected pesticides residues were species related (Table 5 and 6). Profenofos residues has been detected in examined tissues of sheep and camels whereas, amitraz and permethrin have been detected only in muscle and liver of cattle carcass (Table 5 and 6). Coumaphos detected only in examined tissues of sheep carcass while Lambda-Cyhalothrin residues were detected only in muscle and liver tissues of camel carcass (Tables 5 and 6). The variation of pesticides contamination among tested animals may attribute to different contaminated areas because animals who admitted to Al-Ahsa abattoir were from different areas of Al-Ahsa governorate. The area dependent pesticides contamination has been confirmed in other study in Egypt (35). The data described in Tables 5 and 6 indicated that, all values of detected pesticide residues were below the international permissible limits (14). Parallel to the current findings, earlier report (9) demonstrated that, the organochlorines residues detected in muscle and liver tissues of camel, sheep and cattle were well below the respective MRLs set by local or international organizations. Data summarized in Tables 7 indicated that, the investigated toxic metal residues have been detected in muscle and liver tissues of all examined carcasses. The heavy metal loads were species independent (Tables 7). The concentrations of Pb and As in liver tissues were comparable to that of muscle tissues of all tested animals. However, the concentration of Cd in liver was significantly higher than its concentration in muscle in all

tested animals (Tables 7). This may attribute to the fact that, the liver is main organ for detoxification in the live organism (36). The current findings come in accordance with recent work (21) reported that, liver tissues had a higher loads of heavy metals (Cd, Pb and As) than that of muscle tissues in camel and sheep slaughtered in the same area of Saudi Arabia. All values of detected heavy metals were well below the international permissible limit as described in Tables 7 (4, 13, 14, 20, 21, 37). The highest detected average of Arsenic, lead and cadmium residues either in muscle or in liver tissues were  $11.6 \pm 2.0 \mu\text{g/kg}$ ,  $10.5 \pm 1.8 \mu\text{g/kg}$  and  $0.9 \pm 0.1 \mu\text{g/kg}$  whereas the arsenic, lead and cadmium MRLs are  $1000 \mu\text{g/kg}$ ,  $500 \mu\text{g/kg}$  and  $1000 \mu\text{g/kg}$ , respectively. This indicated that, the contaminated tissues with all toxic elements are negligible and safe for human consumption. The detected values of Arsenic, lead and cadmium residues were much lower than that reported in liver and kidney bovine tissues ( $27.42\text{--}30.55 \mu\text{g/kg}$ ;  $231\text{--}226.96 \mu\text{g/kg}$ ;  $207.5\text{--}197 \mu\text{g/kg}$ ; (38), respectively. The wide range between detected elements in the current study compared with earlier report (38) may attribute to different detection limits and sensitivity. Earlier detection limits (38) were  $100 \mu\text{g/kg}$  for Cd,  $150 \mu\text{g/kg}$  for Pb and  $30 \mu\text{g/kg}$  for As. However, in the current study the detection limits were  $1 \mu\text{g/kg}$  for the three investigated elements. The detected values of Cd and As in liver of camel ( $1.3 \pm 0.1 \mu\text{g/kg}$ ;  $1.4 \pm 0.4 \mu\text{g/kg}$ ) and sheep ( $11.6 \pm 2.0 \mu\text{g/kg}$ ;  $8.0 \pm 2.0 \mu\text{g/kg}$ ), respectively were near to that reported recently (21) in liver of camel ( $2.18 \pm 0.71 \mu\text{g/kg}$ ;  $1.79 \pm 0.66 \mu\text{g/kg}$ ) and sheep ( $38.41 \pm 25.15 \mu\text{g/kg}$ ;  $30.29 \pm 22.57 \mu\text{g/kg}$ ), respectively. The values of Cd and As in the muscle of camel ( $0.9 \pm 0.1 \mu\text{g/kg}$ ;  $0.6 \pm 0.1 \mu\text{g/kg}$ ) and sheep ( $8.0 \pm 1.1 \mu\text{g/kg}$ ;  $6.4 \pm 1.2 \mu\text{g/kg}$ ) respectively were near to that reported recently (21) in muscle of camel ( $0.29 \pm 0.27 \mu\text{g/kg}$ ;  $0.44 \pm 0.17 \mu\text{g/kg}$ ) and sheep ( $12.89 \pm 4.24 \mu\text{g/kg}$ ;  $10.05 \pm 3.77 \mu\text{g/kg}$ ), respectively. In the current study, the detected values of Pb in liver and muscle of camel and sheep were exactly comparable to that reported earlier in the same tissues of the same tested animals (21).

