Activity Concentration Index (I_γ):
The activity Concentration Index (I_γ) was given by the following equation [10]

$$I_\gamma = \frac{A_U}{150} + \frac{A_{Th}}{100} + \frac{A_k}{1500} \quad (7)$$

3. Results and Discussions

The specific activity values of ^{238}U ,^{232}Th and ^{40}K radionuclides for 30 soil sample are tabulated in table(2). They have been found to lie in the range of (3.65±1.33;17 to 20.92±3.30;19) Bq/kg with an average of 9.37±4.41Bq/kg, from (1.98±1.14;12 to 15.87±3.24;4) Bq/kg with an average 7.66±2.18Bq/kg and (30.61±2.57;18 to 152.43±5.75;5) Bq/kg with an average 67.32±3.71Bq/kg for ^{238}U ,^{232}Th and ^{40}K respectively .The result shows that all values of ^{238}U ,^{232}Th and ^{40}K specific activity for all soil sample are in the worldwide average (35Bq/kg for ^{238}U , 30 Bq/kg for ^{232}Th and 400 Bq/kg for^{40}K) [10,11]. The radium equivalent activities was calculated and listed in table (2) .Ra eq values vary from (13.74±4.12;11 to 48.72±8.08;19) Bq/ kg with average value of (25.61±5.39) Bq/kg .The absorbed dose rate(AD)calculated and listed in table (2) range from (6.56±1.88;11 to 22.47±3.65;19) nGy/h with average 12.02±2.52nGy/h.It can seen be that the Ra eq values and absorbed dose rate(AD) for all samples are lower than the recommended worldwide [10,11].

Table 2: The absorbed dose rate, Radium equivalent Ra_{eq} and Activity concentration of (238U, 232Th and 40K) for samples in depth (10-20) cm

Sample No.	absorbed dose rate(AD)(nGy/h)	Ra_{eq}(Bq/Kg)	^{232}Th(Bq/Kg)	^{238}U(Bq/Kg)	^{40}K(Bq/Kg)
1	10.13±2.44	21.86±5.39	6.61±2.09	8.89±2.15	45.60±3.14
2	11.90±2.32	26.03±5.18	2.64±1.32	17.26±3.01	64.99±3.74
3	8.93±2.18	19.31±4.84	3.96±1.62	9.94±2.28	47.99±3.22
4	20.75±3.61	45.35±7.99	15.87±3.24	18.13±3.09	56.45±3.50
5	17.82±2.95	37.01±6.49	9.25±2.47	12.03±2.50	152.43±5.75
6	14.15±2.90	30.17±6.35	15.21±3.17	4.70±1.56	48.20±3.23
7	16.21±2.90	34.36±6.41	7.27±2.19	16.21±2.91	104.20±3.23
8	9.03±1.97	18.58±4.34	3.30±1.47	6.80±1.88	91.63±4.46
9	13.40±2.71	28.23±5.96	9.25±2.47	8.37±2.09	85.99±4.32
10	16.31±3.12	35.08±6.87	11.90±2.80	12.55±2.56	71.44±3.93
11	6.56±1.88	13.74±4.12	4.62±1.74	3.66±1.38	44.94±3.12
12	8.02±1.80	16.70±3.98	1.98±1.14	7.84±2.02	78.17±4.12
13	9.48±2.27	20.04±5.01	5.95±1.98	6.80±1.88	61.45±3.65
14	12.75±2.62	26.62±5.73	9.92±2.56	5.75±1.73	86.85±4.34
15	14.16±2.84	30.62±6.28	7.93±2.29	14.12±2.71	66.88±3.81
16	13.69±2.67	28.89±5.88	7.27±2.19	10.98±2.39	97.50±4.60
17	12.19±2.60	25.61±5.68	11.90±2.80	3.65±1.33	64.05±3.72
18	8.68±2.16	18.53±4.78	4.62±1.74	6.80±1.88	30.61±2.57
19	22.47±3.65	48.72±8.08	14.55±3.10	20.92±3.30	90.76±4.43
20	7.78±1.98	16.17±4.35	4.62±1.74	4.70±1.56	62.97±3.69
21	9.84±2.39	20.93±5.26	7.93±2.29	5.75±1.73	49.72±3.28
22	7.84±1.89	16.21±4.15	3.30±1.47	5.75±1.73	74.48±4.02
23	9.81±2.46	21.23±5.44	7.93±2.29	7.32±1.95	33.22±2.68
24	12.58±2.81	27.25±6.20	11.24±2.72	8.37±2.09	36.48±2.81
25	9.66±2.34	20.43±5.13	7.27±2.19	5.76±1.83	55.59±3.47
26	9.74±2.26	20.59±4.99	5.29±1.87	7.84±2.02	67.31±3.82
27	15.81±3.05	34.32±6.76	9.92±2.56	15.17±2.81	64.49±3.74
28	8.87±2.12	18.62±4.68	4.62±1.74	6.80±1.88	67.53±3.82
29	12.53±2.74	27.12±6.06	8.59±2.38	10.98±2.39	49.94±3.29
30	9.54±2.23	20.10±4.92	5.29±1.87	7.32±1.95	67.75±3.83
Min.	6.56±1.88	13.74±4.12	1.98±1.14	3.65±1.33	30.61±2.57
Max.	22.47±3.65	48.72±8.08	15.87±3.24	20.92±3.30	152.43±5.75
Average	12.02±2.52	25.61±5.39	7.66±2.18	9.37±4.41	67.32±3.71

