Effect of anthocyanins on gut health markers, *Firmicutes-Bacteroidetes* ratio and short-chain fatty

acids: A systematic review via meta-analysis

Payal Kapoor

	Exp	erimental		(Control			Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% Cl	IV, Random, 95% Cl
Chen et al., 2022 (a)	8.2	1.55	8	5.6	2.2	8	2.8%	1.29 [0.18, 2.40]	
Chen et al., 2022 (b)	5.7	1.4	8	5.6	2.2	8	2.8%	0.05 [-0.93, 1.03]	+
Chen et al., 2022 (c)	9.5	1.65	8	5.6	2.2	8	2.7%	1.90 [0.66, 3.13]	
Chen et al., 2022 (d)	3.6	1.3	8	5.6	2.2	8	2.8%	-1.05 [-2.11, 0.02]	
Cremonini et al., 2019	48.27586	23.4451	6	40.51724	18.29862	6	2.7%	0.34 [-0.80, 1.48]	+-
Han et al., 2020	3.167095	1.15807	5	1.789203	0.413874	5	2.6%	1.43 [-0.05, 2.91]	<u> </u>
Heyman-Lindén et al., 2017	0.212903	0.07606	8	1.896774	0.802817	8	2.6%	-2.79 [-4.28, -1.31]	
Kapoor et al. 2022 (a)	0.368029	0.025413	3	1.07	0.359	3	2.0%	-2.21 [-4.87, 0.46]	
<apoor (b)<="" 2022="" al.="" et="" td=""><td>0.60119</td><td>0.067725</td><td>3</td><td>0.628582</td><td>0.18476</td><td>3</td><td>2.5%</td><td>-0.16 [-1.76, 1.45]</td><td>_</td></apoor>	0.60119	0.067725	3	0.628582	0.18476	3	2.5%	-0.16 [-1.76, 1.45]	_
Kapoor et al. 2022 (c)	0.5147	0.1235	3	0.628582	0.18476	3	2.5%	-0.58 [-2.28, 1.12]	-+
Kapoor et al. 2022 (d)	0.4685	0.116	3	1.07	0.359	3	2.2%	-1.80 [-4.17, 0.56]	<u> </u>
in et al., 2020	0.863787	0.21262	3	2.697674	0.225914	3	0.8%	-6.69[-13.34, -0.03]	
_iu et al. 2021 (a)	1	0.34	9	0.8	0,29	9	2.8%	0.60 (-0.35, 1.55)	+
iu et al. 2021 (b)	0.58	0,22	9	0.8	0,29	9	2.8%	-0.81 [-1.79, 0.16]	
iu et al. 2021 (c)	0.8	0.29	ğ	0.8	0.29	g	2.8%	0.00 (-0.92, 0.92)	+
iu et al. 2021 (d)	0.0	0.1	ğ	0.0	0.20	ğ	2.0%	-1 76 [-2 89 -0 63]	
iu et al. 2022 (a)	2.18	0.1	12	2.79	0.20	12	2.1%	-1 50 [-2 43 -0 58]	
iu et al. 2022 (u)	1.0	0.20	12	2.10	0.400	12	2.0%	-7.26[-3.32]-1.20]	
iu et al. 2022 (b)	1.0	0.21	12	2.13	0.435	12	2.0%	-2.20 [-3.32, -1.20]	
iu et al. 2022 (c)	0.603123	0.13	6	0.485673	0.435	6	2.0%	0.96 [-0.00, -2.07]	
iu et al., 2020 (a)	0.000120	0.11327	0 8	0.405073	0.004005	6	2.7%	0.57 [-0.60 1 73]	<u>_</u>
Liuetal., 2020 (b) Liuetal., 2021 (a)	0.0214	1 20021	0 8	7 792210	1 727967	0	2.7.0	1.221.0.05.2.511	
Lidetal, 2021 (e) Marquee et al. 2019	1 21 271	0.00016	5	1 166222	0.064000	5	2.7.0	0.60[.0.70_1.97]	
Malques et al., 2010 Nakana at al., 2020	1.21371	0.03010	5	1.103323	0.034030	5	2.7.0	2 27 1 4 06 0 401	