**Table 1:** Specifications for pesticides standards used in the study

No	Name of pesticide	Retention time	Quantifying ion	Qualifying ion1	Qualifying ion2	No	Name of pesticide	Retention time	Quantifying ion	Qualifying ion1	Qualifying ion2
1	Demeton-S-methyl	10.129	263	169	127	26	Propargite-I	31.003	135	350(7)	173(16)
2	$\alpha$ -HCH	11.108	219	183(98)	221(47)	27	Profenofos*	31.382	339	374 (39)	297 (37)
3	Diazinon *	15.670	304	179(192)	137(172)	28	Bifenthrin	32.39	181	166 (25)	165 (23)
4	HCB	17.567	284	282(51)	286(81)	29	Methoxychor	32.672	277	228(16)	212(4)
5	Phorate	18.271	260	121(160)	231(156)	30	Captan	32.782	264	149(104)	150(70)
6	$\beta$ -HCH	19.954	219	217(78)	181(94)	31	Formothion	32.884	170	224(97)	257(63)
7	$\delta$ -HCH	20.108	219	217(80)	181(99)	32	p,p'-DDT	33.108	235	237(65)	246(7)
8	Heptachlor	20.503	272	237(40)	337(27)	33	p,p'-DDD	33.232	235	237(64)	199(12)
9	Aldrin	20.743	263	265(65)	293(40)	34	Cis-Permethrin *	33.759	183	184(14)	255(1)
10	Lambda-Cyhalothrin-II *	22.533	181	241(205)	243(152)	35	Captafol	34.565	149	150(79)	152(79)
11	$\alpha$ -Endosulfan	23.087	241	265(66)	339(46)	36	p,p'-DDE	36.154	318	316(80)	246(139)
12	chlorothalonil	23.995	264	266(109)	268(62)	37	O,p'-DDD	36.337	235	237(65)	165(39)
13	Methylparathion	25.056	263	233(66)	246(8)	38	Cypermethrin*	36.457	181	152(23)	180(16)
14	Endosulfan sulfate	25.313	241	265(66)	339(46)	39	Amitraz*	36.613	293	162(113)	132(104)
15	Dieldrin	27.196	263	277(82)	380(30)	40	coumaphos*	37.106	362	226(56)	364(39)
16	Endrin	27.432	263	317(30)	345(26)	41	Trans-Permethrin	37.231	183	184(14)	255(1)
17	O,p'-DDE	27.683	246	318(34)	176(26)	42	Fenvalerate	37.317	167	225(53)	419(37)
18	Dicofol	28.104	139	141(72)	250(23)	43	Deltamethrin	37.969	181	172(25)	174(25)
19	Malathion	28.418	173	158(36)	143(15)	44	Cyfluthrin	41.512	206	199(63)	226(72)
20	Fenithrothion	29.053	277	260(52)	247(60)	45	Esfenvalerate	46.085	419	225(158)	181(189)
21	Bromopropylate	29.452	341	183(34)	339(49)						
22	penconazol	30.101	248	250(33)	161(50)						
23	Pirimiphos-methyl	30.281	290	276(86)	305(74)						
24	Procymidone	30.448	283	285(70)	255(15)						
25	o,p'-DDT	30.767	235	237(65)	246(7)						

\*Tissues detected pesticides

**Table 2:** Limit of Detection (LOD), Limit of Quantification (LOQ) and recovery percentages of pesticide measured using the ions for each pesticide molecule

