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Radioactive and radio nuclides in some Egyptian honey

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Key Words:
Bee honey - Heavy **Bi^{214}, Th^{234} Cs^{137} U^{238} Tl^{208} Bb^{210} Ra^{226}** and **K^{40}**

ABSTRACT

A total of 24 samples of honeybee samples were collected from 12 governorates of Egypt during 2016 and 2017. The most radioactive elements were the K-40 irradiated potassium element in 2016, with the highest sample of Sohag -190 Bq / kg, And the lowest sample was the sample of the lake 0.72 Becquerel / kg, the radioactive thorium was the highest sample in Minia 10.32 Bq / kg and the lowest sample in Aswan 2.5 Bq / kg, Kg, cesium was the highest sample in Sohag 0.1 435 Beckerl/ kg while the lowest sample in Luxor 0.133 . Bq/ kg with an average of 2.51 bq / kg. In 2017, the highest irradiated potassium in Aswan was 40.59 Bq/ kg and the lowest in Assiut was 4.42 Bq / kg. Beryllium was the highest sample in Sohag 3.87 Bq / kg while the lowest sample was in Minya 0.559 Bq/ kg, thorium highest sample. In Sohag 3, 10.66 peckerell / kg, and the lowest sample in Dakahlia was 2.86 Bq / kg, cesium was the highest sample in Sohag 2 506 Bq / kg and the lowest in Sohag 3 252.pikril / kg, uranium was the highest sample in Giza 5.32 Bq / the lowest in Sohag 2 2.01 Bq/ kg.

INTRODUCTION

A significant amount of artificial radionuclides have been produced and spread into the atmosphere. The main sources are the atmospheric nuclear weapon tests and the accident at the nuclear power plant at Chernobyl. Artificial radionuclides from the atmosphere have been deposited on the earth surface as fallout resulting from both wet and dry deposition processes. The assessment of radioactivity in honey is of particular interest when tracing radioactive contamination from fallout. High levels of 137 Cs have been reported in heather honey (**Jackson, 1989; Assmann-Werthmüller *et al.*, 1991**), and health hazards associated with the ingestion of contaminated honey cannot be ignored. Caesium deposits are generally fixed rapidly in the top soil layer. Migration from the surface into deeper layers is a very slow process (**Filipovi & Jadnr; Vincekovi & Jadnr *et al.*, 1991**). The caesium migration rate can be further retarded by sorption processes. The relative

abundance of clay and mica minerals, particularly illite, results in rapid and almost irreversible caesium immobilization within the soil (**Cremers *et al.*, 1988**). On the other hand, radionuclides, which behave like cations, can move upward in the soil profile via plant uptake. 137 Cs appears in flowers, pollen and honey (**Molzahn *et al.*, 1993**) depending on the contamination level, the vertical distribution of 137 Cs in the surface soil layer, as well as on the type of honeybee pasture (**Bari & Jadnr & Jadnr *et al.*, 1992**). Despite the high spatial variability in soil types, 134 Cs and 137 Cs contamination levels and vertical distribution profiles, and data on specific activity level of Cs in pollen and honey provide very useful general information about the transfer of 134 Cs and 137 Cs from soil to plant products. Concentration of radioactive isotopes in honey constitutes an important bio-indicator of environmental radiation. In general radiation exposure can be caused by the environment resulting from nuclear explosions, radiation accidents and the presence of artificial radionuclides in foodstuffs. Due to air movement in the atmosphere, the radioactive substances released containing traceable amounts of radionuclides

The honey bee may therefore be considered to be a biological indicator. This work aimed to study three selected heavy elements (Nickel, Lead and Chromium) in more than one hundred honey, wax, pollen samples from northern, middle and southern of Egypt and Red Sea region from different botanical sources and during the period starting from 2013 to 2016. This will be throw light of the subject of clean and non-polluted or "organic honey". However, this needs more and intensive studies, in future about other pollutants which can be found in honey and other hive products and about other components of the environment. A total of 24 samples from bee honey products (honey, wax and pollen) were collected from governorates mentioned previously during the three years 2014-2017. Samples were collected from different governorates and placed in small, clean glass containers, sent to the Radiation Laboratory at the Institute of Research and Graduate Studies - Alexandria University for the determination of radiation elements.

