CHAPTER IV
RESULTS

Three different mango seed kernels varieties *(Mangifera indica* L.*)* which were Kaew, Mahachanok and Keaw morakot and the Black queen grape seed variety *(Vitis vinifera)* were extracted by four different extraction solvents comprised 95% ethanol, rice whisky (contained 40% ethanol), water and hot water. These extracts were studies for their antioxidant activity on total phenolic contents (TPC), reducing power (RP) and DPPH scavenging activity. The results of all experiments were shown below.

4.1 Total phenolic content (TPC)

The total phenolic contents of extracted mango seed kernel and grape seed which expressed as gallic acid equivalent (GAE) were shown below.

4.1.1 Total phenolic contents of mango seed kernel extracts

The level of total phenolic content of mango seed kernel extracts were ranged from 80.45 ± 2.75 to 413.51 ± 6.90 mg GAE/g extract (Table 4.1).

From Table 4.1, the total phenolic contents of Kaew were in range 413.51±6.90 to 180.19±4.21 mg GAE/g extract , which the ranks of values in extraction solvents were 95% ethanol > rice whisky > water > hot water. Total phenolic contents of Keaw morakot were found in range 350.52±18.99 to 80.45±2.75 mg GAE/g extract and the ranks of extracted by extraction solvents were not similar to Kaew : rice whisky > 95% ethanol > hot water > water. Finally, Mahachanok variety showed the lowest contents of total phenolic as found in range 240.16±9.64 to 112.73±4.47 mg GAE/g extract which had similar ranks of Keaw morakot variety.

Table 4.1 Total phenolic content of mango seed kernel

Varieties	**Extraction solvent**	**Total phenolics (mgGAE/g extract)**
KAEW	95% Ethanol	413.51±6.90*
	Rice whisky	411.01±4.63
	Water	181.37±19.73
	Hot water	180.19±4.21
MAHACHANOK	95% Ethanol	216.47±5.62
	Rice whisky	240.16±9.64
	Water	112.73±4.47
	Hot water	117.12±5.09
KEAW MORAKOT	95% Ethanol	318.26±3.22
	Rice whisky	350.52±18.99
	Water	80.45±2.75
	Hot water	86.13±6.09

*Mean ± SD obtained from analysis of three replicate extracted samples, in five replicate experiments which repeat tested in three replicate.

The comparison of total phenolic contents in mango seed kernel by the statistical analysis (used the statistical significance level of 0.05) classified by varieties and extraction solvents showed that the difference of varieties and extraction solvents had influence on the total phenolic contents values ($p < 0.05$). These means the values of TPC were depended on difference varieties of mango seed kernel varieties and extraction solvents (Table 4.2). Accordingly, the average of TPC values in terms of mango seed kernel varieties showed the significantly different ($p < 0.05$) by extraction of Kaew variety was likely to be greater than other varieties followed by Keaw morakot and Mahachanok respectively as showed in Table 4.3.

When focus on the extraction solvents, the results showed that the rice whisky extract was significantly greater than others ($p < 0.05$) followed by the 95% ethanol, hot water and water respectively as showed in Table 4.3.

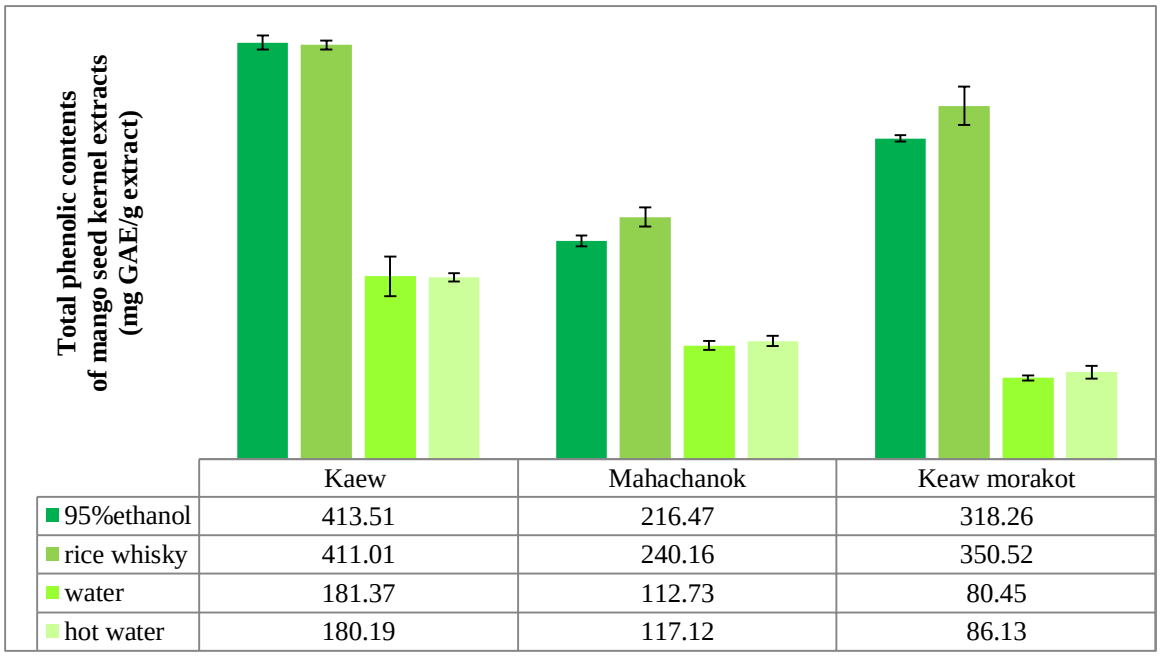
Table 4.2 The comparison of total phenolic content values classified by varieties and extraction solvents

Source of variance	SS	df	MS	F	p
Variety	1480379.964	2	740189.982	8361.472	0.000
Extraction solvents	5349803.742	3	1783267.914	20144.484	0.000
Variety*Extraction solvents	514804.302	6	85800.717	969.238	0.000
Error	46740.610	528	88.524		
Total	34889977.0	540			

Table 4.3 The multiple comparisons of average total phenolic content values from difference mango seed kernel varieties and extraction solvents

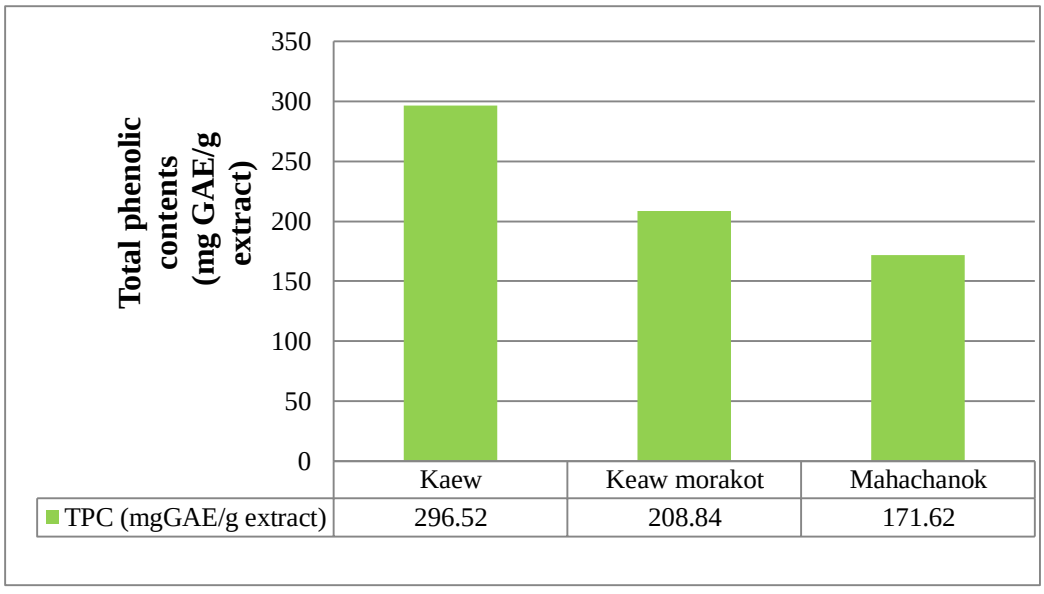
TPC	N	mean	Mean difference	Standard error	P
Variety					
1. Kaew	180[a]	296.52	124.90* (1-3)[c]	0.99	0.000
2. Keaw morakot	180	208.84	87.68* (1-2)	0.99	0.000
3. Mahachanok	180	171.62	37.22* (2-3)	0.99	0.000
Extraction solvent					
1. 95% ethanol	135[b]	316.08	17.82* (1-2)	1.14	0.000
2. Rice whisky	135	333.89	209.05* (2-3)	1.14	0.000
			206.08* (2-4)	1.14	0.000
3. Water	135	124.85	191.23* (3-1)	1.14	0.000
4. Hot water	135	127.81	188.27* (1-4)	1.14	0.000
			2.96* (4-3)	1.14	0.049

* The mean difference is significant at the 0.05 level ($\alpha = 0.05$)
a. Use harmonic mean sample size = 180.00
b. Use harmonic mean sample size = 135.00
c. The comparison between subjects in group e.g. (1-2) = the comparison of Kaew (1) and Keaw morakot (2) in variety group.