No	Name of pesticide	RT	LOD ( $\mu\text{g/g}$ )	LOQ ( $\mu\text{g/g}$ )	Recovery %
1	Demeton-S-methyl	10.129	0.02	0.06	89.2
2	$\alpha$ -HCH	11.108	0.02	0.06	90.2
3	Diazinon *	15.670	0.006	0.017	95.0
4	HCB	17.567	0.02	0.06	92.1
5	Phorate	18.271	0.03	0.12	89.9
6	$\beta$ -HCH	19.954	0.01	0.03	90.5
7	$\delta$ -HCH	20.108	0.01	0.03	90.6
8	Heptachlor	20.503	0.002	0.007	92.4
9	Aldrin	20.743	0.02	0.05	89.5
10	Lambda-Cyhalothrin-II *	22.533	0.004	0.01	91.7
11	$\alpha$ -Endosulfan	23.087	0.003	0.008	90.9
12	chlorothalonil	23.995	0.006	0.015	93.3
13	Methylparathion	25.056	0.004	0.012	94.5
14	Endosulfan sulfate	25.313	0.002	0.006	93.4
15	Dieldrin	27.196	0.02	0.008	93.1
16	Endrin	27.432	0.01	0.04	92.2

**Table 2:** Continuation

No	Name of pesticide	RT	LOD ( $\mu\text{g/g}$ )	LOQ ( $\mu\text{g/g}$ )	Recovery %
17	O,p'-DDE	27.683	0.02	0.06	90.5
18	Dicofol	28.104	0.003	0.009	90.7
19	Malathion	28.418	0.005	0.012	90.0
20	Fenithrothion	29.053	0.004	0.013	91.9
21	Bromopropylate	29.452	0.005	0.015	92.9
22	penconazol	30.101	0.004	0.012	93.0
23	Pirimiphos-methyl	30.281	0.006	0.018	90,1
24	Procymidone	30.448	0.01	0.030	90,7
25	o,p'-DDT	30.767	0.009	0.016	91.7
26	Propargite-I	31.003	0.009	0.015	91.4
27	Profenofos*	31.382	0.004	0.010	92.5
28	Bifenthrin	32.39	0.002	0.006	90.4
29	Methoxychor	32.672	0.006	0.012	93.7
30	Captan	32.782	0.01	0.03	94.0
31	Formothion	32.884	0.004	0.012	90.2
32	p,p'-DDT	33.108	0.002	0.006	92.9
33	p,p'-DDD	33.232	0.003	0.013	91.9
34	Cis-Permethrin *	33.759	0.004	0.010	93.7
35	Captafol	34.565	0.001	0.004	91,4
36	p,p'-DDE	36.154	0.004	0.011	89.8
37	O',p'-DDD	36.337	0.004	0.012	89.7
38	Cypermethrin*	36.457	0.003	0.009	93.9
39	Amitraz*	36.613	0.002	0.006	89.6
40	coumaphos*	37.106	0.002	0.006	94.0
41	Trans-Permethrin	37.231	0.003	0.009	90.9
42	Fenvalerate	37.317	0.02	0.06	90.8
43	Deltamethrin	37.969	0.002	0.007	94.3
44	Cyfluthrin	41.512	0.003	0.009	90.1
45	Esfenvalerate	46.085	0.01	0.03	90.2

\*Tissues detected pesticides

**Table 3:** Programs of heating method of graphite furnace atomic absorption (GFAAS) for Arsenic (As), lead (Pb) and cadmium (Cd)

Steps	Temperature ( $^{\circ}\text{C}$ )			Ramp(s)	Hold(s)	Argon flow rate (ml min <sup>-1</sup> )
	As	Pb	Cd			
Drying 1	150	150	150	5	20	250
Drying 2	200	200	200	5	15	250
Pyrolysis	1200	800	500	10	20	250
Atomization	2000	2000	1800	0	5	0
Clean-out	2000	2200	2200	1	3	250