MATERIALS AND METHODS

The activities of $\mathbf{Bi^{214}}$,$\mathbf{Th^{234}}$ $\mathbf{Cs^{137}}$ $\mathbf{U^{238}}$ $\mathbf{Tl^{208}}$ $\mathbf{Bb^{210}}$ $\mathbf{Ra^{226}}$ and $\mathbf{K^{40}}$ were determined by gamma-ray spectrometry, using a low background hyper pure germanium (HP Ge) semiconductor detector system coupled to a 4096 channel analyzer Fig(1). The spectra were recorded 80000s and analyzed with a personal computer (PC) using GENIE PC Canberra software. Activities of 137 Cs in samples were recalculated.

Samples counting

The procedure of sample analyses of **honey** was as follows: Container of the sample (Marinelli beaker, Petri dishes or bottles) is weighted before and after filling with sample and the mass of the sample was calculated. The container of the sample is then placed over the detector. The energy calibration is to be entered to the computer before starting collection, this is for qualitative analysis. Normal collection is started for 43200 s. The background spectrum is subtracted from the sample spectrum to obtain the net one of the samples. Save the net spectrum and net count under each peak is obtained.

The specific activity (A) of each radionuclide is calculated according to the following equation **(Hu and Benoan, 1987)**

$$A(Bq/kg) = \frac{\text{net cps (E)}}{\varepsilon(\text{E})\text{x m x } P_{\gamma}(\text{E})}$$

Where, net cps, is the net count per second at energy (E), ε, is the absolute detection efficiency of γ-ray at energy (E), m, is the mass of measured sample and Pγ (E), is the probability of gamma transition per disintegration at energy (E)