	Kaew	Mahachanok	Keaw morakot
95%ethanol	413.51	216.47	318.26
rice whisky	411.01	240.16	350.52
water	181.37	112.73	80.45
hot water	180.19	117.12	86.13

Figure 4.1 Total phenolic contents of mango seed kernel extracts in different extraction solvents



	Kaew	Keaw morakot	Mahachanok
TPC (mgGAE/g extract)	296.52	208.84	171.62

Figure 4.2 The rank of average values of total phenolic contents from various mango seed kernel extract varieties

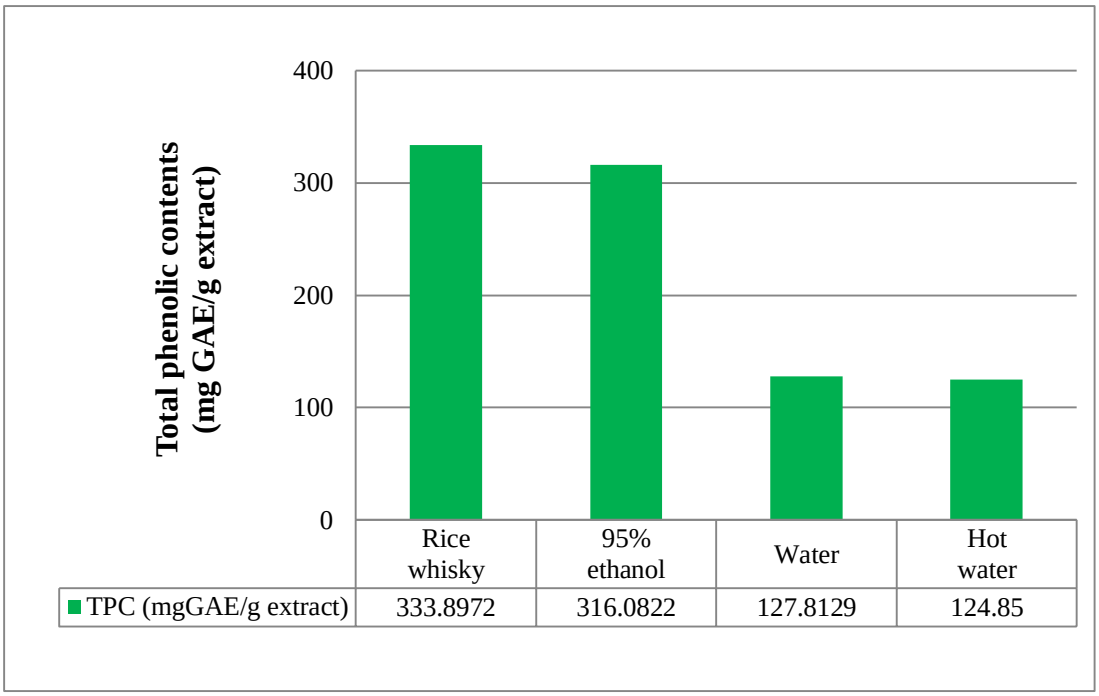


Figure 4.3 The rank of average values of total phenolic contents from various extraction solvents

4.1.2 Total phenolic contents of grape seed extracts

The level of total phenolic contents of grape seed extracts (Black queen variety) showed in Table 4.4. Their total phenolic contents were ranged from 311.26±16.49 to 683.22±27.52 mg GAE/g extract. The results showed that the rice whisky extracts was significantly greater than other extraction solvents ($p < 0.05$), followed by 95% ethanol, water and hot water respectively.

Table 4.4 Total phenolic content of grape seed extracts (Black queen variety).

Variety	Extraction solvent	Total phenolics (mgGAE/g extract)
Black queen (Grape seed)	95% Ethanol	665.94±21.05
	Rice whisky	683.22±27.52
	Water	329.27±16.49
	Hotwater	311.26±12.61

*Mean ± SD obtained from analysis of three replicate extracted samples, in five replicate experiments which repeat tested in three replicate.

Table 4.5 The comparisons of total phenolic contents values from different extraction solvents of grape seed extracts

Source of variance	SS	df	MS	F	p
Between groups	5663136.00	3	1887711.837	4627.042	0.000
Within groups	71803.392	176	407.974		
Total	5734939.392	179			

Table 4.6 The multiple comparisons of average TPC values from extraction solvents

TPC	N	mean	Mean difference	Standard error	P
Extraction solvent					
1. 95% ethanol	45[a]	665.94	17.28* (1-2)[b]	4.26	0.000
2. Rice whisky	45	683.22	353.95* (2-3)	4.26	0.000
			371.95* (2-4)	4.26	0.000
3. Water	45	329.27	336.67* (3-1)	4.26	0.000
4. Hot water	45	311.26	354.67* (1-4)	4.26	0.000
			18.00* (4-3)	4.26	0.000

* The mean difference is significant at the 0.05 level ($\alpha = 0.05$)
a. Use harmonic mean sample size = 45.00
b. The comparison between subjects in group e.g. (1-2) = the comparison of 95% ethanol (1) and Rice whisky (2)

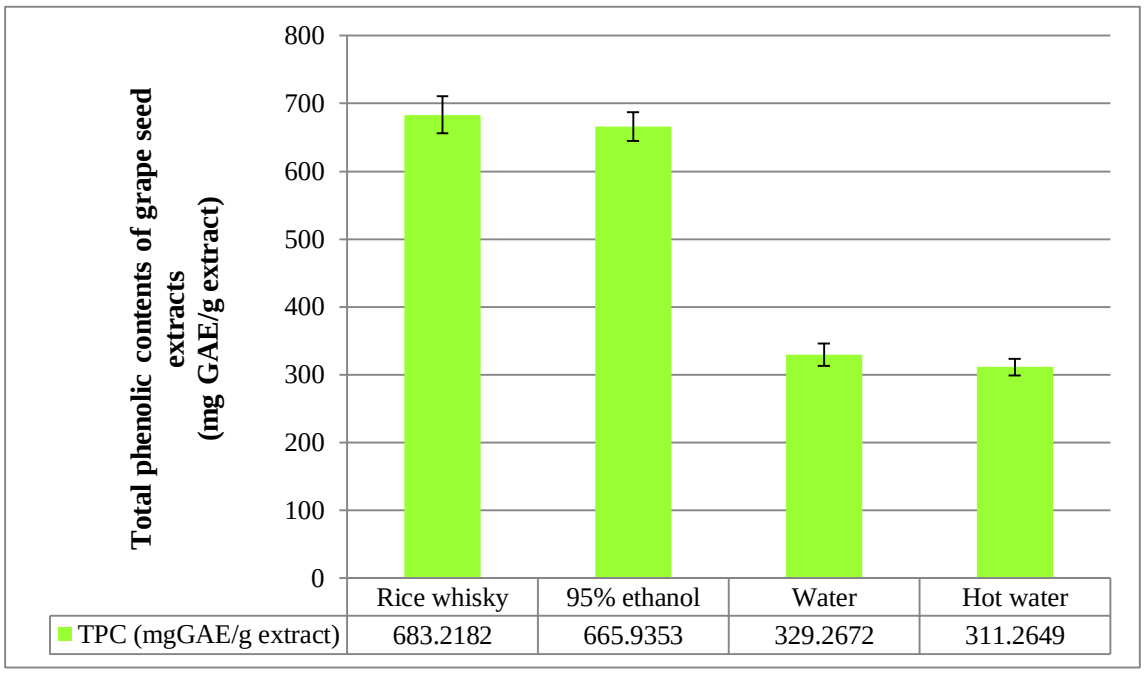


Figure 4.4 Total phenolic contents of grape seed extracts (Black queen variety)

4.2 Reducing Power (RP)

The reducing power of extracts of mango seed kernel and grape seed which expressed as ascorbic acid equivalent (AAE) showed below.

4.2.1 Reducing Power (RP) of mango seed kernel extracts

The results of reducing power of mango seed kernel extracts described above has shown in Table 4.7. The level of reducing power of mango seed kernel extracts ranged from 69.69±4.41 to 308.66±6.35 mg AAE/g extract while the reducing power of Kaew extracts was in range 308.66±6.35 to 149.37±7.79 mg AAE/g extract which the ranks of values in extracted by extraction solvents were 95% ethanol extract > rice whisky > water > hot water. Keaw morakot variety was found RP in range 200.19±7.69 to 69.69±4.41 mg AAE/g extract which extracted from rice whisky > 95% ethanol > hot water > water respectively. Finally, Mahachanok variety was found RP in range 186.49±5.30 to 20 mg AAE/g extract which the ranks of values in extracted by extraction solvents were rice whisky > 95% ethanol > hot water > water.

The comparison of reducing power values of mango seed kernel by the statistical analysis (used the statistical significance level of 0.05) classified by varieties and extraction solvents showed that the difference of varieties and extraction solvents had influence on the reducing power values ($p < 0.05$). These mean that the values of RP were depended on difference varieties of mango seed kernel varieties and extraction solvents (Table 4.8). Accordingly, the average of RP values in terms of mango seed kernel varieties showed the significantly different ($p < 0.05$) by extract of Kaew variety was likely to be greater than other varieties followed by Keaw morakot and Mahachanok respectively as showed in Table 4.9.

When focus on the extraction solvents, the results showed that the rice whisky extract was significantly greater than others ($p < 0.05$) followed by the 95% ethanol, water and hot water respectively as showed in Table 4.9.

Table 4.7 Reducing Power of mango seed kernels extracts

Varieties	**Extraction solvent**	**Reducing Power (mgAAE/g extract)**
KAEW	95% Ethanol	308.66±6.35
	Rice whisky	272.21±14.83
	Water	170.36±5.37
	Hotwater	149.37±7.79
MAHACHANOK	95% Ethanol	112.25±4.49
	Rice whisky	186.49±5.30
	Water	84.07±4.79
	Hotwater	87.05±3.00
KEAW MORAKOT	95% Ethanol	96.83±5.27
	Rice whisky	200.19±7.69
	Water	73.75±3.52
	Hotwater	69.69±4.41

*Mean ± SD obtained from analysis of three replicate extracted samples, in five replicate experiments which repeat tested in three replicate.

