

APPENDICES

Appendix 1: Phytochemical compound detected in Ajwa dates hot extract using UHPLC-ESI-QTOF- MS/MS

Peak	RT	m/z	Major fragment (MS/MS)	Compound	Formula	Reference
1	0.32	175	90.96, 102.91, 118.92, 130.97, 146.94,	Penylvaleric acids	-	-
2	1.154	1064	365.16, 541.20, 718.08, 847.80, 1022.16, 1064.06	Unknown	-	-
3	1.378	879	175.00, 351.01, 527.02, 703.19, 791.66, 879.81	Unknown	-	-
4	1.60	195	74.88, 86.93, 128.96, 177.04, 195.09	Gluconic acid	-	-
5	1.715	291	183.01, 127.98, 171.04, 213.09, 237.00, 273.07, 291.11	Unknown	-	-
6	1.883	327	164.02, 144.06, 178.05, 238.10, 286.12, 310.09, 328.14	Trihydroxy-9,14-octadecadienoic acid	C ₁₈ H ₃₁ O ₅	(Frag et al., 2014)
7	2.164	373	179.05, 209.07, 287.15, 287.15, 313.08, 373.15	Unknown	-	-
8	2.556	367	148.56, 234.09, 262.10, 350.12, 368.12	Unknown	-	-
9	2.669	456	161.04, 178.08, 276.05, 366.12, 483.13, 456.17	Oleanolic acid	C ₃₀ H ₄₈ O ₃	NCBI
10	2.894	356	163.03, 195.07, 221.16, 270.17, 339.12, 357.13	Unknown	-	-
11	3.061	425	130.98, 425.19	Acyl sucrose	C ₁₇ H ₂₉ O ₁₂	(Frag et al., 2014)
12	3.173	293	131.04, 173.01, 293.14	Unknown	-	-

13	3.286	452	174.03, 293.10, 336.08, 434.19, 452.15	Unknown	-	-
14	3.567	269	124.95, 136.92, 183.00, 269.13, 251.13	Apigenin	C ₁₅ H ₉ O ₅	(Farag et al., 2014)
15	3.905	273	129.00, 201.12, 192.96, 229.20, 255.12, 273.09,	Unknown	-	-
16	4.129	150	108.96, 135.90, 150.03	Tartaric acid	C ₄ H ₆ O ₆	NCBI
17	4.353	644	165.00, 195.07, 225.17, 378.96, 418.21, 482.04, 608.24, 596.30, 626.31, 644.22	Unknown	-	-
18	4.465	329	171.12, 211.15, 229.19, 311.31, 329.27	3,30-di-O-methyl ellagic acid	-	-
19	4.577	714	678.65, 714.45	Unknown	-	-
20	4.689	828	790.78, 828.57	Unknown	-	-
21	4.912	542	241.03, 300.07, 542.06	Punicalagin isomer	-	-
22	5.079	309	171.16, 195.12, 209.22, 291.24, 270.00, 309.29	Unknown	-	-
23	5.413	540	241.07, 255.27, 299.11, 480.33, 541.03	Punicalagin isomer	-	-
24	5.747	504	224.04, 279.25, 504.29	Isoquercetrin acetate	C ₂₃ H ₂₁ O ₁ 3	(Farag et al., 2014)
25	5.914	556	279.31, 504.27, 556.32	Unknown	-	-
26	6.082	367	114.96, 187.08, 277.09, 277.09, 306.96, 367.17	Unknown	-	-
27	6.249	529	241.06, 349.16, 529.24	Hexosyl luteolin sulfate	-	(Hong et al., 2006)
28	6.861	541	241.03, 256.26, 299.15, 481.33, 541.10	Chrysoeriol hexadecyl sulfate	C ₂₂ H ₂₁ O ₁ 4S	(Farag et al., 2014)
29	7.196	529	151.06, 240.96, 287.14, 367.15, 529.17	Unknown	-	-
30	7.474	721	241.24, 269.30, 721.50	Unknown	-	-
31	7.752	303	96.85, 135.00, 134.52, 151.03,	Unknown	-	-

			165.00, 226.08, 241.02, 264.08, 287.07, 304.05			
32	8.030	297	183.08, 253.32, 297.28, 279.24	Oxooctadeca noic acid	-	-
33	8.307	722	241.23, 270.38, 722.53	Unknown	-	-
34	8.696	804	744.48, 768.64, 804.56	Unknown lignan	$C_{39}H_{49}O_1$ 8	(Farag et al., 2014)
35	9.195	255	255.24	Palmitic acid	$C_{16}H_{31}O_2$	(Farag et al., 2014)
36	9.694	283	283.30	Unknown		
37	13.196	833	617.65, 797.66, 833.61	Unknown	-	-
38	13.420	832	616.61, 634.68, 796.67, 832.62	Unknown	-	-
39	14.090	366	1144.96, 187.04, 205.10, 277.15, 307.08, 367.14	Unknown	-	-

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Appendix 2: Phytochemical compound detected in Ajwa dates cold aqueous extract using UHPLC-ESI-QTOF- MS/MS.