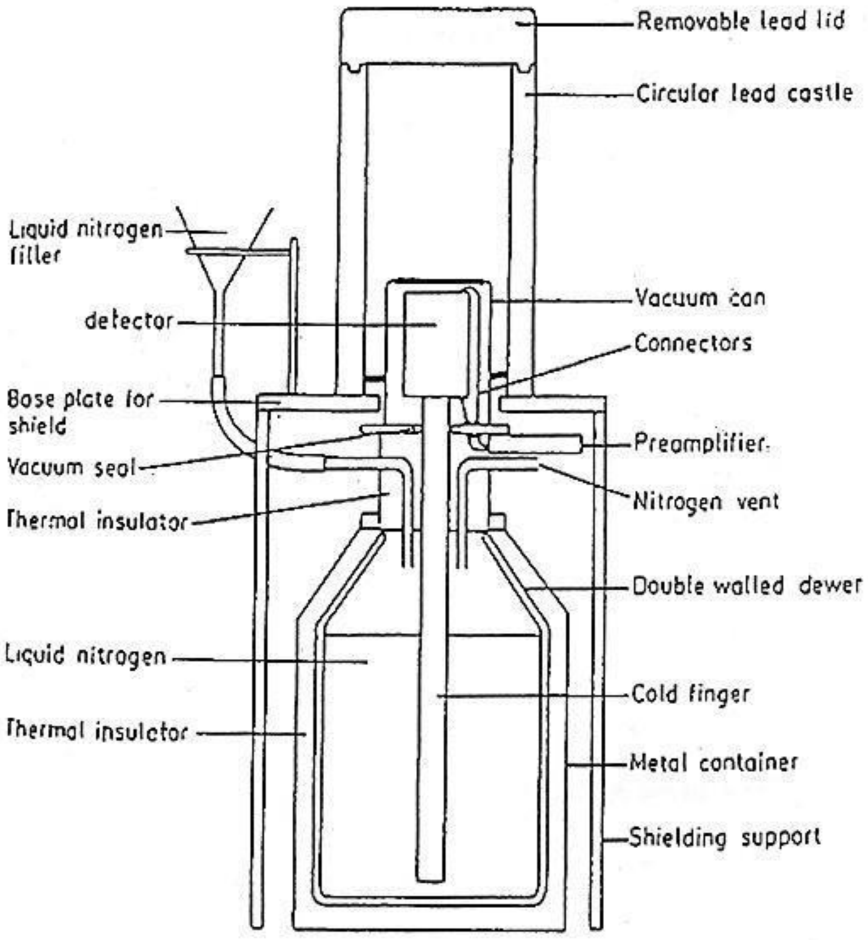


Fig. 1. An arrangement of HPGe detectors.

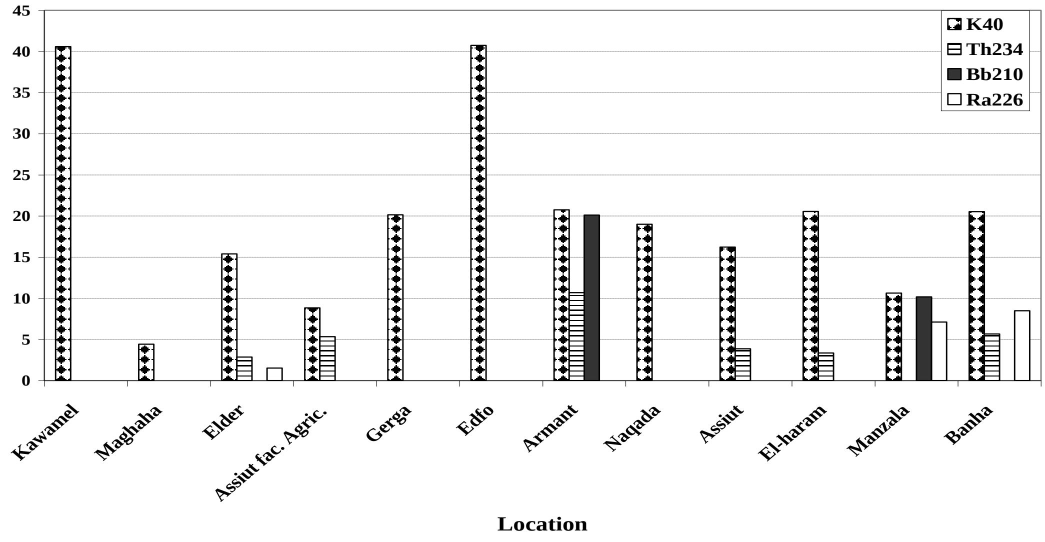
RESULTS AND DISCUSSION

Labeling of honey must be supported by analysis that confirms its provenance and safety. The ground features and elemental composition of honey depends upon its botanical and geographical origin. Table 1 shows some radinuclides activities (Bq.Kg) in some types of honey produced in different regions of Egypt during 2016. Statistically, a signficiant difference ($P<0.05$) were found for tested radiomulides elements between the different locations. K^{40} ranged from 0.00 to 90.41 Bq/kg of honey, with a mean value (29.85±8.716 Bq/kg). Bi^{214} ranged from 0.00 to 4.19 Bq/kg of honey, with a mean value (1.308±0.38 Bq/kg). Th^{234} ranged from 0.00 to 10.32 Bq/kg of honey, with a mean value (2.625±1.122 Bq/kg). Cs^{137} ranged from 0.00 to 0.435 Bq/kg of honey with a mean value (0.0988±0.047 Bq/kg). U^{238} ranged from 0.00 to 8.15 Bq/kg of honey, with a mean value (1.9662±0.911 Bq/kg). Be^{7} ranged from 0.00 to 9.11 Bq/kg of honey, with a mean value (2.055±0.893 Bq/kg). Ti^{208} ranged from 0.00 to 0.616 Bq/kg of honey, with a mean value (0.178±0.062 Bq/kg). Bb^{210} ranged from 0.00 to 10.2 Bq/kg of honey with a mean (2.332±1.104 Bq/kg). Ra^{226} ranged from 0.00 to 20.11 Bq/kg of honey, with a mean (4.839±1.911 Bq/kg).