**Table 4:** The recovery of heavy metals (As, Pb and Cd) from digested liver and muscle samples:-

Heavy metals	Added Heavy metals ( $\mu\text{g}/\text{kg}$ )	Recovered from liver ( $\mu\text{g}/\text{kg}$ )	Recovery (%)	Recovered from muscle ( $\mu\text{g}/\text{kg}$ )	Recovery (%)
As	5	4.47	89.6	4.39	89.4
Pb	5	4.69	94.2	4.44	88.8
Cd	5	4.66	93	4.25	85

AS: (Arsenic); Pb: Lead; Cd: Cadmium

**Table 5:** Pesticides residues (mg/kg) detected in muscle tissues (n=42) of sheep, cattle and dromedary camels admitted to Al-Ahsa Abattoir, Saudi Arabia

Animal Species	No. of Animals tested	No. of samples	No of Residues containing samples	No of detected pesticides residues	Types of detected pesticides residues	Concentration of detected pesticides residues	Permissible limit (13, 14)
Sheep	21	21	3	4	Diazinon	0.005	0.02
					Profenofos	0.015	0.05
					Cypermethrin	0.009	0.20
					Caumaphos	0.018	0.01
Cattle	10	10	3	4	Diazinon	0.017	0.02
					Cypermethrin	0.035	0.20
					Amitraz	0.033	0.02
					Permethrin	0.029	0.50
Camel	11	11	2	3	Diazinon	0.018	0.02
					Profenofos	0.019	0.05
					Lambda-Cyhalothrin	0.033	0.50

**Table 6:** Pesticides residues (mg/kg) detected in Liver tissues (n=42) of sheep, cattle and dromedary camels admitted to Al-Ahsa Abattoir, Saudi Arabia.

Animal Species	No. of Animals tested	No. of samples	No of Residues containing samples	No of detected pesticides residues	Types of detected pesticides residues	Concentration of detected pesticides residues	Permissible limit (13, 14)
Sheep	21	21	3	4	Diazinon	0.012	0.02
					Profenofos	0.022	0.05
					Cypermethrin	0.015	0.05
					Coumaphos	0.024	0.01
Cattle	10	10	3	4	Diazinon	0.034	0.02
					Cypermethrin	0.041	0.02
					Amitraz	0.023	0.20
					Permethrin	0.014	0.05
Camel	11	11	2	3	Diazinon	0.027	0.02
					Profenofos	0.029	0.05
					Lambda-Cyhalothrin	0.053	0.50

**Table 7:** Heavy metals ( $\mu\text{g}/\text{kg}$ ) detected in muscle and liver tissues ( $n=42$ ) of sheep, cattle and dromedary camels admitted to Al-Ahsa Abattoir, Saudi Arabia.

Animal Species	No. of Animals tested	No. of samples	Heavy metals concentration (ppb)					
			*Pb in muscle tissues	Pb in liver tissues	†Cd in muscle tissues	Cd in liver tissues	‡As in muscle tissues	As in liver tissues
Sheep	21	21	$4.98 \pm 1.44^{\text{aw}}$	$7.8 \pm 1.2^{\text{aw}}$	$0.6 \pm 0.1^{\text{ax}}$	$1.4 \pm 0.4^{\text{ay}}$	$6.4 \pm 1.2^{\text{aw}}$	$8.0 \pm 2.0^{\text{aw}}$
Cattle	10	10	$7.40 \pm 2.00^{\text{aw}}$	$7.9 \pm 1.5^{\text{aw}}$	$0.7 \pm 0.2^{\text{ax}}$	$1.3 \pm 0.2^{\text{ay}}$	$8.7 \pm 2.0^{\text{aw}}$	$11.1 \pm 2.5^{\text{aw}}$
Camel	11	11	$7.30 \pm 1.20^{\text{aw}}$	$10.5 \pm 1.8^{\text{aw}}$	$0.9 \pm 0.1^{\text{ax}}$	$1.3 \pm 0.1^{\text{ay}}$	$8.0 \pm 1.1^{\text{aw}}$	$11.6 \pm 2.0^{\text{aw}}$

\*Permissible limit of Pb ( $500\mu\text{g}/\text{kg}$ ) (38).