Peak	RT	m/z	Ms/ms	Compound	Formul a	Referenc e
1	1.155	908	174.96,365.04, 541.16, 732.21, 908.14	Unknown	-	-
2	1.490	352	78.87, 84.96, 112.92 130.92, 177.00, 192.96, 230.52, 291.96, 333.36, 96.96, 86.92, 78.87, 156.96, 260.96,274.01, 351.99	Unknown	-	-
3	1.603	377	161.07, 143.04, 233.13, 323.19, 179.10, 221.11, 341.19, 377.13	Caffeic acid derivative	-	-
4	1.771	128	82.00, 127.97	Unknown	-	-
5	2.107	535	135.96, 178.08, 208.10 269.10, 287.17, 313.20 355.21, 379.28, 226.11 415.20, 445.20 475.19, 517.20, 535.20	Hydroxypinore sinol hexoside	C ₁₂ H ₁₈ N ₄ O ₄ PS +	NCBI
6	2.332	401	86.92, 163.10, 179.10, 191.13 247.10, 265.13 295.14, 325.13, 355.21 383.11, 401.14	Caffeic acid derivative	-	-
7	2.613	493	120.96, 209.10, 194.06 243.08 331.15, 493.12	Dihydroxyl dimethyl 19-[(Dglucopyranos yl)oxy]-19- oxo-ent-labda- 8(17),13-dien- 16,15-olide derivative	-	-
8	2.837	293	131.00, 203.07, 293.16		-	-
9	3.062	421	135.03, 179.06, 221.08 251.06, 281.12, 341.14, 421.06	Caffeic acid derivative	-	-

10	3.230	421	135.03, 179.06, 221.08 251.06, 281.12, 341.14, 421.06	Caffeic acid derivative	-	-
11	3.399	179	134.99 179.04	Caffeic Acid	-	-
12	3.680	744	420.22, 582.22, 744.27	Unknown	-	-
13	3.848	390	147.04, 176.09, 191.09, 330.13, 390.20, 375.12	Unknown	-	-
14	4.016	541	96.84, 241.14, 284.16, 299.16 541.07	Punicalagin	-	-
15	4.353	601	565.44, 601.36	Unknown	-	-
16	4.521	715	678.56, 714.53	Unknown	-	-
17	4.744	345	171.12, 201.12, 327.26, 345.27	Thiamine monophosphate	-	-
18	5.412	541	241.01, 299.09, 481.34, 256.24, 284.07, 541.04	Chrysoeriol hexadecyl sulfate	C ₂₂ H ₂₁ O ₁₄ S	(Farag et al., 2014)
19	5.579	481	224.11, 255.25, 480.32,	Unknown	-	-
20	5.745	311	171.08, 185.12, 293.26, 311.24	2(3,4-Dihydroxyphe nyl)-7-hydroxy-5-benzenepropan oic acid	-	-
21	6.300	555	555.30	Unknown	-	-
22	6.522	325	183.00, 325.24	Decanoic acid derivative	-	-
23	6.745	708	241.25, 255.29, 707.48	Unknown	-	-
24	6.856	571	241.07, 255.23, 409.22, 571.29	Unknown	-	-
25	8.301	281	281.34	Stearic acid	C ₁₈ H ₃₃ O ₂	(Farag et al., 2014)
26	9.024	671	255.29, 391.30, 671.46	Unknown	-	-
27	10.51	707	241.26, 707.47	Unknown	-	-

28	10.85 2	717	255.25, 716.52	Unknown	-	-
29	12.13 0	807	768.63, 806.56	Unknown	-	-

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Appendix 3: Phytochemical compound detected in Ajwa dates methanol extract using UHPLC-ESI-QTOF- MS/MS

Peak	RT	m/z	Ms/ms	Compound	Formula	Reference
1	1.874	337	84.96 161.07, 275.13, 305.11, 337.13	Unknown	-	-
2	2.154	414	208.08, 252.24, 324.02, 370.18, 414.16	Unknown	-	-
3	2.434	355	209.09, 269.07, 191.04, 337.15, 355.15	Apigenin derivative	-	-
4	3.106	426	264.12, 366.18, 426.18	Unknown	-	-
5	3.275	540	378.19, 450.17, 480.21 286.16, 360.16, 522.19, 540.12	Unknown	-	-
6	3.668	582	420.18, 567.12, 582.19	Unknown	-	-
7	3.893	541	96.84, 241.14, 284.16, 299.16 541.07	Chrysoeriol hexadecyl sulfate	C ₂₂ H ₂₁ O ₁₄ S	(Farag et al., 2014)
8	4.118	329	171.00, 211.13, 229.17, 311.18, 329.22	3,30-di-O- methyl ellagic acid	-	-
9	4.230	305	203.02, 231.10, 287.22, 305.11	Unknown	-	-
10	4.622	829	790.49, 828.57	Unknown	-	-
11	5.071	566	224.04, 281.28, 506.34, 566.33	Sphingolipid conjugate III	C ₂₇ H ₅₃ N O ₉ P	(Farag et al., 2014)
12	5.463	999	383.04, 541.08, 559.08, 721.29, 739.29, 999.44	Unknown	-	-
13	5.574	297	183.02, 197.04, 297.21	Oxooctadeca noic acid	-	-
14	5.909	311	170.14, 197.14, 239.19, 183.13, 311.27	15,16- dihydroxy- 9Z,12Z- octadecadien oic acid	-	-