The specific activity values of ^{238}U ,^{232}Th and ^{40}K radionuclides for 30 soil sample are tabulated in table(3). They have been found to lie in the range of (1.04±0.73;3 to 35.05±4.28;4) Bq/kg with an average of 15.66±2.76Bq/kg, from (5.95±1.98;22 to 29.10±4.38;25) Bq/kg with an average 13.59±2.93Bq/kg and (40.17±2.95;24 to 152.43±5.75;5) Bq/kg with an average 77.39±4.05Bq/kg for ^{238}U ,^{232}Th and ^{40}K respectively .The result shows that all values of ^{238}U ,^{232}Th and ^{40}K specific activity for all soil sample are in the worldwide average (35Bq/kg for ^{238}U , 30 Bq/kg for ^{232}Th and 400 Bq/kg for^{40}K) [10,11]. The radium equivalent activities was calculated and listed in table (3) .Ra eq values vary from (18.13±4.53;11 to 72.80±9.91;5) Bq/ kg with average value of (41.07±7.30) Bq/kg .The absorbed dose rate(AD)calculated and listed in table (3) range from (8.72±2.09;3 to 34.09±4.51;5) nGy/h with average 19.01±3.28nGy/h.It can seen be that the Ra eq values and

absorbed dose rate(AD) for all samples are lower than the recommended worldwide [10,11].

Table 3: The absorbed dose rate, Radium equivalent Ra_{eq} and Activity concentration of (238U, 232Th and 40K) for samples in depth (30-40)cm

Sample No.	absorbed dose rate(nGy/h)	Ra_{eq}(Bq/Kg)	^{232}Th(Bq/Kg)	^{238}U(Bq/Kg)	^{40}K(Bq/Kg)
1	19.76±3.50	43.22±7.74	13.88±3.03	18.83±3.13	58.84±3.57
2	23.72±3.17	50.62±8.17	17.19±3.37	16.74±2.95	120.73±5.12
3	8.72±2.09	18.13±4.53	9.25±2.47	1.04±0.73	49.94±3.29
4	26.42±3.98	58.95±8.87	13.88±3.03	35.05±4.28	52.55±3.37
5	34.09±4.51	72.80±9.91	28.43±4.33	20.40±3.26	152.43±5.75
6	27.65±4.20	60.35±9.28	23.14±3.91	21.97±3.39	68.61±3.86
7	22.98±3.51	49.98±7.81	9.92±2.56	27.20±3.77	111.61±4.92
8	15.42±2.93	33.38±6.50	7.93±2.29	16.21±2.91	75.56±4.05
9	17.01±3.01	36.47±6.64	7.93±2.29	17.26±3.01	102.06±4.70
10	22.20±3.66	48.58±8.11	13.88±3.03	23.01±3.47	74.04±4.01
11	14.50±2.97	31.31±6.56	11.24±2.72	10.98±2.39	55.15±3.46
12	22.43±3.72	48.26±8.19	20.50±3.68	13.07±2.61	79.21±4.06
13	17.57±3.23	38.17±7.15	11.24±2.72	16.74±2.95	69.48±3.88
14	25.78±3.97	55.44±8.74	21.82±3.79	16.47±2.95	97.28±4.59
15	19.90±3.40	43.10±7.53	11.90±2.80	19.35±3.18	87.29±4.35
16	15.28±3.05	33.28±6.76	10.58±2.64	14.12±2.71	52.33±3.37
17	15.18±2.99	32.28±6.55	13.22±2.95	7.84±2.02	71.65±3.94
18	13.35±2.68	28.40±5.92	7.27±2.19	11.50±2.45	84.25±4.27
19	17.83±3.23	37.95±7.11	14.55±3.10	10.46±2.33	86.85±4.34
20	10.80±2.42	22.72±5.32	7.27±2.19	6.80±1.88	71.65±3.94
21	18.57±3.37	39.89±7.42	16.53±3.30	10.98±2.39	68.40±3.85
22	11.57±2.42	24.27±5.33	5.95±1.98	8.89±2.15	89.24±4.40
23	12.40±2.76	26.94±6.11	9.25±2.47	10.46±2.33	42.12±3.02
24	19.58±3.56	42.85±7.86	17.19±3.37	15.17±2.81	40.17±2.95
25	31.14±4.44	67.44±9.78	29.10±4.38	19.35±3.19	84.03±4.27
26	16.54±3.07	35.42±6.78	10.58±2.64	13.60±2.66	86.85±4.34
27	20.19±3.50	43.87±7.73	13.88±3.03	18.31±3.09	74.04±4.01
28	14.97±2.89	32.32±6.40	7.93±2.29	15.17±2.18	75.35±4.04
29	19.34±3.45	42.10±7.62	13.88±3.03	17.26±3.01	64.71±3.74
30	15.64±2.97	33.80±6.58	8.59±2.38	15.69±2.86	75.56±4.05
Min.	8.72±2.09	18.13±4.53	5.95±1.98	1.04±0.73	40.17±2.95
Max.	34.09±4.51	72.80±9.91	29.10±4.38	35.05±4.28	152.43±5.75
Average	19.01±3.28	41.07±7.30	13.59±2.93	15.66±2.76	77.39±4.05