Table 4.8 The comparison of Reducing Power values classified by varieties and extraction solvents

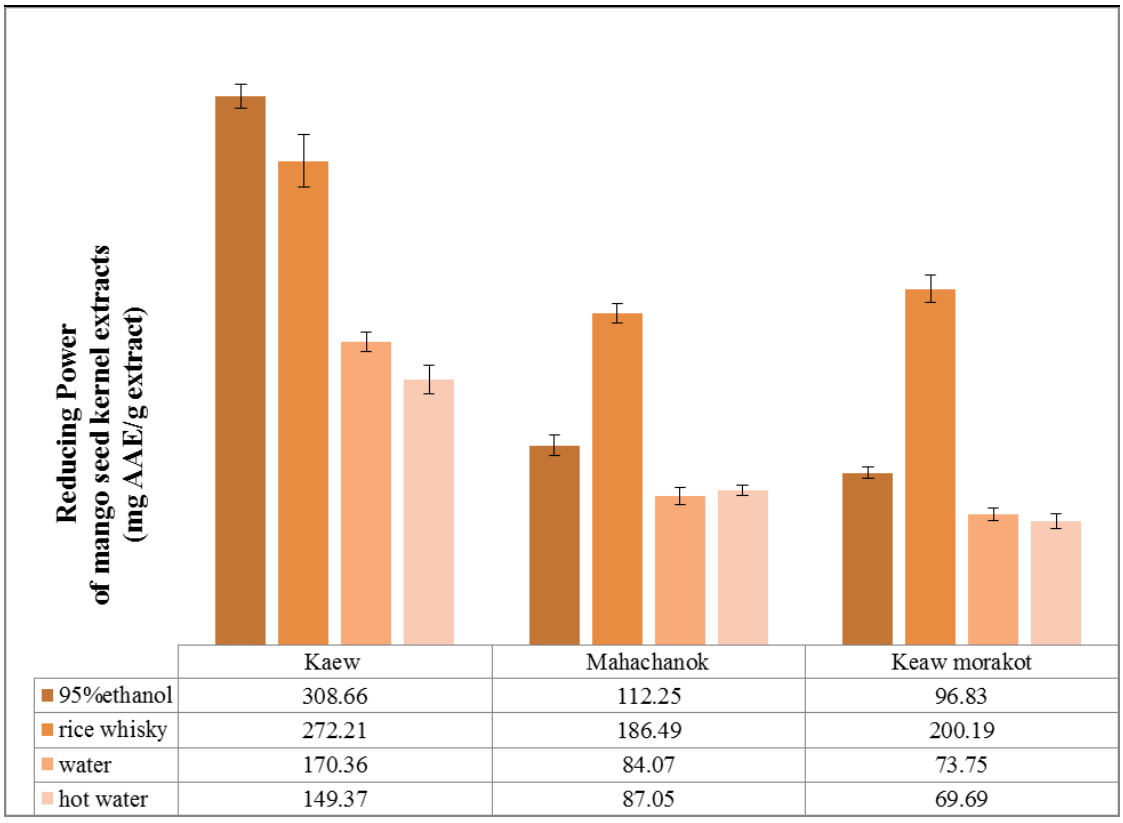
Source of variance	SS	df	MS	F	p
Variety	1492947.426[a]	2	746473.713	16319.641	0.000
Extraction solvents	1256085.070	3	418695.023	9153.641	0.000
Variety*Extraction solvents	364430.478	6	60738.413	1327.882	0.000
Error	24151.152	528	45.741		
Total	15435296.4	540			

a. R Squared = 0.992 (Adjusted R Squared = 0.992)

Table 4.9 The multiple comparisons of average Reducing Power values from difference mango seed kernel varieties and extraction solvents

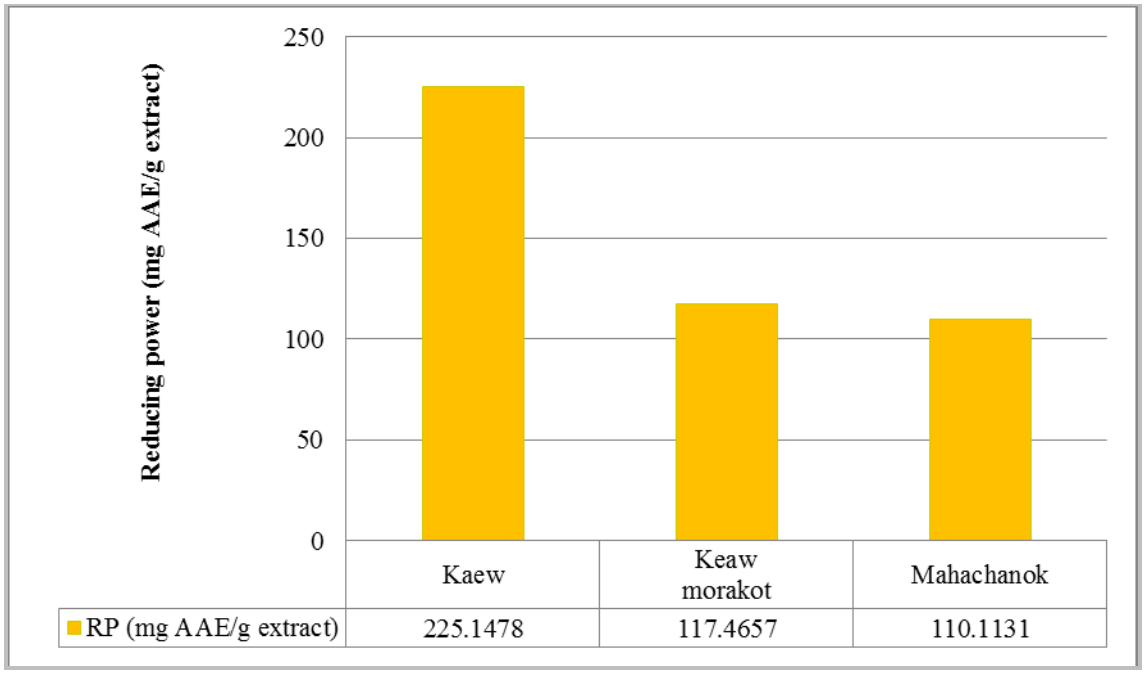
RP	N	mean	Mean difference	Standard error	P
Variety					
1. Kaew	180[a]	225.15	107.68* (1-3)[c]	0.71	0.000
2. Keaw morakot	180	110.11	115.03* (1-2)	0.71	0.000
3. Mahachanok	180	117.47	7.35* (2-3)	0.71	0.000
Extraction solvent					
1. 95% ethanol	135[b]	172.58	47.05* (1-2)	0.82	0.000
2. Rice whisky	135	219.63	110.24* (2-3)	0.82	0.000
			117.59* (2-4)	0.82	0.000
3. Water	135	109.39	63.18* (3-1)	0.82	0.000
4. Hot water	135	102.03	70.54* (1-4)	0.82	0.000
			7.36* (4-3)	0.82	0.000

* The mean difference is significant at the 0.05 level ($\alpha = 0.05$)
a. Use harmonic mean sample size = 180.00
b. Use harmonic mean sample size = 135.00
c. The comparison between subjects in group e.g. (1-2) = the comparison of Kaew (1) and Keaw morakot (2) in variety group.



	Kaew	Mahachanok	Keaw morakot
95%ethanol	308.66	112.25	96.83
rice whisky	272.21	186.49	200.19
water	170.36	84.07	73.75
hot water	149.37	87.05	69.69

Figure 4.5 Reducing power of mango seed kernel extracts in different extraction solvents



	Kaew	Keaw morakot	Mahachanok
RP (mg AAE/g extract)	225.1478	117.4657	110.1131

Figure 4.6 The rank of average values of reducing power from various mango seed kernel varieties extract

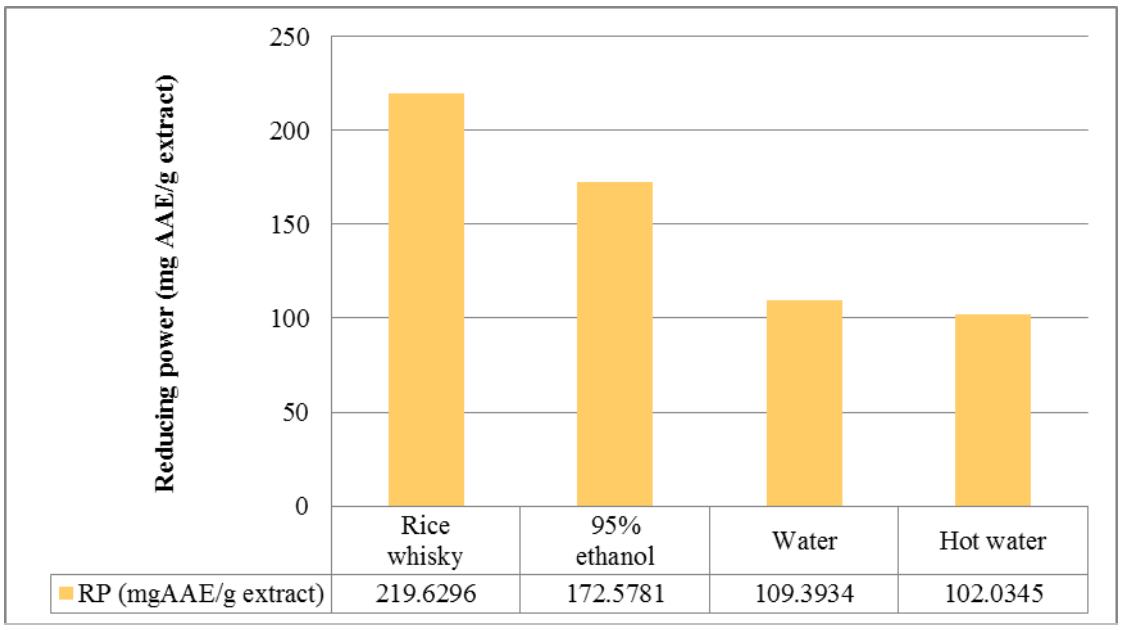


Figure 4.7 The rank of average values of reducing power from various extraction solvents

4.2.2 Reducing power of grape seed extracts

The level of reducing power of grape seed extracts (Black queen variety) was showed in Table 4.10. Their reducing power were ranged from 392.95±21.52 to 154.82±6.66 mg AAE/g extract. The results showed that the rice whisky extracts was significantly greater than other extraction solvents ($p < 0.05$), followed by 95% ethanol, water and hot water respectively (figure 4.8).