Based on the results obtained in this study, it can seen that the radioactive contamination of honey samples were showed some variation between differed locations or regions. As shown as in Table (2) a significant differences (P<0.05) were detected between some tested locations for some radioactive contamination of honey produced from these regions during 2017. K^{40} ranged from 4.42 to 40.74 Bq/kg of honey, with a mean value (19.32±31.93 Bq/kg) and it was detectable in the 100% of the honey samples. Considering the level of radioactive Bi^{214}, the highest level (3.87 Bq/kg) was recorded in enzyme honey samples produced from Faculty of Agriculture, Sohag University. For Th^{234} radioactive level, the maximum value (10.69 Bq/kg) was noticed in honey samples produced from the previous location also. Cs^{137} not found in most honey samples but found in honey samples produced from Faculty of Agriculture and Wanena, Sohag Governorate, only with means 0.252 and 0.506 Bq/kg of honey, respectively. Similar result was found for U^{238}, where it found in two locations only Ministry of Agriculture, Giza Governorate and Gerga, Sohag. Also, Be^{7} not found most honey samples, but found in two honey samples produced in Mansora (Dakhalya Governorate) and Banha (Qlubea Governorate) only with means 1.62±0.966 and 3.32±1.06 Bq/kg of honey, respectively. Tl^{208} ranged from 0.00 to 10.46 Bq/kg of honey, with a mean value (1.063±0.861 Bq/kg). Bb^{210} ranged from 0.00 to 20.12 Bq/kg of honey, with a mean value (2.526±1.809 Bq/kg). Ra^{226} ranged from 0.00 to 8.49 Bq/kg of honey, with a mean value (1.428±0.873 Bq/kg). Concentrations of tested radionuclides in clover honey are illustrated in Table (3). Cs^{137} level was the lowest concentration in clover honey produce during 2016 and 2017 seasons, with means 0.125±0.077 and 0.076±0.001 Bq/kg, respectively. While K^{40} concentration was the highest value in clover honey produced during experimental year 2016 and 2017, with means 23.26±5.381 and variation in natural radionucleides content are preferential abusability of the plant use of fertilizers, irrigation water and climatic conditions. Plant enters radionuclides indirectly through roots from soil and through direct deposition of radionuclides in the leaf or in the flower (**Baratta, 1994**). It is necessary to remark that the flowering periods are in an opposite order. Hence, the trend for honey contamination is explainable by admitting that the radio-activity in honey is closely related to the contamination of nectar (**Tonelli *et al*., 1990)**. Human industrial activity affects the environmental pollution. Migration of the toxic microelements in the environment leads to their accumulation in the body of bees, honey, beebread and in humans through beekeeping products (**Kodes and Bychkova, 2010**). **Maikanov *et al*. (2017)** stated that, honey contamination is mainly associated with the environmental degradation, feeding and treating of bees. Moreover, in the process of collecting nectar, external substances can penetrate honey.

Table (1): Comparison of some radionuclide activity level (Bq/kg) ±SD of honey produced in different regions of Egypt during 2016.