The Indoor and Outdoor Annual Effective Dose, Activity Concentration Index (I_γ),External hazard index (Hex) and Internal hazard index (Hin) are calculated and listed in table (4) The Indoor Effective Dose range from (0.0321±0.0092;11 to 0.1102±0.0179;19) µSv/y with average 0.0589±0.0123 µSv/y, the Outdoor Annual Effective Dose rang are from (0.0080±0.0023;11 to 0.0275±0.0044;19) (µSv/y) with average 0.0147±0.0030(µSv/y) all the soil samples have the annual effective dose less than the world average 460 (µSv/y) [10,11], Representative level index (Iγ) range from (0.1006±0.0288;11 to 0.3455±0.0560;19) with average 0.1848±0.0387, External hazard index (Hex) range from (0.0371±0.0111;11 to 0.1316±0.0218;19) with average 0.0691±0.0150 and Internal hazard index (Hin) range from (0.0470±0.0148;11 to 0.1881±0.0307;19) with average 0.0946±0.0208. External and internal hazard and gamma activity concentration were lower than unity according to the Radiation Protection 112 [10].

Table 4: External hazard index(H_{ex}),internal hazard index (H_{in}),the annual effective dose and activity concentration index (I_γ) in depth (10-20) cm

Sample No.	Activity Concentration Index (I_γ)	Internal Hazard Index (H_{in})	External Hazard Index(H_{ex})	Effective dose rate $mSv.yr^{-1}$	
				Indoor	Outdoor
1	0.1558±0.0373	0.0830±0.0203	0.0590±0.0145	0.0497±0.0119	0.0124±0.0029
2	0.1846±0.0357	0.1169±0.0221	0.0703±0.0140	0.0584±0.0113	0.0146±0.0028
3	0.1379±0.0335	0.0790±0.0192	0.0521±0.0130	0.0438±0.0107	0.0109±0.0026
4	0.3184±0.0553	0.1720±0.0299	0.1225±0.0216	0.1018±0.0177	0.0254±0.0044
5	0.2744±0.0453	0.1324±0.0243	0.0999±0.0175	0.0874±0.0145	0.0218±0.0036
6	0.2156±0.0443	0.0942±0.0214	0.0814±0.017	0.0694±0.0142	0.0173±0.0035
7	0.2502±0.0445	0.1373±0.0252	0.0935±0.0173	0.0795±0.0142	0.0198±0.0035
8	0.1395±0.0303	0.0685±0.0168	0.0502±0.0117	0.0443±0.0096	0.0110±0.0024
9	0.2057±0.0415	0.0988±0.0217	0.0762±0.0161	0.0657±0.0133	0.0164±0.0033
10	0.2503±0.0477	0.1286±0.0255	0.0947±0.0185	0.0800±0.0153	0.0200±0.0038
11	0.1006±0.0288	0.0470±0.0148	0.0371±0.0111	0.0321±0.0092	0.0080±0.0023
12	0.1242±0.0277	0.0663±0.0162	0.0451±0.0107	0.0393±0.0088	0.0098±0.0022
13	0.1458±0.0348	0.0725±0.0186	0.0541±0.0135	0.0465±0.0111	0.0116±0.0027
14	0.1954±0.0400	0.0874±0.0201	0.0719±0.0154	0.0625±0.0128	0.0156±0.0032