Table 4.10 Reducing Power of grape seed extracts in Black queen variety

Varieties	Extraction solvent	Reducing Power (mg AAE/g extract)
Black queen (Grape seed)	95% Ethanol	367.67±17.17*
	Rice whisky	392.95±21.52
	Water	173.28±8.84
	Hotwater	154.82±6.66

*Mean ± SD obtained from analysis of three replicate extracted samples, in five replicate experiments which repeat tested in three replicate.

Table 4.11 The comparisons of reducing power values from different extraction solvents of grape seed extracts

Source of variance	SS	df	MS	F	p
Between groups	2126676	3	708892.120	3220.575	0.000
Within groups	38739.984	176	220.114		
Total	2165416	179			

Table 4.12 The multiple comparisons of average RP values from extraction solvents

TPC	N	mean	Mean difference	Standard error	P
Extraction solvent					
1. 95% ethanol	45[a]	367.67	25.28* (1-2)[b]	3.13	0.000
2. Rice whisky	45	392.95	219.68* (2-3)	3.13	0.000
			238.13* (2-4)	3.13	0.000
3. Water	45	173.28	194.39* (3-1)	3.13	0.000
4. Hot water	45	154.82	212.85* (1-4)	3.13	0.000
			18.45* (4-3)	3.13	0.000

* The mean difference is significant at the 0.05 level ($\alpha = 0.05$)
a. Use harmonic mean sample size = 45.00
b. The comparison between subjects in group e.g. (1-2) = the comparison of 95% ethanol (1) and Rice whisky (2)

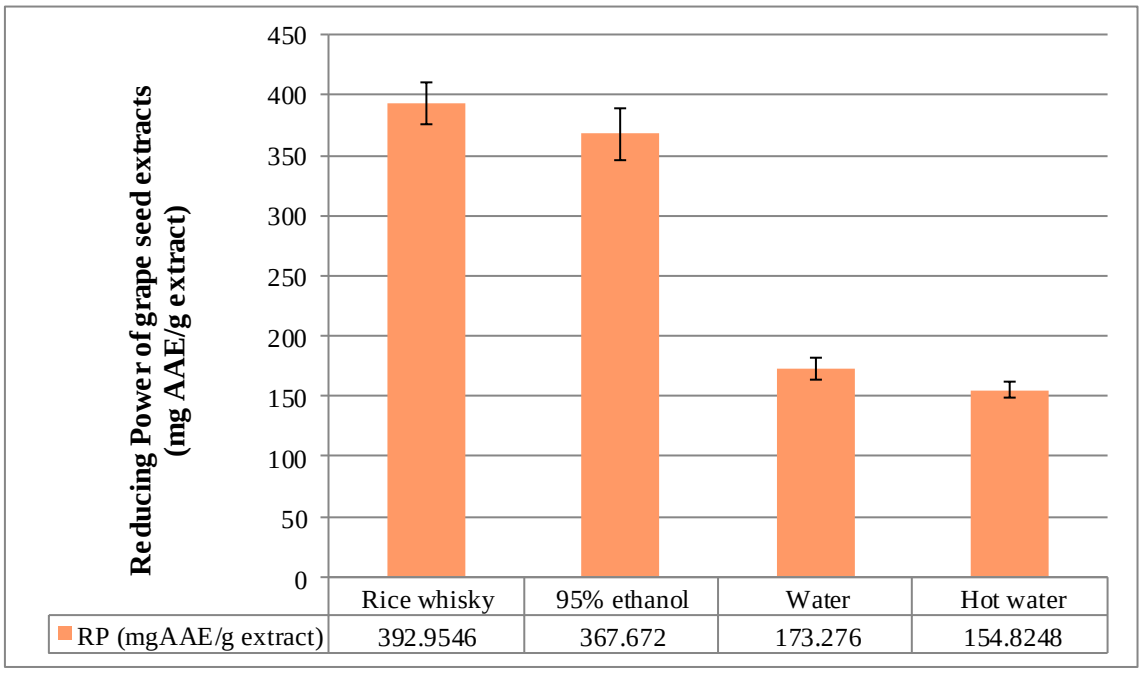


Figure 4.8 Reducing power of grape seed extracts

4.3 Free radical scavenging activity

4.3.1 DPPH radical scavenging activity

Mango seed kernel extracts and grape seed extracts were tested for their free radical scavenging activity using DPPH radical scavenging assay. The results were shown in % DPPH scavenging activity that showed below.

4.3.1.1 %DPPH radical scavenging activity of mango seed kernel extracts.

The % DPPH scavenging activity of mango seed kernel extracts were shown in Table 4.13. These demonstrated the relationship of mango seed kernel varieties and extraction solvents influenced % DPPH scavenging activity (Table 4.14) which depended on the difference mango varieties and extraction solvents ($p < 0.05$). The mango seed kernel extracts from the three mango varieties showed significantly different values of % DPPH radical scavenging activities, ranged from 11.41% to 63.44% (Table 4.15). The highest % DPPH radical scavenging activity of

three mango seed kernel varieties were found in Kaew variety followed by Keaw morakot and Mahachanok. % DPPH radical scavenging activity of Kaew were in range 34.34% to 63.44% which the highest value found in rice whisky extract followed by 95% ethanol, water and hot water extract respectively. Keaw morakot variety was found % DPPH radical scavenging activity in range 11.41% to 42.05% which extracted from rice whisky, 95% ethanol, water and hot water respectively. Finally, Mahachanok variety found % DPPH radical scavenging activity in range 13.35% to 33.11% which the highest extraction solvents sequence as followed by rice whisky, 95% ethanol, water and hot water respectively (Table 4.15).

Table 4.13 %DPPH scavenging activity of mango seed kernel extracts

	Extraction solvent	**% DPPH scavenging activity**
KAEW	95% Ethanol	53.92±0.83*
	Rice whisky	63.44±2.64
	Water	35.47±1.13
	Hotwater	34.34±1.53
MAHACHANOK	95% Ethanol	29.68±1.04
	Rice whisky	33.11±1.41
	Water	16.21±1.21
	Hotwater	13.35±0.90
KEAW MORAKOT	95% Ethanol	35.96±0.98
	Rice whisky	42.05±2.15
	Water	13.14±1.14
	Hotwater	11.41±0.83

*Mean ± SD obtained from analysis of three replicate extracted samples, in five replicate experiments which repeat tested in three replicate.

Table 4.14 The comparison of %DPPH scavenging activity classified by varieties and extraction solvents

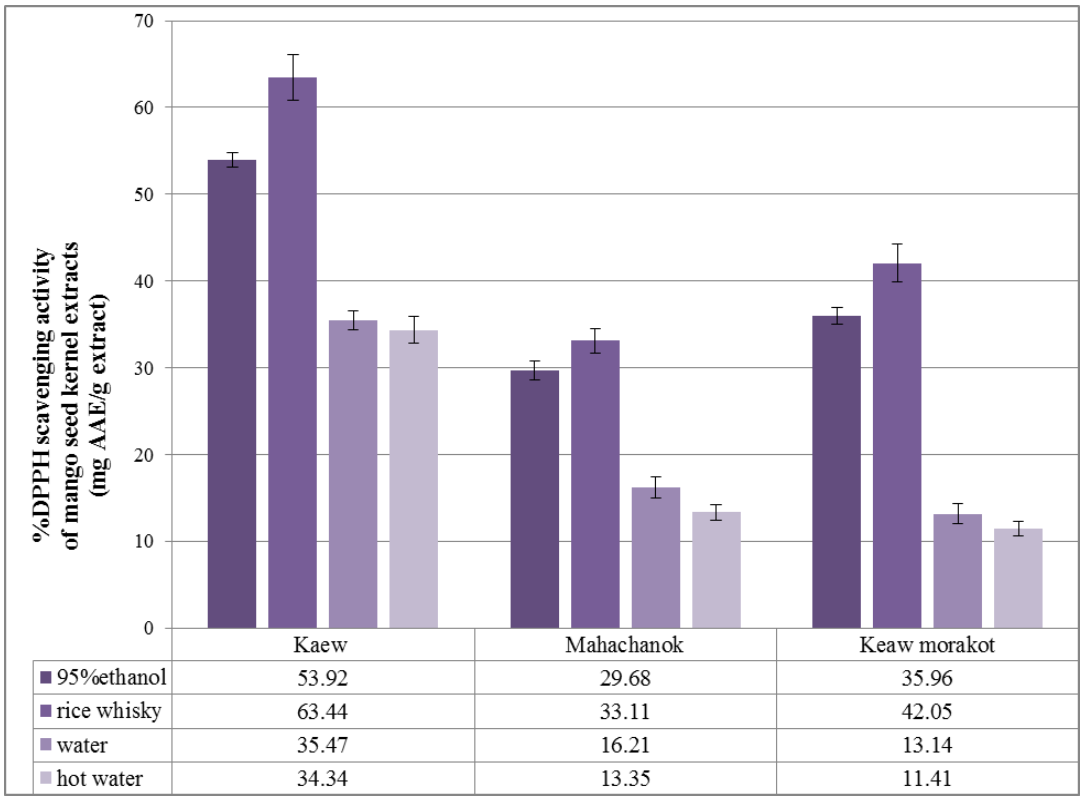
Source of variance	SS	df	MS	F	p
Variety	60961.314[a]	2	30480.657	15106.072	0.000
Extraction solvents	70542.589	3	23514.196	11653.526	0.000
Variety*Extraction solvents	2887.583	6	481.264	238.512	0.000
Error	1065.385	528	2.018		
Total	682928.834	540			