Nakano et al., 2020 Potricio Dioz Echovo ot ol., 2020 (o)	0.3	0.22301	10	1.13	0.447214	10	2.370	-2.27 [-4.00, -0.43] 11 67 [15 00 - 7 54]	
Patricia Diez-Echave et al., 2020 (a) Patricia Diez-Echave et al., 2020 (b)	4	0.0	10	10	1.3	10	1.470	-11.07 [-10.00, -7.04]	←
Patricia Diez-Ethave et al., 2020 (b)	1.7	0.3	10	10	1.3	10	1.170	-14.02 [-18.01, -8.42]	· · · · · · · · · · · · · · · · · · ·
Fatricia Diez-Echave et al., 2020 (c) Dong et al., 2010 (c)	0.077040	0.2	10	0 464404	0.000054	10	1.1%	-10.14[-20.40,-9.60]	· ·
Fengletal, 2019 (a) Departol, 2010 (b)	0.377049	0.20	10	0.404401	0.030231	10	2.0%	-0.47 [-1.30, 0.42]	
Fengletal, 2019 (b) Dedrímuez Deze et el 2020 (e)	0.174003	0.10240	10	0.404401	0.036231	10	2.0%	-3.39 [-3.11, -2.07]	
Rouriguez-Daza et al., 2020 (a) Dedrímuez Deze et al., 2020 (b)	5.2	1.1	12	3.9	0.7	12	2.8%	1.30 [0.40, 2.27]	
Rodriguez-Daza et al., 2020 (b)	5 ()		12	3.9	0.7	12	2.8%	1.23 [0.34, 2.12]	Ľ
Rodriguez-Daza et al., 2020 (c)	4.3	0.00004	12	3.9	0.7	12	2.8%	0.48 [-0.33, 1.29]	
Song et al., 2021 Finn stall, 2024 (s)	2.004843	0.36804	4	2.498/89	0.40678	4	2.0%	-1.11 [-2.69, 0.47]	
Tian et al., 2021 (a)	4.3	0.5	8	10.3	1.5	8	2.2%	-5.07 [-7.32, -2.82]	
manietal., 2021 (0) Tianistal., 2024 (s)	4	0.6	8	10.3	1.5	8	2.2%	-5.21 [-7.51, -2.91]	
Han et al., 2021 (C)	3.7	0.8	8	10.3	1.5	8	2.2%	-5.19 [-7.48, -2.90]	
wang et al., 2020 (a)	1.4	0.1	12	2.5	0.25	12	2.4%	-5.58 [-7.48, -3.68]	
wang et al., 2020 (b)	1.6	0.1	12	2.5	0.25	12	2.5%	-4.56 [-6.19, -2.94]	
vvang et al., 2020 (c)	0.7	0.075	12	2.5	0.25	12	1.9%	-9.42 [-12.44, -6.39]	
xu et al., 2019	0.88712	0.3112	7	2.7156	0.2412	7	1.9%	-6.15 [-9.03, -3.26]	
Zhong et al., 2020	0.918047	0.99407	9	1.314103	U.975495	9	2.8%	-0.38 [-1.32, 0.55]	
Fotal (95% CI)			332			332	100.0%	-1.80 [-2.48, -1.12]	•
Heterogeneity: Tau ² = 4.08; Chi ² = 40 Test for overall effect: Z = 5.17 (P < 0.	9.44, df = 40 00001)	(P < 0.0000	01); I²=	90%					-10 -5 0 5 10 Favours [experimental] Favours [control]

S Figure 1: Forest plot of studies investigating the effect of anthocyanin supplementation on the *Firmicutes* to *Bacteroidetes* ratio (Fir/Bac). Pooled effect estimates (diamonds) for Fir/Bac are shown. Values are standardized mean differences with 95% CIs determined with the use of random-effects models. Heterogeneity was quantified by I², inverse variance and standardised mean difference (SMD).