15	0.2181±0.0435	0.1209±0.0243	0.0827±0.0169	0.0694±0.0139	0.0173±0.0034
16	0.2109±0.0409	0.1077±0.0223	0.0780±0.0159	0.0672±0.0131	0.0168±0.0032
17	0.1861±0.0397	0.0790±0.0190	0.0691±0.0153	0.0598±0.0127	0.0149±0.0031
18	0.1337±0.0332	0.0712±0.0184	0.0500±0.0129	0.0426±0.0106	0.0106±0.0026
19	0.3455±0.0560	0.1881±0.0307	0.1316±0.0218	0.1102±0.0179	0.0275±0.0044
20	0.1196±0.0304	0.0564±0.0160	0.0436±0.0117	0.0381±0.0097	0.0095±0.0024
21	0.1508±0.0366	0.0720±0.0189	0.0565±0.0142	0.0483±0.0117	0.0120±0.0029
22	0.1210±0.0290	0.0593±0.0159	0.0438±0.0112	0.0385±0.0092	0.0096±0.0023
23	0.1503±0.0377	0.0771±0.0199	0.0573±0.0146	0.0481±0.0121	0.0120±0.0030
24	0.1925±0.0430	0.0962±0.0224	0.0736±0.0167	0.0617±0.0138	0.0154±0.0034
25	0.1481±0.0358	0.0707±0.0185	0.0552±0.0138	0.0474±0.0114	0.0118±0.0028
26	0.1501±0.0347	0.0768±0.0189	0.0556±0.0134	0.0478±0.0111	0.0119±0.0027
27	0.2433±0.0468	0.1337±0.0258	0.0927±0.0182	0.0776±0.0150	0.0194±0.0037
28	0.1366±0.0326	0.0686±0.0177	0.0502±0.0126	0.0435±0.0104	0.0108±0.0026
29	0.1925±0.0420	0.1029±0.0228	0.0732±0.0163	0.0614±0.0134	0.0153±0.0033
30	0.1469±0.0343	0.0741±0.0186	0.0543±0.0133	0.0468±0.0109	0.0117±0.0027
Min.	0.1006±0.0288	0.0470±0.0148	0.0371±0.0111	0.0321±0.0092	0.0080±0.0023
Max.	0.3455±0.0560	0.1881±0.0307	0.1316±0.0218	0.1102±0.0179	0.0275±0.0044
Average	0.1848±0.0387	0.0946±0.0208	0.0691±0.0150	0.0589±0.0123	0.0147±0.0030

The Indoor and Outdoor Annual Effective Dose, Activity Concentration Index (I_γ),External hazard index (Hex) and Internal hazard index (Hin) are calculated and listed in table (5) The Indoor Effective Dose range from (0.0427±0.0102;3 to 0.1672±0.0221;5) μSv/y with average 0.0932±0.0161μSv/y, the Outdoor Annual Effective Dose rang are from (0.0106±0.0025;3 to 0.0418±0.0055;5) (μSv/y) with average 0.0232±0.0039 (μSv/y) all the soil samples have the annual effective dose less than the world average 460 (μSv/y) [10,11], Representative level index (Iγ) range from (0.1328±0.0318;3 to 0.5220±0.0689;5) with average 0.2920±0.0506, External hazard index (Hex) range from (0.0489±0.0122;3 to 0.1966±0.0267;5) with average 0.1109±0.0196 and Internal hazard index (Hin) range from (0.0517±0.0142;3 to 0.2540±0.0355;4) with average 0.1532±0.0331. External and internal hazard and gamma activity concentration were lower than unity according to the Radiation Protection 112 [10].