a. R Squared = 0.992 (Adjusted R Squared = 0.992)

Table 4.15 The multiple comparisons of average %DPPH scavenging activity from difference mango seed kernel varieties and extraction solvents

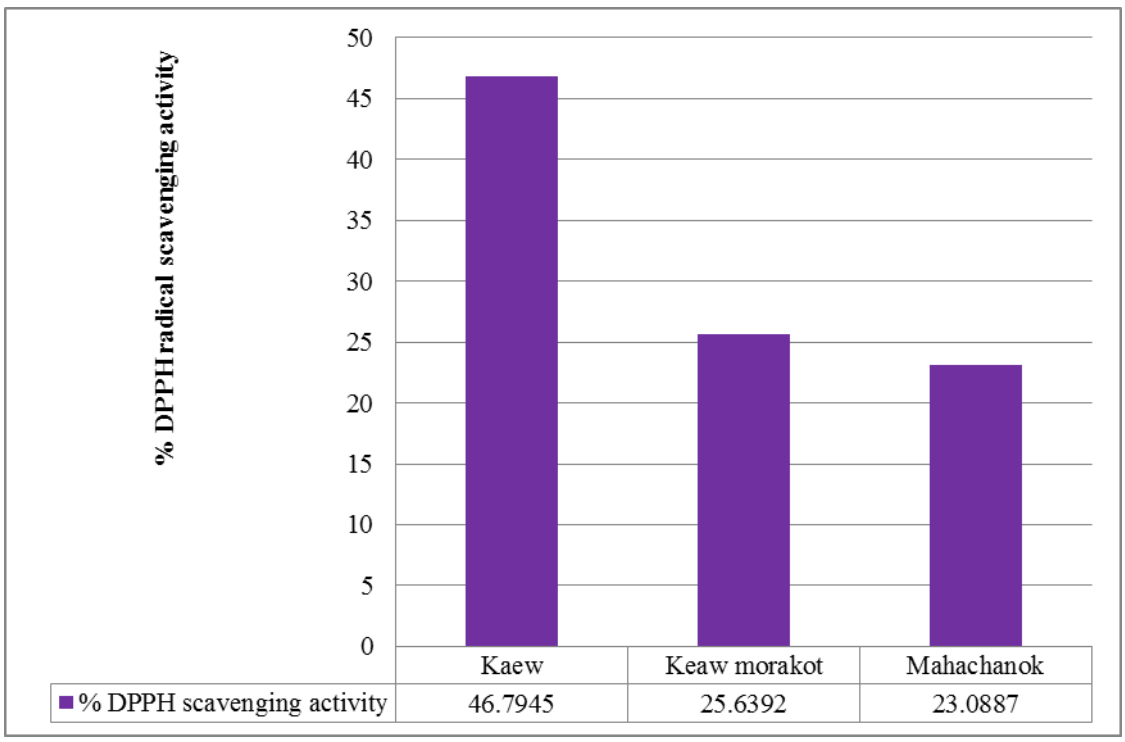
RP	N	mean	Mean difference	Standard error	P
Variety					
1. Kaew	180[a]	46.79	23.71* (1-3)[c]	0.15	0.000
2. Keaw morakot	180	25.64	21.16* (1-2)	0.15	0.000
3. Mahachanok	180	23.09	2.55* (2-3)	0.15	0.000
Extraction solvent					
1. 95% ethanol	135[b]	39.85	6.35* (1-2)	0.17	0.000
2. Rice whisky	135	46.20	24.59* (2-3)	0.17	0.000
			26.50* (2-4)	0.17	0.000
3. Water	135	21.61	18.25* (3-1)	0.17	0.000
4. Hot water	135	19.69	20.15* (1-4)	0.17	0.000
			1.91* (4-3)	0.17	0.000

* The mean difference is significant at the 0.05 level ($\alpha = 0.05$)
a. Use harmonic mean sample size = 180.00
b. Use harmonic mean sample size = 135.00
c. The comparison between subjects in group e.g. (1-2) = the comparison of Kaew (1) and Keaw morakot (2) in variety group.



	Kaew	Mahachanok	Keaw morakot
95%ethanol	53.92	29.68	35.96
rice whisky	63.44	33.11	42.05
water	35.47	16.21	13.14
hot water	34.34	13.35	11.41

Figure 4.9 % DPPH radical scavenging activity of mango seed kernel extracts



	Kaew	Keaw morakot	Mahachanok
% DPPH scavenging activity	46.7945	25.6392	23.0887

Figure 4.10 The rank of average values of % DPPH scavenging activity from various mango seed kernel varieties

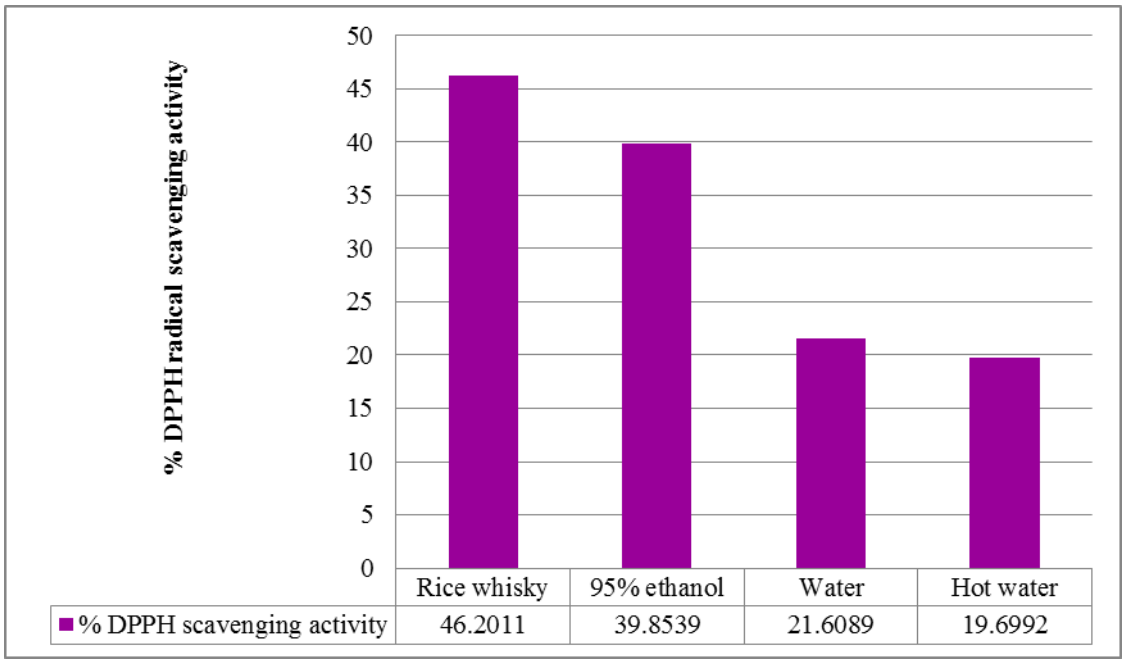


Figure 4.11 The rank of average values of % DPPH radical scavenging activity from various extraction solvents

4.3.1.2 DPPH radical scavenging activity of grape seed extracts.

The level of %DPPH radical scavenging activity of grape seed extracts (Black queen variety) was showed in Table 4.16. Their %DPPH radical scavenging activity was ranged from 13.47% to 49.80%. The results showed that the rice whisky extracts was significantly greater than other extraction solvents ($p < 0.05$), followed by 95% ethanol, water and hot water respectively (Table 4.18).

Table 4.16 %DPPH scavenging activity of Black queen grape seed extracts

Variety	Extraction solvent	% DPPH radical scavenging activity
Black queen (Grape seed)	95% Ethanol	43.17±1.62*
	Rice whisky	49.80±1.67
	Water	16.79±0.94
	Hotwater	13.47±1.29

*Mean ± SD obtained from analysis of three replicate extracted samples, in five replicate experiments which repeat tested in three replicate.