S Figure 2: Forest plot of the sub-group analysis to study effect of anthocyanin supplementation on the *Firmicutes* to *Bacteroidetes* ratio (Fir/Bac). Sub-grouping was on the basis of duration of the study, dose of the anthocyanin given and disease status of the subjects (animal models). Pooled effect estimates (diamonds) for Fir/Bac are shown. Values are standardized mean differences with 95% CIs determined with the use of random-effects models. Heterogeneity was quantified by I^2 , inverse variance and standardised mean difference (SMD).

Study or Subgroup	Exp Mean	erimental SD	Total	(Mean	Control SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI	Std. Mean Difference IV, Random, 95% CI
2.1.1 Study less than 10 week Rodríguez-Daza et al., 2020 (c)	4.3	0.9	12	3.9	0.7	12	1.3%	0.48 [-0.33, 1.29]	
Rodríguez-Daza et al., 2020 (b)	0.277040	1	12	3.9	0.7	12	1.3%	1.23 [0.34, 2.12]	
Rodríguez-Daza et al., 2020 (a)	0.377049	0.25	12	0.464481	0.038251	12	1.3%	-0.47 [-1.36, 0.42] 1.36 [0.46, 2.27]	
Chen et al., 2022 (b) Chen et al., 2022 (d)	5.7	1.4	8	5.6 5.6	2.2	8	1.2%	0.05 [-0.93, 1.03]	
Chen et al., 2022 (a)	8.2	1.55	8	5.6	2.2	8	1.2%	1.29 [0.18, 2.40]	<u> </u>
Liu et al., 2020 (b) Liu et al., 2020 (a)	0.8214	0.7684	6	0.485673	0.084885	6 6	1.2%	0.57 [-0.60, 1.73] 0.96 [-0.27, 2.18]	
Chen et al., 2022 (c)	9.5	1.65	8	5.6	2.2	8	1.2%	1.90 [0.66, 3.13]	
Subtotal (95% CI)	0.174863	0.10246	100	0.464481	0.038251	100	13.5%	-3.59 [-5.11, -2.07] 0.30 [-0.43, 1.03]	•
Heterogeneity: $Tau^2 = 1.23$; Chi ² = Test for overall effect: $Z = 0.80$ (P	= 54.41, df = = 0.42)	10 (P < 0.0	0001);	l² = 82%					
2.1.2 Study equal to or more tha	n 10 week								
Liu et al, 2021 (c)	0.8	0.29	9	0.8	0.29	9	1.3%	0.00 [-0.92, 0.92]	+
Liu et al, 2022 (a) Zhong et al., 2020	2.18 0.918047	0.25	12	2.79	0.495	12	1.3%	-1.50 [-2.43, -0.58] -0.38 [-1.32, 0.55]	
Liu et al. 2021 (a)	1	0.34	9	0.8	0.29	9	1.3%	0.60 [-0.35, 1.55]	
Liu et al, 2021 (b) Liu et al, 2022 (b)	1.9	0.22	12	2.79	0.29	12	1.3%	-2.26 [-3.32, -1.20]	
Liu et al, 2021 (d)	0.4	0.1	9	0.8	0.29	9	1.2%	-1.76 [-2.89, -0.63]	
Marques et al., 2018	1.21371	0.09016	5	1.165323	0.054098	5	1.2%	0.59 [-0.70, 1.87]	
Han et al., 2020 Heyman-Lindén et al., 2017	3.167095	1.15807	5	1.789203	0.413874	5	1.1%	1.43 [-0.05, 2.91] -2 79 L4 28 -1 31]	