Table 5: External hazard index(H_{ex}),internal hazard index (H_{in}),the annual effective dose and activity concentration index (I_γ) in depth (30-40) cm

Sample No.	Activity Concentration Index (I_γ)	Internal Hazard Index (H_{in})	External Hazard Index(H_{ex})	Effective dose rate $mSv.yr^{-1}$	
				Indoor	Outdoor
1	0.3036±0.0536	0.1676±0.0294	0.1167±0.0209	0.0969±0.0171	0.0242±0.0042
2	0.3640±0.0568	0.1819±0.0300	0.1367±0.0220	0.1163±0.0182	0.0290±0.0045
3	0.1328±0.0318	0.0517±0.0142	0.0489±0.0122	0.0427±0.0102	0.0106±0.0025
4	0.4076±0.0611	0.2540±0.0355	0.1592±0.0239	0.1296±0.0195	0.0324±0.0048
5	0.5220±0.0689	0.2517±0.0356	0.1966±0.0267	0.1672±0.0221	0.0418±0.0055
6	0.4237±0.0643	0.2224±0.0342	0.1630±0.0250	0.1356±0.0206	0.0339±0.0051
7	0.3549±0.0540	0.2085±0.2085	0.1350±0.0211	0.1127±0.0172	0.0281±0.0043
8	0.2378±0.0450	0.1340±0.0254	0.0901±0.0175	0.0756±0.0143	0.0189±0.0035
9	0.2625±0.0460	0.1451±0.0260	0.0985±0.0179	0.0834±0.0147	0.0208±0.0036
10	0.3417±0.0561	0.1934±0.0312	0.1312±0.0219	0.1089±0.0179	0.0272±0.0044
11	0.2224±0.0455	0.1142±0.0242	0.0845±0.0177	0.0711±0.0146	0.0177±0.0036
12	0.3430±0.0569	0.1657±0.0292	0.1303±0.0221	0.1100±0.0182	0.0275±0.0045
13	0.2703±0.0495	0.1483±0.0273	0.1031±0.0193	0.0862±0.0158	0.0215±0.0039
14	0.3947±0.0607	0.1949±0.0316	0.1497±0.0236	0.1264±0.0195	0.0316±0.0048
15	0.3062±0.0521	0.1687±0.0289	0.1164±0.0203	0.0976±0.0166	0.0244±0.0041
16	0.2348±0.0468	0.1280±0.0256	0.0899±0.0182	0.0749±0.0149	0.0187±0.0037
17	0.2323±0.0457	0.1083±0.0231	0.0871±0.0177	0.0745±0.0146	0.0186±0.0036
18	0.2056±0.0411	0.1078±0.0226	0.0767±0.0159	0.0655±0.0131	0.0163±0.0032
19	0.2731±0.0495	0.1307±0.0255	0.1025±0.0192	0.0874±0.0158	0.0218±0.0039
20	0.1658±0.0371	0.0797±0.0194	0.0613±0.0143	0.0529±0.0119	0.0132±0.0029
21	0.2841±0.0516	0.1374±0.0265	0.1077±0.0200	0.0911±0.0165	0.0227±0.0041
22	0.1783±0.0371	0.0896±0.0202	0.0655±0.0144	0.0567±0.0118	0.0141±0.0029
23	0.1904±0.0423	0.1010±0.0228	0.0727±0.0165	0.0608±0.0135	0.0152±0.0033
24	0.2998±0.0544	0.1567±0.0288	0.1157±0.0212	0.0960±0.0174	0.0240±0.0043
25	0.4760±0.0679	0.2344±0.0350	0.1821±0.0264	0.1527±0.0218	0.0381±0.0054
26	0.2544±0.0471	0.1324±0.0255	0.0956±0.0183	0.0811±0.0150	0.0202±0.0037
27	0.3103±0.0536	0.1679±0.0292	0.1185±0.0209	0.0990±0.0171	0.0247±0.0042
28	0.2307±0.0443	0.1283±0.0249	0.0873±0.0173	0.0734±0.0141	0.0183±0.0035
29	0.2971±0.0528	0.1604±0.0287	0.1137±0.0206	0.0949±0.0169	0.0237±0.0042
30	0.2409±0.0456	0.1337±0.0255	0.0913±0.0177	0.0767±0.0146	0.0191±0.0036
Min.	0.1328±0.0318	0.0517±0.0142	0.0489±0.0122	0.0427±0.0102	0.0106±0.0025
Max.	0.5220±0.0689	0.2540±0.0355	0.1966±0.0267	0.1672±0.0221	0.0418±0.0055
Average	0.2920±0.0506	0.1532±0.0331	0.1109±0.0196	0.0932±0.0161	0.0232±0.0039

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