Table 4.17 The comparisons of %DPPH scavenging activity from different extraction solvents of grape seed extracts

Source of variance	SS	df	MS	F	p
Between groups	45482.896	3	15160.965	7610.839	0.000
Within groups	350.596	176	1.992		
Total	45833.492	179			

Table 4.18 The multiple comparisons of average %DPPH scavenging activity from extraction solvents

TPC	N	mean	Mean difference	Standard error	P
Extraction solvent					
1. 95% ethanol	45[a]	43.1682	6.64* (1-2)[b]	0.29	0.000
2. Rice whisky	45	49.80	33.02* (2-3)	0.29	0.000
			36.33* (2-4)	0.29	0.000
3. Water	45	16.79	26.38* (3-1)	0.29	0.000
4. Hot water	45	13.47	29.69* (1-4)	0.29	0.000
			3.31* (4-3)	0.29	0.000

* The mean difference is significant at the 0.05 level ($\alpha = 0.05$)

a. Use harmonic mean sample size = 45.00

b. The comparison between subjects in group e.g. (1-2) = the comparison of 95% ethanol (1) and Rice whisky (2)

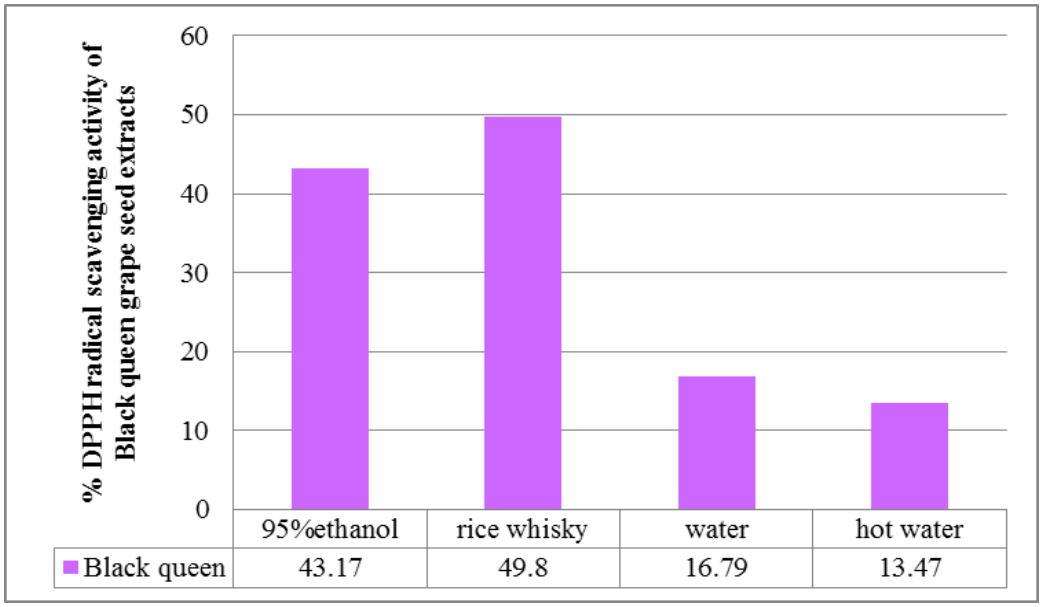


Figure 4.12 % DPPH radical scavenging activity of Black queen grape seed extracts

4.3.2 DPPH radical scavenging activity, expressed as milligrams of Ascorbic acid equivalents (AAE)

DPPH radical scavenging activity was expressed as milligrams of Ascorbic Acid Eequivalents (AAE) per gram extract weight and the results were shown below.

4.3.2.1 DPPH radical scavenging activity of mango seed kernel extracts

The mango seed kernel extracts from the three mango varieties showed significant different values of free radical scavenging activities, ranging from 2.24±0.22 to 15.80±0.69 mg AAE/g extract. The highest free radical scavenging activity of three mango seed kernel varieties was found in Kaew variety followed by Keaw morakot and Mahachanok . The free radical scavenging activity of Kaew was in range 8.22±0.40 to 15.80±0.69 mg AAE/g extract which the highest value found in rice whisky extract followed by 95% ethanol, water and hot water extract respectively. Keaw morakot variety was found free radical scavenging activity in range 2.24±0.22 to 10.22±0.56 mg AAE/g extract, which extracted from rice whisky, 95% ethanol, water and hot water respectively. Finally, Mahachanok variety was found free radical scavenging activity in range 2.75±0.23 to 7.90±0.37 mg AAE/g extract, which the highest extraction solvents sequence as followed by rice whisky, 95% ethanol, water and hot water respectively.

Table 4.19 DPPH radical scavenging activity, expressed as milligrams of Ascorbic acid equivalents (AAE)

Variety	**Extraction solvent**	**DPPH (mgAAE/g extract)**
KAEW	95% Ethanol	13.32±0.22*
	Rice whisky	15.80±0.69
	Water	8.51±0.30
	Hotwater	8.22±0.40
MAHACHANOK	95% Ethanol	7.00±0.27
	Rice whisky	7.90±0.37
	Water	3.49±0.31
	Hotwater	2.75±0.23
KEAW MORAKOT	95% Ethanol	8.64±0.26
	Rice whisky	10.22±0.56
	Water	2.69±0.30
	Hotwater	2.24±0.22

*Mean ± SD obtained from analysis of three replicate extracted samples, in five replicate experiments which repeat tested in three replicate.

Table 4.20 The comparison of DPPH scavenging activity classified by varieties and extraction solvents

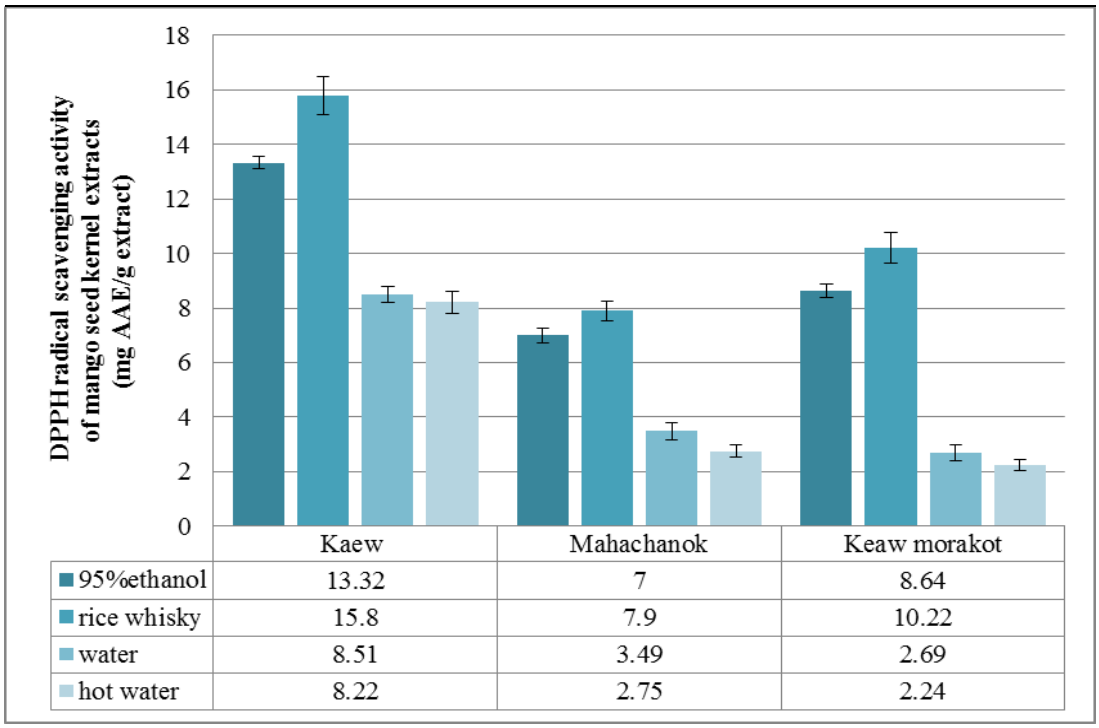
Source of variance	**SS**	**Df**	**MS**	**F**	**p**
Variety	4138.514[a]	2	2069.257	15106.072	0.000
Extraction solvents	4788.963	3	1596.321	11653.526	0.000
Variety*Extraction solvents	196.031	6	32.672	238.512	0.000
Error	72.326	528	0.137		
Total	40087.560	540			

a. R Squared = 0.992 (Adjusted R Squared = 0.992)

Table 4.21 The multiple comparisons of average DPPH scavenging activity values from difference mango seed kernel varieties and extraction solvents