Lin et al., 2020	5.831202	2.19949	8	12.12276	2.058824	8	1.1%	-2.79 [-4.28, -1.31]	
Song et al., 2021	2.004843	0.36804	4	2.498789	0.40678	4	1.1%	-1.11 [-2.69, 0.47] -4.46 [-6.06]-2.87]	
Kapoor et al, 2022 (b)	0.60119	0.067725	3	0.628582	0.18476	3	1.1%	-0.16 [-1.76, 1.45]	-+-
Wang et al., 2020 (b) Kappor et al. 2022 (c)	1.6 0.5147	0.1	12	2.5 0.628582	0.25	12	1.1%	-4.56 [-6.19, -2.94] -0 58 [-2 28 1 12]	
Nakano et al., 2020	0.3	0.22361	5	1.19	0.447214	5	1.1%	-2.27 [-4.06, -0.49]	
vvang et al., 2020 (a) Tian et al., 2021 (a)	1.4	0.1	12	2.5 10.3	0.25	12 8	1.0% 0.9%	-5.58 [-7.48, -3.68] -5.07 [-7.32, -2.82]	
Tian et al., 2021 (c)	3.7	0.8	8	10.3	1.5	8	0.9%	-5.19 [-7.48, -2.90]	
Han et al., 2021 (b) Kapoor et al. 2022 (d)	4 0.4685	0.6 0.116	8	10.3 1.07	1.5 0.359	8	0.9%	-5.21 [-7.51, -2.91] -1.80 [-4.17. 0.56]	
Kapoor et al, 2022 (a)	0.368029	0.025413	3	1.07	0.359	3	0.8%	-2.21 [-4.87, 0.46]	
Heterogeneity: Tau ² = 2.91; Chi ² :	= 163.13, df=	= 23 (P < 0.	182 00001)	; I² = 86%		182	20.6%	-1.81 [-2.56, -1.05]	▼
Test for overall effect: Z = 4.68 (P	< 0.00001)		,						
2.1.3 Lower Dose Rodríguez-Daza et al. 2020 (a)	6.2	4.4	10	20	0 7	10	1 206	1 36 0 46 2 27	
Liu et al, 2021 (c)	0.8	0.29	9	0.8	0.29	9	1.3%	0.00 [-0.92, 0.92]	+
Liu et al, 2022 (a) Liu et al. 2021 (a)	2.18	0.25	12	2.79	0.495	12	1.3%	-1.50 [-2.43, -0.58]	-
Chen et al., 2021 (a)	8.2	1.55	9	0.8 5.6	2.2	9	1.3%	1.29 [0.18, 2.40]	
Liu et al., 2020 (a)	0.593123	0.11927	6	0.485673	0.084885	6	1.2%	0.96 [-0.27, 2.18]	<u>+-</u>
Kapoor et al. 2022 (c)	0.5147	0.1235	3	0.628582	0.18476	3	1.1%	-0.58 [-2.28, 1.12]	
Wang et al., 2020 (a) Tian et al., 2021 (c)	1.4	0.1	12	2.5	0.25	12	1.0%	-5.58 [-7.48, -3.68]	
Kapoor et al, 2022 (a)	4.3	0.025413	3	1.07	0.359	3	0.8%	-2.21 [-4.87, 0.46]	
Subtotal (95% Cl) Heterogeneity: Tau ² = 3.14; Chi ² :	= 92.51, df =	10 (P < 0.0	90 (0001)	I≊= 89%		90	12.5%	-0.60 [-1.74, 0.54]	-
Test for overall effect: Z = 1.03 (P	= 0.30)								
2.1.4 Higher Dose						10	4	0.401.0.00.4.00	\perp
Liu et al, 2021 (b)	4.3	0.9	9	3.9 0.8	0.29	9	1.3%	-0.81 [-1.79, 0.16]	
Chen et al., 2022 (b) Chen et al., 2022 (d)	5.7	1.4	8	5.6	2.2	8	1.2%	0.05 [-0.93, 1.03]	
Liu et al, 2021 (d)	5.6 0.4	0.1	9	5.6 0.8	2.2 0.29	9	1.2%	-1.76 [-2.89, -0.63]	
Liu et al., 2020 (b) Liu et al. 2022 (c)	0.8214	0.7684	6 1 2	0.485673	0.084885 0.495	6 12	1.2%	0.57 [-0.60, 1.73]	†