15	6.188	293	96.91,185.16, 249.32, 293.25	-	-
16	6.299	325	170.16, 183.20, 197.25, 239.33, 325.56	Decanoic acid derivative	-
17	6.467	480	78.93, 168.30, 242.39, 224.41, 255.50, 480.31	Myricetin-3- galactoside	C ₂₁ H ₂₀ O ₁₃ NCBI
18	6.914	507	224.10, 242.15, 281.31, 506.32	Unknown	-
19	7.082	567	224.13, 242.19, 281.33, 506.33, 566.30	Unknown	-
20	7.360	452	153.00, 171.00, 378.35, 452.31	Unknown	-
21	8.307	281	281.32	Unknown	-
22	8.919	591	279.25, 171.10, 211.15, 293.28, 329.28, 311.28, 591.42	Unknown	-
23	9.697	833	240.96, 255.26 279.25, 553.34, 833.52	Unknown	-
24	11.19 9	750	533.62, 551.67, 713.64, 749.51	Unknown	-
25	12.31 5	794	225.07, 537.42, 793.44	Unknown	-
26	13.99 1	708	153.03, 227.30, 241.29, 255.31, 391.41, 483.24, 707.49	Unknown	-

Appendix 4: Phytochemical compound detected in Mariami dates hot aqueous extract using UHPLC-ESI-QTOF- MS/MS

Peak	RT	m/z	Ms/ms	Compound	Formula	Reference
1	0.611	376	179.05, 341.14, 161.04, 221.09, 377.12	Caffeic acid derivative	-	-
2	0.948	379	161.04, 221.07, 179.07, 343.14, 379.10	caffeic acid derivative	-	-
3	1.733	377	161.04, 221.10, 341.16, 179.04, 377.11	Caffeic acid derivative	-	-
4	2.126	378	162.00, 179.04, 222.12, 342.12, 360.24, 378.12	Caffeic acid derivative	-	-
5	2.519	215	113.00, 179.08, 58.91, 124.96, 197.16, 215.08	Caffeic acid derivative	-	-
6	2.687	181	100.93, 163.05, 181.08	Unknown	-	-
7	2.911	372	178.08, 286.15, 312.14, 178.08 286.15, 312.14, 226.11, 372.14	Unknown	-	-
8	3.527	543	243.09, 284.12, 463.16, 299.13, 543.07	Ellagic acid hexoside derivative	-	-
9	3.696	233	145.09, 161.05, 177.0, 205.09, 233.07	Unknown	-	-
10	3.864	253	136.99, 205.11, 225.07, 122.96, 235.08, 253.09	Unknown	-	-
11	4.033	255	96.96, 193.08, 227.10, 137.04, 211.11, 255.09	p- hydroxybenzoic acid derivative	-	-
12	2.295	379	88.95, 221.04, 179.07, 343.22, 379.10,	Caffeic acid derivative	-	-
13	4.369	363	137.04, 177.05, 205.15, 231.01, 259.09, 273.02,	Unknown	-	-

			291.13, 319.08, 345.12, 363.13			
14	4.706	325	162.96 183.00 235.20 307.20, 325.20	Unknown	-	-
15	5.099	324	89.00, 208.15, 288.14, 306.12, 238.03, 324.12	Unknown	-	-
16	5.436	413	163.08, 341.16, 233.04, 269.16, 395.28, 413.04	Unknown	-	-
17	5.661	355	122.03, 337.13, 191.08, 179.06, 311.14, 209.09, 208.11, 269.14, 355.16	Apigenin derivative	-	-
18	5.773	361	88.94, 161.04, 317.16, 343.19, 323.16, 361.12	Unknown	-	-
19	5.998	359	88.92, 233.16, 268.98, 341.19, 323.13 161.04, 359.13	Rosmarinic acid	-	-
20	6.671	558	245.16, 378.15, 396.00, 522.12, 540.00, 558.20	Unknown	-	-
21	7.063	373- 2	123.96, 253.12, 355.21, 211.10, 373.17	Unknown	-	-
22	7.906	377	112.96, 179.06, 341.20, 251.0, 359.12, 377.12	Caffeic acid derivative	-	-
23	8.467	377	161.06, 179.05, 221.14, 341.14, 359.07, 377.10	Caffeic acid derivative	-	-
24	9.140	358	143.04, 305.14, 341.08, 161.04, 233.09, 323.15, 359.10	Rosmarinic acid derivative	-	-
25	9.702	323	112.96, 179.06, 305.24, 323.14	Unknown	-	-
26	10.543	377	161.04, 179.09, 341.19, 215.09,	Caffeic acid derivative	-	-

27	10.993	377	359.16, 377.14 161.06, 179.10, 341.21, 221.10, 359.19, 377.14	Caffeic acid derivative	-	-
28	11.217	377	84.96, 161.04, 143.04, 341.28, 221.16, 359.28, 377.04	Caffeic acid derivative	-	-
29	12.059	413- 2	323.13, 269.09, 395.18, 189.00, 413.15	Unknown	-	-
30	13.907	379	161.04, 179.04, 217.14, 343.03, 379.11	Caffeic acid derivative	-	-
31	14.693	377	84.96, 161.06, 341.18, 221.07, 377.14	Caffeic acid derivative	-	-