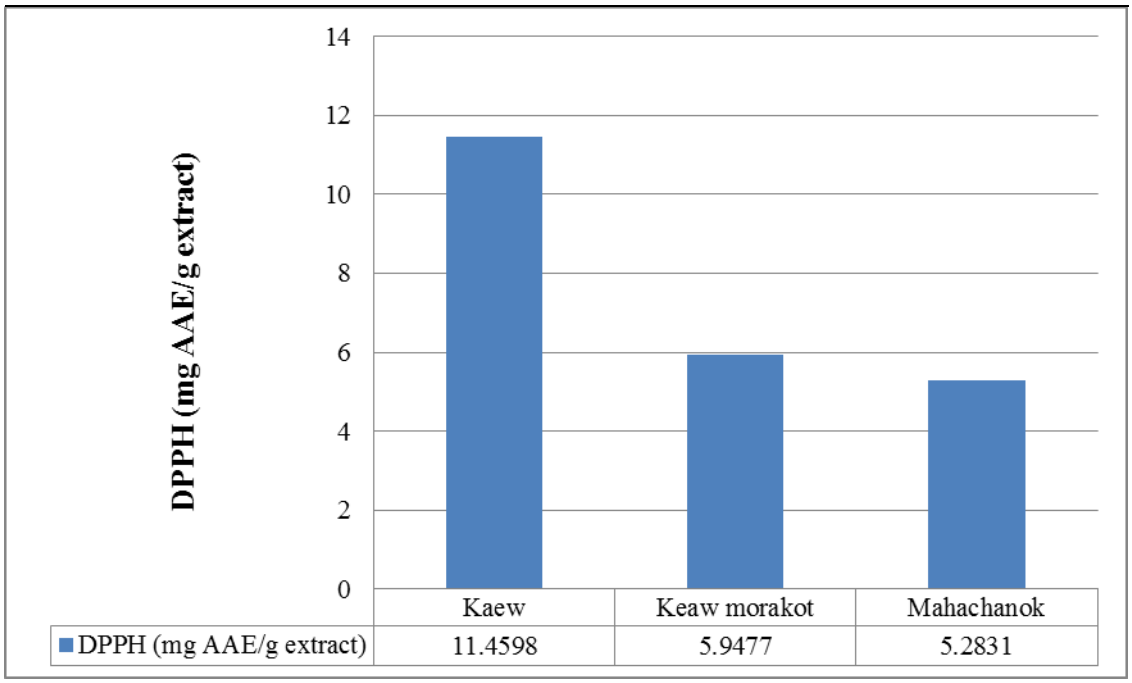
RP	N	Mean	Mean difference	Standard error	P
Variety					
1. Kaew	180[a]	11.46	6.18* (1-3)[c]	0.04	0.000
2. Keaw morakot	180	5.95	5.51* (1-2)	0.04	0.000
3. Mahachanok	180	5.28	0.66* (2-3)	0.04	0.000
Extraction solvent					
1. 95% ethanol	135[b]	9.65	1.65* (1-2)	0.05	0.000
2. Rice whisky	135	11.31	6.41* (2-3)	0.05	0.000
			6.91* (2-4)	0.05	0.000
3. Water	135	4.89	4.75* (3-1)	0.05	0.000
4. Hot water	135	4.40	5.25* (1-4)	0.05	0.000
			0.49* (4-3)	0.05	0.000

* The mean difference is significant at the 0.05 level ($\alpha = 0.05$)
a. Use harmonic mean sample size = 180.00
b. Use harmonic mean sample size = 135.00
c. The comparison between subjects in group e.g. (1-2) = the comparison of Kaew (1) and Keaw morakot (2) in variety group.



	Kaew	Mahachanok	Keaw morakot
95%ethanol	13.32	7	8.64
rice whisky	15.8	7.9	10.22
water	8.51	3.49	2.69
hot water	8.22	2.75	2.24

Figure 4.13 DPPH radical scavenging activity of mango seed kernel extracts (mg AAE/g extract)



	Kaew	Keaw morakot	Mahachanok
DPPH (mg AAE/g extract)	11.4598	5.9477	5.2831

Figure 4.14 The rank of DPPH scavenging activity values from various mango seed kernel varieties

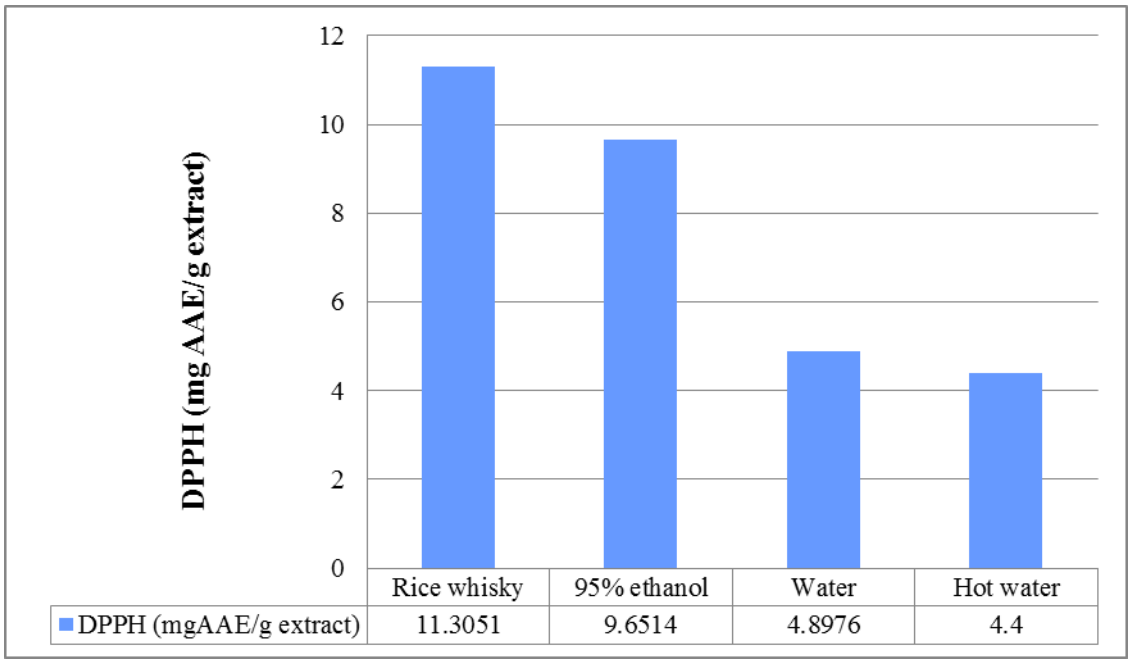


Figure 4.15 The rank of DPPH radical scavenging activity values from various extraction solvents

4.3.2.2 DPPH radical scavenging activity of grape seed extracts

The level of DPPH radical scavenging activity of grape seed extracts (Black queen variety) ranged from 2.78±0.34 to 12.24±0.43 mg AAE/g extract. The results showed that the rice whisky extracts was significantly greater than other extraction solvents ($p < 0.05$), followed by 95% ethanol, water and hot water respectively (Table 4.24).

Table 4.22 DPPH scavenging activity of Black queen grape seed extracts

Variety	**Extraction solvent**	**DPPH radical scavenging activity** (mg AAE/g extract)
Black queen	95% Ethanol	10.51±0.42*
	Rice whisky	12.24±0.43
	Water	3.64±0.25
	Hotwater	2.78±0.34

*Mean ± SD obtained from analysis of three replicate extracted samples, in five replicate experiments which repeat tested in three replicate.

Table 4.23 The comparisons of DPPH scavenging activity from different extraction solvents of grape seed extracts

Source of variance	SS	Df	MS	F	p
Between groups	3087.722	3	1029.241	7610.839	0.000
Within groups	23.801	176	0.135		
Total	3111.523	179			

Table 4.24 The multiple comparisons of average DPPH scavenging activity from extraction solvents

TPC	N	Mean	Mean difference	Standard error	P
Extraction solvent					
1. 95% ethanol	45[a]	10.51	1.72* (1-2)[b]	0.08	0.000
2. Rice whisky	45	12.24	8.60* (2-3)	0.08	0.000
			9.47* (2-4)	0.08	0.000
3. Water	45	3.64	6.87* (3-1)	0.08	0.000
4. Hot water	45	2.78	7.74* (1-4)	0.08	0.000
			0.86* (4-3)	0.08	0.000

* The mean difference is significant at the 0.05 level ($\alpha = 0.05$)
a. Use harmonic mean sample size = 45.00
b. The comparison between subjects in group e.g. (1-2) = the comparison of 95% ethanol (1) and Rice whisky (2)

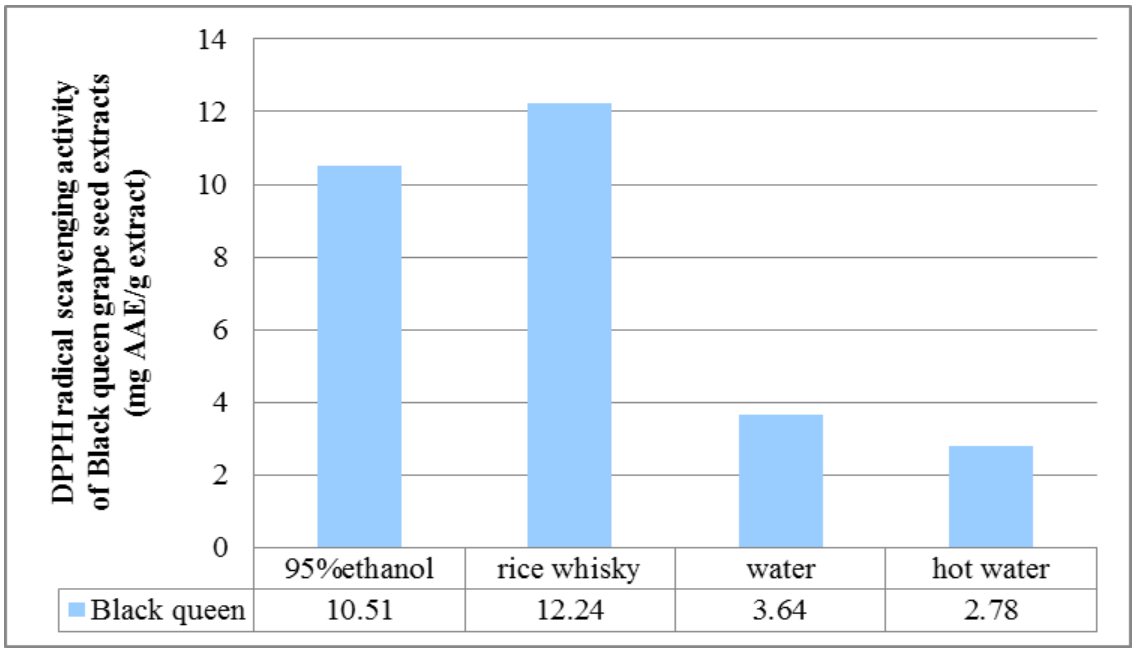


Figure 4.16 DPPH radical scavenging activity of Black queen grape seed extracts

4.4 The comparison of antioxidant analysis of mango seed kernel extracted by 95% ethanol, rice whisky (contained 40% ethanol), water and hot water