E lement L ocation	K^{40}	Bi^{2} 14	Th 234	Cs^{13} 7	U^{23} 8	Be^{7}	Tl^{208}	Bb^{210}	Ra^{226}	T otal
K awamel	90.41 ±19.37a	4.1 9±1.51a	0.0 0±0.00f	0.43 5±0.282a	6.2 7±1.92b	4.8 1±1.131c	0.20 7±0.072e	2.04± 0.961d	10.85 ±3.11b	1 19.212
M aghaha	10.35 ±2.35h	1.7 5±0.53e	10. 32±2.11a	0.00 ±0.00e	0.0 0±0.00e	2.5 8±1.73d	0.06 1±0.025g	0.171 ±0.081g	0.00± 0.00g	2 5.232
E lder	6.79± 1.69i	1.9 2±0.98d	3.8 9±0.973d	0.23 1±0.083c	0.0 0±0.00e	6.3 ±1.46b	0.26 6±0.103c	0.365 ±0.151f	10.31 ±2.024d	3 0.072
A ssiut fac. Agric.	5.49± 3.71j	2.1 8±0.88c	0.0 0±0.00f	0.00 ±0.00e	2.5 1±0.735d	0.0 0±0.00f	0.00 ±0.00h	4.05± 2.336c	0.00± 0.00g	1 4.23
G erga	30.95 ±9.25e	1.0 9±0.48f	0.0 0±0.00f	0.00 ±0.00e	0.0 0±0.00e	0.0 0±0.00f	0.00 ±0.00h	0.00± 0.00h	0.00± 0.00g	3 2.04
E dfo	20.96 ±7.154c	0.0 0±0.00i	2.0 5±0.898e	0.00 ±0.00e	0.0 0±0.00e	0.0 0±0.00f	0.00 ±0.00b	1.16± 0.934e	20.11 ±6.152a	4 4.28
A rmant	10.34 ±3.761h	1.0 7±0.959g	0.0 0±0.00f	0.13 3±0.077d	5.6 1±2.138c	0.0 0±0.00f	0.26 4±0.096d	0.00± 0.00h	1.52± 0.779f	1 8.937
N aqada	50.84 ±17.338c	0.0 0±0.00i	0.0 0±0.00f	0.00 ±0.00e	0.0 0±0.00e	1.8 6±0.093e	0.61 6±0.052a	10.00 2±2.048b	0.00± 0.00g	6 3.18
A ssiut	10.71 ±4.055g	0.0 0±0.00i	5.7 7±2.313x	0.00 ±0.00e	0.0 0±0.00e	9.1 1±3.117a	0.53 3±0.224b	0.00± 0.00h	0.00± 0.00g	2 6.123
E l-haram	40.77 ±15.62d	2.7 8±0.685b	0.0 0±0.00f	0.00 ±0.00e	0.0 0±0.00e	0.0 0±0.00f	0.00 ±0.00f	0.00± 0.00h	0.00± 0.00g	4 3.55
M anzala	80.62 ±32.175b	0.7 2±0.339h	0.0 0±0.00f	0.38 6±0.179b	8.1 5±4.19a	0.0 0±0.00f	0.18 9±0.116f	10.2± 4.532a	4.84± 0.04e	1 05.105
B anha	0.00± 0.00k	0.0 0±0.00i	9.4 7±4.16b	0.00 ±0.00e	0.0 0±0.00e	0.0 0±0.00f	0.00 ±0.00f	0.00± 0.00h	10.44 ±0.3524c	1 9.91
G rand mean±SE	29.85 ±8.716	1.3 08±0.38	2.6 25±1.122	0.09 88±0.047	1.9 62±0.911	2.0 55±0.893	0.17 8±0.62	2.332 ±1.104	4.839 ±1.211	
M aximum	90.41	4.1 9	10. 32	0.43 5	8.1 5	9.1 1	0.61 6	0.00	0.00	
M inimum	0.00	0.0 0	0.0 0	0.00	0.0 0	0.0 0	0.00	0.00	0.00	