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Appendix 5: Phytochemical compound detected in Mariami dates cold aqueous extract using UHPLC-ESI-QTOF- MS/MS

Peak	RT	m/z	Ms/ms	Compound	Formula	Reference
1	1.399	181	100.98, 163.08, 112.94, 181.08	Unknown	-	-
2	2.578	377	179.04, 341.12, 161.05, 221.10, 359.14, 377.13	Caffeic acid derivative	-	-
3	3.926	330	139.37, 211.54, 329.84, 171.39, 183.50, 201.47, 311.75,	3,30-di-O- methyl ellagic acid	-	-
4	4.151	379	343.18, 179.04, 161.08, 221.10, 289.19, 379.11	Caffeic acid derivative	-	-
5	4.769	367	187.04, 169.06, 217.09, 307.16, 337.08, 277.11, 367.13	Unknown	-	-
6	9.202	379	179.04, 221.07, 161.04, 343.14, 379.11	Caffeic acid derivative	-	-
7	11.557	377	179.04, 161.04, 221.04, 341.16, 377.16	Caffeic acid derivative	-	-
8	11.894	372	178.07, 250.06, 226.11, 286.11, 312.15, 372.16	Unknown	-	-

Appendix 6: Phytochemical compound detected in Mariami dates methanol extract using UHPLC-ESI-QTOF- MS/MS

Peak	RT	m/z	Ms/ms	Compound	Formula	Reference
1	0.447	379	343.17, 161.04, 179.08, 294.96, 302.76, 379.12	Caffeic derivative	acid	-
2	1.009	144	144.04, 126.00	Unknown	-	-
3	1.290	191	191.05, 110.98, 86.98, 162.96	Quinic Acid	-	-
4	1.738	377	161.04, 221.08, 179.07, 341.14, 377.12	Caffeic derivative	acid	-
5	2.076	196	74.86, 128.99, 87.00, 195.06	Gluconic Acid	-	-
6	2.244	283	210.00, 283.31	Unknown	-	-
7	2.805	380	144.07, 195.12, 344.14, 128.88, 212.22, 380.19	Unknown	-	-
8	3.142	284	210.04, 128.04, 200.01, 284.29	Unknown	-	-
9	3.423	542	299.11, 541.03,, 241.04, 284.13	Punicalagin	-	-
10	4.041	378	179.04, 232.14, 360.21, 378.13	Unknown	-	-
11	4.210	379	379.11, 179.07, 343.20, 112.95, 221.07	Unknown	-	-
12	4.490	323	275.12, 233.10, 84.87, 161.04, 257.08, 287.14, 323.15	Unknown	-	-
13	4.884	279	279.27, 261.25	Linoleic acid	C ₁₈ H ₃₁ O ₂	(Farag et al., 2014)
14	4.996	331	171.12, 212.16, 231.15, 313.28, 331.27	Unknown	-	-
15	5.332	400	160.04, 192.09, 132.00, 252.14, 308.15, 382.16, 400.19	Unknown	-	-
16	5.557	180	135.00, 151.01, 120.96, 108.96,	Caffeic Acid	-	-

			179.03,				
17	5.725	401	160.05, 192.12, 132.00, 148.92, 239.06, 355.14, 383.10, 401.19	Unknown		-	-
18	5.838	386	208.10, 358.19, 178.08, 238.17, 252.2, 386.19	Sinapic acid hexoside	$C_{17}H_{21}O_{10}$	(Frag et al., 2014)	
19	6.063	355	193.08, 209.10, 269.12, 133.99, 177.96, 337.20, 355.18	Apigenin derivative		-	-
20	6.343	356	178.06, 238.10, 150.00, 338.21, 356.18	Unknown		-	-
21	6.511	401-2	160.08, 193.11, 132.00, 253.14, 369.09, 401.18	Unknown		-	-
22	6.680	338	337.17, 275.14, 99.00, 161.04, 305.16,	Unknown		-	-
23	7.017	387	161.04, 179.05, 209.15, 269.25, 355.09, 387.19	Caffeoyl glucose derivative		-	-
24	7.241	286-2	178.12, 208.11, 326.17, 148.08, 190.10, 354.20, 282.18, 386.17,	Luteolin	$C_{15}H_9O_6$	(Frag et al., 2014)	
25	7.691	387	178.09, 208.11, 238.11, 326.17, 148.08, 120.00 300.23, 368.16, 386.17	Unknown		-	-
26	8.140	361	197.06, 323.09, 161.05, 143.03, 215.08, 305.14, 359.13	Rosmarinic acid		-	-
27	8.308	215	136.96, 197.08, 70.75, 94.92, 215.07	Unknown		-	-
28	8.421	367	367.16, 187.03, 277.16, 157.03, 307.08	Unknown		-	-