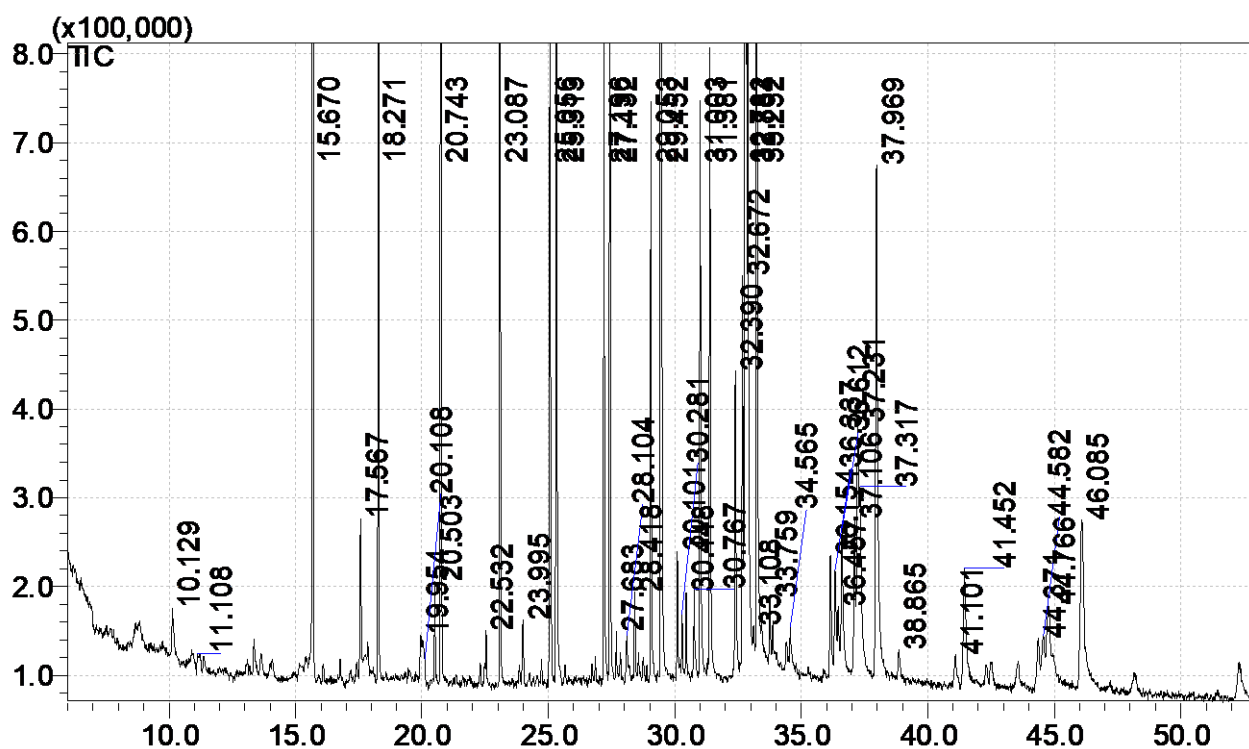
†Permissible limit of Cd ( $1000\mu\text{g}/\text{kg}$ ) (38).

‡Permissible limit of As ( $1000\mu\text{g}/\text{kg}$ ) (38).

Values are expressed as Mean  $\pm$  SD.

Means within the same column with different superscripts are significantly different ( $P < 0.05$ ).

Means within the same row with different superscripts are significantly different ( $P < 0.05$ ).

**Figure 1:** GC/MS chromatogram of investigated pesticides standards

## Conclusion

The current study concludes the existence of pesticide residues and toxic metal residues in muscle and liver tissues of sheep, cattle and dromedary camel carcasses at Al-Ahsa governorate. Diazinon contaminated muscle and liver tissues of all examined carcasses. Other pesticide residues differed according to the areas that animals originated. The heavy metal loads

were species independent. The concentrations of Pb and As in liver tissues were comparable to that of muscle tissues of all tested animals. However, the concentration of Cd in liver was significantly higher than its concentration in muscle in all tested animals. Consumption of carcasses is safe to human health because the detected pesticide and toxic metal residues were well below international permissible limit.

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