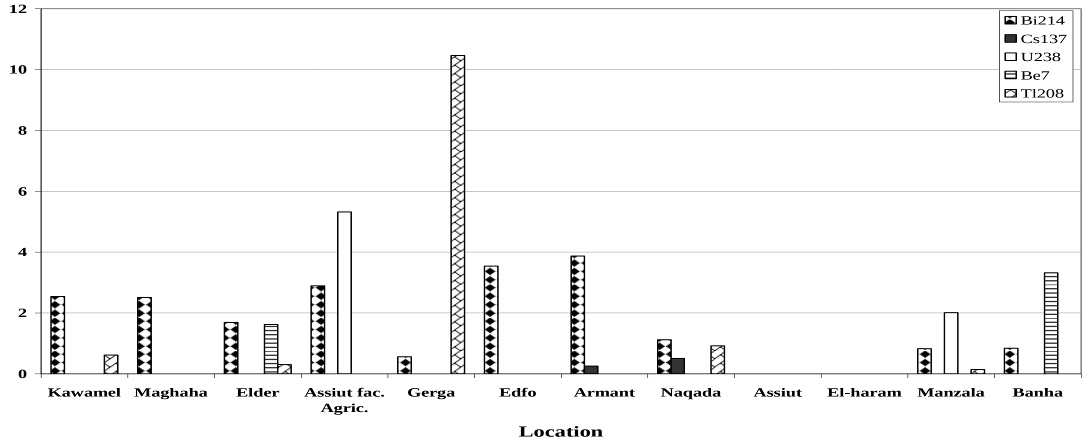


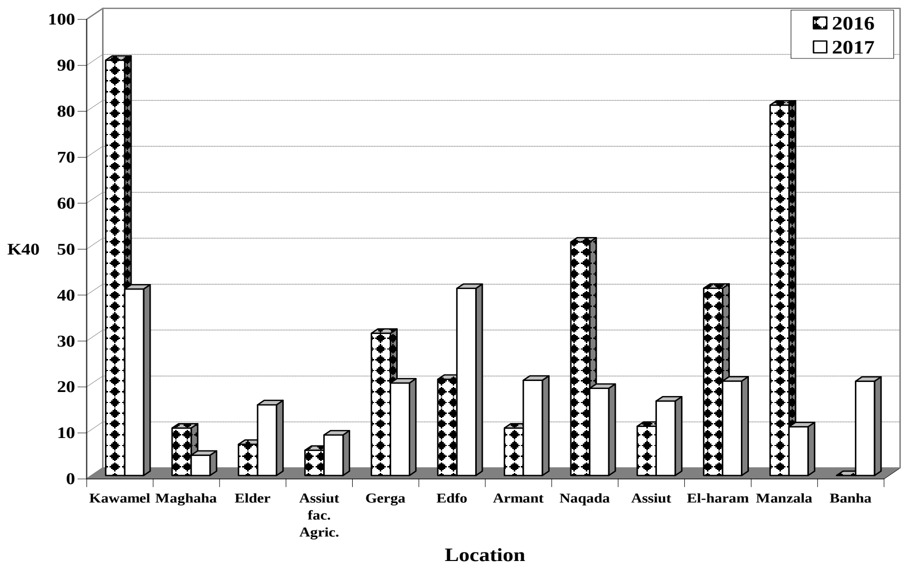
Table (2): Regions of Egypt during 2016 and 2017

Year	2016 (n= 6)			2017 (n= 10)		
Element	Mean ±SD	Maximum	Minimum	Mean± SD	Maximum	Minimum
K^{40}	23.26 ±5.381	80.62	0.00	20.664 ±4.052	40.74	4.42
Bi^{214}	0.8±0.077	1.92	0.00	1.956± 0.731	3.87	0.00
Th^{234}	3.53± 1.005	9.47	0.00	2.842± 1.006	10.69	0.00
Cs^{137}	0.125 ±0.007	0.386	0.00	0.076± 0.001	0.506	0.00
U^{238}	2.293 ±0.988	8.15	0.00	0.532± 5.32	5.32	0.00
Be7	2.568 ±0.795	9.11	0.00	0.494± 0.008	3.32	0.00
TP^{208}	0.209 ±0.005	0.533	0.00	1.23±0.751	10.46	0.00
Bb^{210}	1.761 ±0.654	10.2	0.00	2.012± 1.73	20.12	0.00
Ra^{226}	4.518 ±1.036	10.44	0.00	1.002± 0.069	8.49	0.00

Table (3): Comparison of some radionuclide activity level (Bq/kg) ±SD of honey produced in different regions of Egypt during 2017.