29	8.533	379- 2	161.07, 179.06, 343.19, 221.08, 379.11,	Unknown	-	-
30	8.813	369	323.36, 207.01, 351.28, 369.31	Unknown	-	-
31	9.319	181	181.07, 100.97, 163.06	Unknown	-	-
32	9.656	304	226.11, 166.03, 196.04, 123.97, 213.18, 286.08, 304.14	Unknown	-	-
33	10.105	377	161.04, 221.08, 179.07, 341.14, 377.12	Caffeic acid derivative	-	-
34	10.891	305	137.03, 215.04, 257.10, 305.12	Unknown	-	-
35	11.397	290	170.05, 212.05, 154.06, 192.09, 242.16, 127.97, 200.07, 290.13	Catechin/Cianidan ol	$C_{15}H_{14}O_6$	NCBI
36	11.565	195	74.88, 129.00, 177.03, 98.96, 195.06	Unknown	-	-
37	11.902	377	161.04, 221.08, 179.07, 341.14, 377.12	Caffeic acid derivative	-	-
38	12.183	367- 2	187.05, 277.11, 307.15, 367.12	Unknown	-	-
39	13.808	181- 2	181.09, 100.95, 163.06	Unknown	-	-

Appendix 7: Phytochemical compound detected in Medjool dates hot aqueous extract using UHPLC-ESI-QTOF- MS/MS.

Peak	RT	m/z	Ms/ms	Compound	Formula	Reference
1	0.331	498	161.04, 336.14, 179.04, 342.13, 498.14	Caffeic acid derivative	-	-
2	0.667	379	161.04, 179.04, 305.04, 343.08, 379.08	Caffeic acid derivative	-	-
3	0.947	377	179.08, 161.08, 221.11, 341.21, 143.08, 377.13	Caffeic acid derivative	-	-
4	1.281	379	161.04, 179.04, 305.04, 343.08, 379.08,	Caffeic acid derivative	-	-
5	1.673	379	161.04, 179.04, 305.04, 343.08, 379.08	Caffeic acid derivative	-	-
6	1.897	377	161.04, 179.04, 221.05, 341.13, 359.153, 377.13	Caffeic acid derivative	-	-
7	2.121	133	132.88, 114.96, 70.95, 88.92	Malic acid	-	-
8	2.234	181	84.96, 100.95, 163.08, 181.07	Unknown	-	-
9	2.514	340	183.00, 296.16, 340.21	Sucrose	C ₁₂ H ₂₁ O ₁₁	(Frag et al., 2014)
10	2.682	372	226.08, 286.12, 178.06, 312.12, 162.00, 372.16	Unknown	-	-
11	2.907	379	161.04, 179.04, 305.04, 343.08, 379.08	Caffeic acid derivative	-	-
12	3.410	354	299.13, 242.88, 286.08, 543.10	Ellagic acid hexoside derivative	-	-
13	3.577	300	299.09, 284.08, 227.06, 256.09	Diomestin	-	-
14	3.633	543	300.10, 241.03, 285.11, 542.05	Punicalagin	-	-
15	3.800	361	343.18, 205.10, 235.08, 361.13	Unknown	-	-

16	3.913	305	142.90, 269.02, 287.10, 122.79, 305.05	Unknown	-	-
17	4.137	325	195.10 223.06 307.13, 325.16	Unknown	-	-
18	4.362	359	143.04, 359.13, 323.13, 161.04, 233.13, 341.09, 359.13	Rosmarinic acid	-	-
19	4.474	396	188.04 234.02 306.07, 378.1, 396.13	Unknown	-	-
20	4.699	468	208.08, 270.15, 342.18, 432.07, 468.15	Unknown	-	-
21	4.923	354	354.17, 208.09, 268.11, 162.04, 190.07, 276.11, 310.14	caffeoylquinic acid isomer	-	-
22	5.091	323	88.97, 161.04, 233.04, 305.14, 323.14	Unknown	-	-
23	5.203	287	151.01, 179.03 269.09, 287.11	Caffeic acid derivative	-	-
24	5.316	199	197.05, 179.04, 136.98, 151.02, 108.99	Syringic acid	-	-
25	5.541	355	209.07, 269.13, 191.14, 163.11, 337.06, 355.16	Apigenin derivative	-	-
26	5.709	354	354.12, 208.08, 268.08, 178.08, 150.00, 276.12, 310.20, 122.04	caffeoylquinic acid isomer	-	-
27	5.878	354	354.12, 208.08, 268.08, 178.08, 150.00, 276.12, 310.20, 122.04	Caffeoylquinic acid isomer	-	-
28	6.215	268	208.07, 268.09, 178.08, 190.03, 250.16, 122.02, 176.04	Apigenin isomer	-	-

29	6.495	377	161.04, 179.04, 221.05, 341.13, 359.1, 377.10	Caffeic acid derivative	-	-
30	7.225	181	84.96, 100.95, 163.08, 181.07	Unknown	-	-
31	8.067	379	161.04, 179.04, 305.04, 343.08, 379.08	Caffeic acid derivative	-	-
32	8.235	233	161.00, 204.96, 124.9, 233.09	Unknown	-	-
33	8.515	181	84.96, 100.95, 163.08, 181.07	Unknown	-	-
34	9.693	181	84.96, 100.95, 163.08, 181.07	Unknown	-	-
35	11.097	181	84.96, 100.95, 163.08, 181.07	Unknown	-	-
36	12.444	283	198.96, 265.22, 283.29	Unknown	-	-
37	13.958	187	125.04, 97.08, 159.03, 187.14	Unknown	-	-
38	14.575	181	84.96, 100.95, 163.08, 181.07	Unknown	-	-

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Appendix 8: Phytochemical compound detected in Medjool dates cold aqueous extract using UHPLC-ESI-QTOF- MS/MS.