The three different mango seed kernels varieties (*Mangifera indica* L.) which were Kaew, Mahachanok and Keaw morakot that extracted by four different extraction solvents comprised 95% ethanol, rice whisky (contained 40% ethanol), water and hot water. These extracts were studied for their total phenolic contents (TPC), reducing power (RP) and DPPH scavenging activity. The results of three experiments above showed quantity and quality of antioxidant compounds contained in each extracts which the relationship of mango seed kernel varieties and extraction solvents influenced its quantity and quality of antioxidants compound. Therefore, the quantity and quality of antioxidant compounds were depending on the different mango varieties and extraction solvents. Their results showed significantly difference at $p < 0.05$ (Table 4.25). The rank of mean results showed that the rice whisky extract was significantly greater than three other extracts ($p < 0.05$) followed by the 95% ethanol, water and hot water respectively as showed in figure 4.17.

Table 4.25 The mean values of TPC RP and %DPPH scavenging activity in terms of rice whisky, 95% ethanol, water and hot water extracts.

Extraction solvent	TPC (mgGAE/g extract)	RP (mgAAE/g extract)	% DPPH scavenging activity
Rice whisky	333.90	219.63	46.20
95% ethanol	316.08	172.58	39.85
Water	127.81	109.39	21.61
Hot water	124.85	102.03	19.70

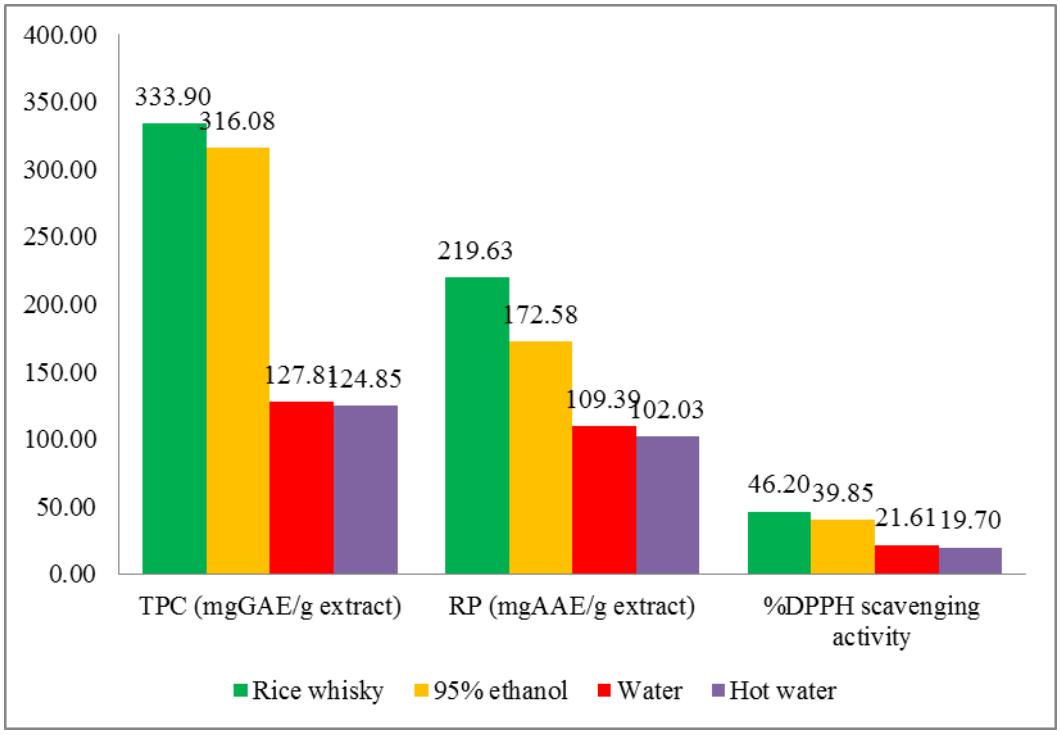


Figure 4.17 The mean results of TPC RP and % DPPH scavenging activity of rice whisky, 95% ethanol, water and hot water extracts

To compare the analysis results of rice whisky extracts with 95% ethanol extracts, it was found that the rice whisky extract was greater than 95% ethanol extracts in equal weight extract. The reason is probably the effective in evaporation of different solvents as a result. The contact time in extraction process was unequal. The rice whisky contained more water than 95% ethanol that means the evaporate on of rice whisky was slowly than 95% ethanol, therefore; the contact time of raw materials and rice whisky into the extraction process was higher. By the way, 95% ethanol extracts may be more effective than rice whisky extract but the volume of the 95% ethanol to extract may require more than the volume of rice whisky to be able to contact raw materials for extraction because 95% ethanol required low temperature for evaporation.

Water and hot water extracts showed the low antioxidant activity, due to the phenolic compound had good solubility in ethanol. The extraction of phenolic compounds out of raw materials may less than ethanol which has the good solubility.

4.5 Quantity and quality of antioxidant compounds from mango seed kernel and grape seed extract

The quantity and quality of antioxidant compounds from three mango seed kernel varieties, including Kaew, Mahachanok and Keaw morakot and the Black queen grape seed were studied. The means result of total phenolic contents (TPC), reducing power (RP) and DPPH. Scavenging activity of the three mango seed kernels and grape seed were shown in Table 4.26 which the mean results of each variety was significantly difference at $p < 0.05$. The ranks of average results showed that the Black queen grape seed was significantly greater than others ($p < 0.05$) followed by Kaew, Keaw morakot and Mahachanok seed kernels respectively as showed in figure 4.18, which the ranging of TPC from 497.42 to 171.62 mg GAE/g extract, RP from 272.18 to 110.11 mg AAE/g extract and % DPPH scavenging activity from 46.79 % to 23.09 %.

To compare with grape seed extract, the highest value of total phenolic contents (TPC) of mango seed kernel extract which found in Kaew variety was 1.68 times lower than those grape seed extract. Like the reducing power of grape seed extract that was 1.21 time higher than Kaew variety. And DPPH scavenging activity experiment, the % inhibition of grape seed extract was 1.52 time lower than Kaew variety but the Mahachanok and Keaw morakot extract was higher than those two mango varieties.

Table 4.26 Quantity and quality of antioxidant compounds from mango seed kernel and grape seed extract (mean values)

Variety	TPC (mgGAE/g extract)	RP (mgAAE/g extract)	% DPPH scavenging activity
Kaew	296.52	225.15	46.79
Mahachanok	171.62	110.11	23.09
Keaw morakot	208.84	117.47	25.64
Black queen (grape)	497.42	272.18	30.81

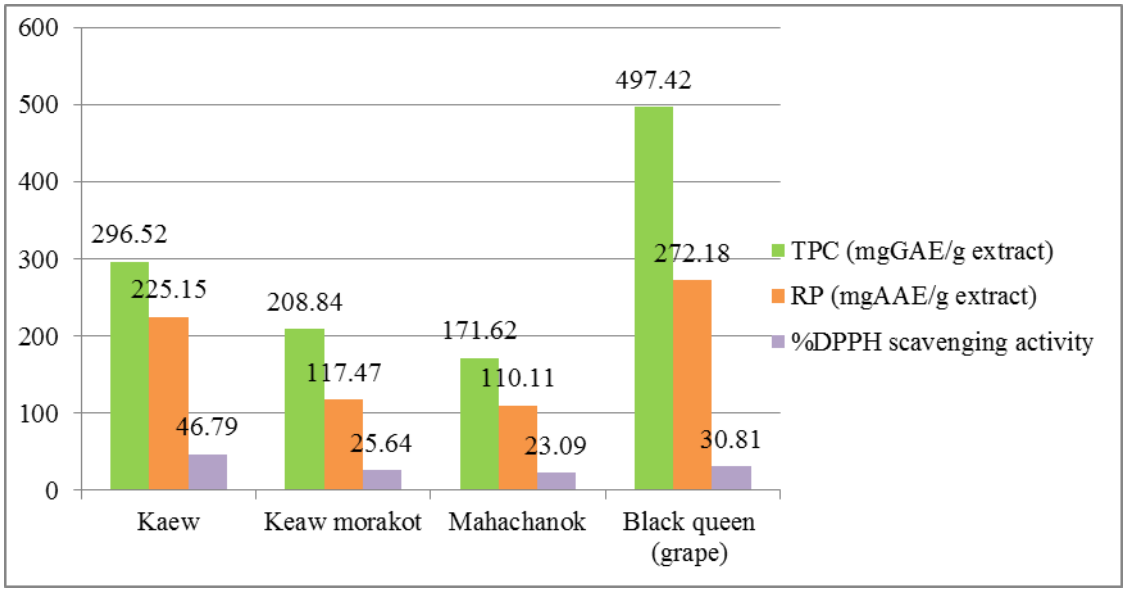


Figure 4.18 Quantity and quality of antioxidant compounds from mango seed kernel and grape seed extract