Element / Location	K^{40}	Bi^{214}	Th^{234}	Cs^{137}	U^{238}	Be^7	Tl^{208}	Bb^{210}	Ra^{226}	Total
Kom-Ombo	40.59 ±17.423b	2.54 ±0.933d	0.00 ±0.00g	0.00 ±0.00b	0.00±0.00c	0.00±0.00c	0.615±0.119c	0.00 ±0.00	0.00 ±0.00d	43.745
El-Fath	4.42± 1.631*l*	2.51 ±1.352e	0.00 ±0.00g	0.00 ±0.00b	0.00±0.00c	0.00±0.00c	0.00 ±0.00f	0.00 ±0.00c	0.00 ±0.00d	6.93
Mansora	15.4± 9.666i	1.69 ±0.811f	2.86 ±0.956f	0.00 ±0.00b	0.00±0.00c	1.62±0.966b	0.303±0.072d	0.00 ±0.00c	1.53 ±1.01c	23.403
Ministry Agric.	8.84± 3.607k	2.89 ±1.111c	5.33 ±1.683c	0.00 ±0.00b	5.32±2.07a	0.00±0.00c	0.00 ±0.00f	0.00 ±0.00c	0.00 ±0.00d	22.39
Maghagha	20.15 ±8.242f	0.559±0.221j	0.00 ±0.00g	0.00 ±0.00b	0.00±0.00c	0.00±0.00c	10.46±2.054a	0.00 ±0.004c	0.00±0.00d	1.169

D eshna	40.74 ±13.093a	3.54 ±1.323b	0.00 ±0.00g	0.00 ±0.00b	0.0 0±0.00c	0.0 0±0.00c	0.00 ±0.00f	0.00 ±0.00c	0.00 ±0.00d	4 4.28
S ohg Fac. Agric.	20.75 ±7.152c	3.87 ±1.113a	10.6 9±2.197a	0.25 2±0.036	0.0 0±0.00c	0.0 0±0.00c	0.00 ±0.00f	20.1 2±5.162a	0.00 ±0.00d	5 5.682
W anena	18.99 ±12.34g	1.12 ±0.609g	0.00 ±0.00g	0.50 6±0.121	0.0 0±0.00c	0.0 0±0.00c	0.91 8±0.317b	0.00 ±0.00c	0.00 ±0.00d	2 1.534
E astern company	16.22 ±4.162h	0.00 ±0.00k	3.87 ±1.009d	0.00 ±0.00b	0.0 0±0.00c	0.0 0±0.00c	0.00 ±0.00f	0.00 ±0.00c	0.00 ±0.00d	2 0.09
B eherah	20.55 ±9.055d	0.00 ±0.00k	3.35 ±0.795e	0.00 ±0.00b	0.0 0±0.00c	0.0 0±0.00c	0.00 ±0.00f	0.00 ±0.00c	0.00 ±0.00d	2 3.9
G erga	10.63 ±3.806j	0.82 5±0.253i	0.00 ±0.00g	0.00 ±0.00b	2.0 1±0.834b	0.0 0±0.00c	0.14 ±0.009e	10.1 8±3.168b	7.11 ±2.005b	3 0.895
B anha	20.53 ±11.41e	0.84 1±0.145h	5.67 ±0.598b	0.00 ±0.00b	0.0 0±0.00c	3.3 2±1.06a	0.00 ±0.00f	0.00 ±0.00c	8.49 ±2.511	3 8.851
G rand mean±SE	19.82 ±3.193	1.69 9±0.387	2.64 8±0.974	0.06 32±0.045	0.6 11±0.459	0.4 12±0.297	1.06 3±0.861	2.52 6±1.809	1.42 8±0.873	
M aximum	40.74	3.87	10.6 9	0.50 6	5.3 2	3.3 2	10.4 6	20.1 2	8.49	
M inimum	4.42	0.00	0.00	0.00	0.0 0	0.0 0	0.00	0.00	0.00	



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