Peak	RT	m/z	Ms/ms	Compound	Formula	Reference
1	0.221	377	341.31, 161.16 221.22, 143.13, 323.30, 377.16	Caffeic acid derivative	-	-
2	0.332	180	179.04, 161.04, 70.81, 130.96, 150.96	Caffeic acid	-	-
3	1.003	377	179.20 341.34, 161.20, 221.24, 143.16, 58.81, 215.27, 323.30, 377.14	Caffeic acid derivative	-	-
4	1.562	542	161.04 179.04 323.15 383.20, 505.23, 541.10	Punicalagin	-	-
5	2.348	540	179.08 383.20 503.17 161.04 341.18 521.16, 539.12	Caffeic acid derivative	-	-
6	2.909	377	341.31, 161.16, 221.22, 143.13, 323.30, 377.16	Caffeic acid derivative	-	-
7	3.246	544	301.08, 241.04 464.11, 284.11, 151.07, 544.05	Ellagic acid hexoside derivative	-	-
8	3.358	542	96.85 342.24 462.15 506.18, 241.23, 285.26	Punicalagin	-	-
9	3.695	425	241.43, 96.91, 225.41, 79.88, 139.09, 153.31, 410.68, 424.79	Caffeic acid derivative	-	-
10	3.975	379	379.14, 343.23, 181.15, 88.94, 221.18, 323.26	Caffeic acid derivative	-	-
11	4.593	396	96.88, 241.08, 306.03, 378.00, 396.11,	Unknown	-	-
12	4.817	425	241.06, 96.9, 225.03, 425.11	Acyl sucrose	C ₁₇ H ₂₉ O ₁₂	(Farang et al., 2014)

13	4.986	377	341.31, 161.16, 221.22, 143.13 323.30, 377.16	Caffeic acid derivative	-	-
14	5.602	377	341.31, 161.16, 221.22, 143.13, 323.30, 377.16	Caffeic acid derivative	-	-
15	6.107	325	163.03, 183.00, 118.99, 195.05, 325.21	Decanoic acid derivative	-	-
16	6.891	372	226.08, 178.09, 286.12, 166.02, 312.19, 372.15	Unknown	-	-
17	7.060	372	226.08, 178.09, 286.12, 166.02, 312.19, 372.15	Unknown	-	-
18	7.284	378	112.94 179.10 222.10 342.17, 378.12	Unknown	-	-
19	8.067	372	226.08, 178.09, 286.12, 166.02, 312.19, 372.15	Unknown	-	-
20	8.572	373	178.08 227.08 287.04 355.20, 373.17	Unknown	-	-
21	9.301	378	378.12, 179.08, 343.18, 100.97, 221.0	Caffeic acid derivative	-	-
22	9.861	377	341.31, 161.16, 221.22, 143.13, 323.30, 377.16	Caffeic acid derivative	-	-
23	10.982	377	341.31, 161.16, 221.22, 143.13, 323.30, 377.16	Caffeic acid derivative	-	-
24	12.044	377	341.31, 161.16, 221.22, 143.13, 323.30, 377.16	Caffeic acid derivative	-	-
25	12.882	377	341.31, 161.16, 221.22, 143.13, 323.30, 377.16	Caffeic acid derivative	-	-
26	14.442	377	341.31, 161.16, 221.22, 143.13, 323.30, 377.16	Caffeic acid derivative	-	-

Appendix 9: Phytochemical compound detected in Medjool methanol extract using UHPLC-ESI-QTOF- MS/MS

Peak	RT	m/z	Ms/ms	Compound	Formula	Reference
1	2.546	311	183.00, 267.24, 311.21	Unknown	-	-
2	3.160	540	96.85, 342.24, 462.15, 506.18, 241.23, 285.26, 540.93	Punicalagin	-	-
3	3.271	299	150.96, 227.08, 256.13, 299.10, 284.11	Diosmetin	-	-
4	3.607	425	96.90, 225.15, 241.13, 410.18, 425.13	Unknown	-	-
5	4.281	516	210.06, 354.13, 318.08, 136.92, 498.13, 516.13	Unknown	-	-
6	4.505	160	84.96, 112.95, 160.84	Unknown	-	-
7	4.617	270	124.92, 180.06, 252.04, 270.10	Apigenin isomer	-	-
8	5.067	354	150.10, 310.18, 148.08, 238.09, 336.20, 208.11, 268.13, 190.1, 354.18	Apigenin derivative	-	-
9	5.405	557	197.04, 233.07, 305.09, 377.15, 395.17, 539.22, 557.12	Unknown	-	-
10	5.517	379	112.95, 241.07, 221.10, 323.17, 181.11, 343.22, 379.13	Caffeic acid derivative	-	-
11	5.798	377	161.21, 179.23, 341.36, 221.26, 84.97, 130.95, 251.29, 323.41, 359.34, 377.17	Caffeic acid derivative	-	-
12	6.080	539	179.09, 341.19, 383.21, 503.18, 161.08, 521.16, 539.11	Caffeic acid derivative	-	-
13	6.866	379	112.95, 241.07, 221.10, 323.17,	Caffeic acid derivative	-	-

			181.11, 343.22, 379.13			
14	7.484	381	110.95, 181.09, 219.12, 363.24, 343.19, 381.13	Unknown	-	-
15	7.708	413	165.11, 233.07, 251.12, 323.16, 395.19, 413.13	Unknown	-	-
16	8.439	378	161.04, 179.04, 222.11, 342.17, 378.12	Caffeic acid derivative	-	-
17	8.943	377	161.21, 179.23, 341.36, 221.26, 84.97, 130.95, 251.29, 323.41, 359.34, 377.17	Caffeic acid derivative	-	-
18	10.905	379	112.95, 241.07, 19221.10, 323.17, 1811.11, 343.22, 379.13	Caffeic acid derivative	-	-
19	13.757	379	112.95, 241.07, 221.10, 323.17, 181.11, 343.22, 379.13	Caffeic acid derivative	-	-

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Effect of Date Fruits (*Phoenix dactylifera*) on Human Pathogenic Bacteria: A Systematic Review

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The beneficial effects of date fruits (*Phoenix dactylifera*) are attributed to their high nutritional content consisting of tannins, phenolic compounds, carbohydrate, oxidative enzymes, alkaloids, steroids, flavonoids, and vitamins. These compounds also contribute to antibacterial activity. This systematic review aims to assess the evidence of antibacterial effects of the date fruits on human pathogenic bacteria. We performed a systematic literature search in Scopus, EMBASE and EBSCOhost until August 2016. In addition, we used Google Scholar and screened the references for additional studies. All published studies that tested only date fruits were included. Studies that used other parts of the date tree were excluded. In addition, only studies that specifically tested the antibacterial effects on human pathogenic bacteria were assessed. We also limited our systematic review on studies written in English language. We identified 14 studies that met all of the inclusion criteria. Out of 14 studies, only 6 studies showed antibacterial activity. In contrast, 2 studies did not show antibacterial activity and 7 studies showed mixed results. From all selected studies, methanol extract of the date fruits showed the highest inhibition zone compared to that of aqueous and other solvents. Date fruits extracts are also more sensitive against gram-positive bacteria compared to gram-negative bacteria. This systematic review has shown that antibacterial activity of date fruits has significant effects on human pathogenic bacteria. Further studies are needed to gain a better understanding of the possible mechanisms underlying these effects.

Keywords: Antimicrobial Activity, Date Fruit, Human Pathogen, Prophetic Food, *Phoenix dactylifera*.

1. INTRODUCTION

The benefit of date fruits on health and their nutritional values have been recognised for centuries.¹ These fruits have high sugar content which are mainly fructose, glucose and sucrose. They are also high in fibre and contain small amounts of protein, macro- and micro-nutrients and polyphenols.²⁻⁴ Date fruit are also rich in vitamins A, C, B₁, B₂, nicotinic acid and folic acid.⁵

The antibacterial effect of date fruits may be due to their high level of phytochemicals such as flavonoids, phenolics, tannins, carbohydrates, oxidative enzymes, alkaloids, steroids, and vitamins.^{6,7} Flavonoids have been reported to possess many useful properties, including anti-inflammatory activity, enzyme inhibition, and antimicrobial activity.⁸

Due to the high prevalence of antibiotic, there is a shift of interest in using natural product with antimicrobial and cytotoxic activities.⁹ Some plants such as citrus and beet have been studied and found to have contained active compounds, which have medicinal properties against infectious diseases through antimicrobial activities.^{10,11} This has led to ethnomedicine or herbal medicine receiving much interest from both the public and pharmaceutical companies. Therefore, the objective of this systematic review is to carefully study the evidence of antibacterial activity

of date fruits on human pathogenic bacteria in order to determine its significance.

2. METHODS

2.1. Search Strategy

A systematic literature search was carried out from inception until August 2016 using the following databases: Scopus, EMBASE and EBSCOhost. Additional studies were identified through Google Scholar search and bibliographic search of studies was included.

Keywords included *dactylifera*, *palm* and *date** were crossed against antimicrobial effects; antimicrobial, anti-microbial, antibacterial, anti-bacterial, and microbicidal. All citations were downloaded to EndNote X7 reference manager and duplications were removed.

2.2. Inclusion and Exclusion Criteria

We included all published studies that used date fruits. Studies that used other parts of the date palm tree were excluded. Only studies written and published in English language were included without any limit on the year of publication. We were interested in studies that tested the antimicrobial effect only on human pathogenic bacteria. Studies that used other types of bacteria

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Effects of Goat Milk and Its Products on Human Pathogenic Bacteria: A Systematic Review

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Goat milk has been consumed widely due to its various benefits to health. It was part of the prophetic diet during the times of the Prophet Muhammad, his family and companions. It has been shown to exhibit antimicrobial activities to various pathogens which are attributed to the presence of bioactive peptides, lactoperoxidase and immunoglobulins. This systematic review aims to assess the evidence of antibacterial effects of goat milk and its products on human pathogenic bacteria. We performed a systematic literature search of Scopus, EMBASE, Medline and PubMed until August 2016. In addition, we used Google Scholar and screened the references for additional studies. We included experimental studies which tested the antibacterial activities of goat milk and its products. Only studies on human pathogenic bacteria were included. Data were collected on the substance tested, methods used as well as the antibacterial effects observed. Risks of biases associated with the studies were also assessed. We identified 10 studies that met the inclusion criteria. These included antibacterial activities of goat milk, whey, goat cheese, yogurt and colostrum. All of the studies showed significant inhibition against various gram-positive and gram-negative human pathogenic bacteria especially *E. coli*. The antibacterial effect was significantly higher when the protein was hydrolysed using human or animal proteolytic enzyme. The antibacterial effects were mainly attributed to the presence of various types of peptides such as lactoferrin. In addition, a study also exhibited antibacterial activity of the enzyme lactoperoxidase. This systematic review has shown significant antibacterial effects of goat milk and its products such as whey, goat cheese, yogurt and colostrum against human pathogenic bacteria. The activities differ according to the types of bacterial strain and peptides as well as hydrolysis of the milk protein.

Keywords: Antibacterial Activity, Goat Milk, Human Pathogenic Bacteria.

1. INTRODUCTION

Scientific and commercial interests in goat milk and its products, which are mainly attributed to their beneficial effects, have increased since the past 20 years.¹ In addition, the bioactive peptides found in goat milk have been identified to provide a control against microbial infections.² It has been reported that most of the antibacterial activities in milk and colostrum are linked to the presence of immunoglobulins.³ However, milk also contains the non-immune proteins such as lactoferrin, lactoperoxidase and lysozyme all of which display distinctive antibacterial activities.⁴ This may be due to the synergistic actions between naturally occurring proteins and peptides in milk generated from inactive protein precursors.⁵

Milk proteins have also shown evidence of having the capability to act as antimicrobial peptide precursors and thus led to speculation that milk proteins are also capable of enhancing natural defences against invading pathogens.⁶ However, Tomita et al. have claimed that enzymatic released peptides have stronger

antibacterial potency than their precursor.⁷ Many of the derived peptides have shown antibacterial activities against a wide spectrum of gram-positive and gram negative bacteria.^{6,8-10} Therefore, the aim of this systematic review is to carefully examine the evidence of antibacterial activity of goat milk and its products on human pathogenic bacteria.

2. METHODS

2.1. Data Sources and Searches

We conducted a systematic literature search between June and August 2016 using Scopus, EMBASE, Medline and PubMed databases. In order to consider the additional literatures, Google Scholar was used to screen relevant additional titles and full articles. Additional studies were also identified through bibliographic search of the eligible studies included.

2.2. Study Selection

We included all studies written and published in English language which had tested goat milk and any of its products. We included

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IN-VITRO ANTIBACTERIAL ACTIVITIES OF AJWA DATE FRUIT (*PHOENIX DACTYLIFERA* L.) EXTRACT AGAINST SELECTED GRAM-NEGATIVE BACTERIA CAUSING GASTROENTERITIS

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Keywords:

Phoenix dactylifera L.,
Ajwa date fruit, Gastroenteritis,
Antibacterial

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ABSTRACT: Gastroenteritis, especially those caused by bacterial pathogens, remains as one of the major health issues in developing countries. Despite the availability of treatment, people are turning their interest in consuming certain food for its therapeutic value given the adverse effects of medications. This includes the consumption of date fruits (*Phoenix dactylifera* L.). This study aims to determine the antibacterial effect of two methods of extraction, *i.e.*, hot aqueous extract and methanol extract of Ajwa date fruit against selected gram-negative bacteria causing gastroenteritis. The antimicrobial activities were determined quantitatively using well diffusion assay together with the minimum inhibitory concentrations (MIC) and minimum bactericidal concentrations (MBC). Results showed that both hot aqueous and methanol extracts have the potential to suppress the growth of all tested bacteria. The methanol extract had higher inhibitory zones compared to hot aqueous extract, and the zones of inhibition were noted to increase with increase in the extract concentration. *S. flexneri* was the most sensitive bacteria to both types of extract. The methanol extract was also more effective in suppressing the bacterial growth and has a higher potential in killing the bacteria compared to hot aqueous extract. These results suggest that Ajwa date extract has a bacteriostatic property at lower concentration and bactericidal property at higher concentration. In conclusion, Ajwa date fruit extract has the antibacterial potential against selected bacterial causing gastroenteritis. Further study on the phytochemical properties that contribute to this effect is currently in progress.

INTRODUCTION: Gastroenteritis is an infection of the intestine usually presented as diarrhea and may be accompanied by nausea, vomiting, abdominal pain, and fever. It can be caused by pathogenic bacteria, viruses, and parasites and remains a significant global health concern with an estimate of up to 2.5 million deaths per year ¹.

The incidence of bacterial gastroenteritis is commonly reported in developing countries where food and water sources are contaminated in addition to poor hygiene practices that lead to fecal-oral transmission ².

Among the common bacteria causing gastroenteritis reported in the community include *Vibrio cholerae*, *Clostridium difficile*, *Staphylococcus aureus*, *Salmonella typhi*, *Campylobacter jejuni*, *Shigella* and *Escherichia coli* ^{2, 3}. These bacteria often disrupt the normal intestinal functions and cause diarrhea by adhering to the mucosal epithelium, produce toxin and may even invade the epithelial cell to produce dysentery ¹.

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