Kapoor et al, 2022 (b)	1.1 0.60119	0.15	3	2.79	0.495	12	1.1%	-4.40 [-0.00, -2.87] -0.16 [-1.76, 1.45]	_ _
Tian et al., 2021 (c) Kanoor et al. 2022 (d)	3.7 0.4695	0.8 0.11e	8	10.3	1.5 0.369	8	0.9% n.9%	-5.19 [-7.48, -2.90] -1 80 [-4.17, 0.68]	
Wang et al., 2020 (c)	0.4005	0.075	12	2.5	0.25	12	0.8%	-9.42 [-12.44, -6.39]	_ _
Suptotal (95% Cl) Heterogeneity: Tau ² = 3.18; Chi ² :	= 87.46, df=	10 (P < 0.0	90 (0001)	I≊= 89%		90	12.2%	-1.79 [-2.95, -0.64]	-
Test for overall effect: Z = 3.04 (P	= 0.002)								
2.1.5 High Fat/Cholesterol Model Rodríguez-Daza et al. 2020 (c)	1 43	ΠQ	12	30	07	17	13%	0.48 [-0.33, 1.20]	<u> </u>
Rodríguez-Daza et al., 2020 (b)	5	1	12	3.9	0.7	12	1.3%	1.23 [0.34, 2.12]	
Rodríguez-Daza et al., 2020 (a) Liu et al. 2022 (a)	5.2 2.1 P	1.1 n 25	12	3.9 2.79	0.7 0.495	12 12	1.3%	1.36 [0.46, 2.27] -1.50 [-2.43 -0.59]	
Zhong et al., 2020	0.918047	0.99407	9	1.314103	0.975495	9	1.3%	-0.38 [-1.32, 0.55]	-+
Chen et al., 2022 (b) Liu et al. 2022 (b)	5.7 1.9	1.4 0.21	8 12	5.6 2.79	2.2 0.495	8 12	1.2%	0.05 [-0.93, 1.03] -2.26 [-3.32, -1.20]	
Chen et al., 2022 (d)	3.6	1.3	8	5.6	2.2	8	1.2%	-1.05 [-2.11, 0.02]	
Chen et al., 2022 (a) Chen et al., 2022 (c)	8.2 9.5	1.55 1.65	8 8	5.6 5.6	2.2 2.2	8 8	1.2% 1.2%	1.29 [0.18, 2.40] 1.90 [0.66, 3.13]	<u> </u>
Liu et al., 2021 (e)	9.827563	1.30921	6	7.782219	1.737867	6	1.2%	1.23 [-0.05, 2.51]	<u> </u>
Marques et al., 2018 Han et al., 2020	1.21371 3.167095	0.09016	5	1.165323	0.054098	5 5	1.2% 1.1%	0.59 [-0.70, 1.87] 1.43 [-0.05 2 91]	
Heyman-Lindén et al., 2017	0.212903	0.07606	8	1.896774	0.802817	8	1.1%	-2.79 [-4.28, -1.31]	
∟inietal., 2020 Songietal., 2021	5.831202	2.19949	8 4	12.12276	2.058824 0.40678	8 4	1.1% 1.1%	-2.79 [-4.28, -1.31] -1.11 [-2.69, 0.471	
Liu et al, 2022 (c)	1.1	0.15	12	2.79	0.495	12	1.1%	-4.46 [-6.06, -2.87]	
11an et al., 2021 (a) Tian et al., 2021 (c)	4.3 3.7	0.5 0.8	8	10.3 10.3	1.5 1.5	8 8	0.9% 0.9%	-5.07 [-7.32, -2.82] -5.19 [-7.48, -2.90]	
Tian et al., 2021 (b)	4	0.6	8	10.3	1.5	172	0.9%	-5.21 [-7.51, -2.91]	_
Heterogeneity: Tau ² = 3.15; Chi ² :	= 183.59, df=	= 19 (P < 0.	00001)	; I² = 90%		173	23.2%	-0.94 [-1.78, -0.11]	•
iest for overall effect: Z = 2.21 (P	= 0.03)								
2.1.6 Other Animal Model Peng et al., 2019 (a)	0.377049	0.25	10	0.464481	0.038251	10	1.3%	-0.47 [-1 36 0 42]	_
Liu et al., 2020 (b)	0.8214	0.7684	6	0.485673	0.084885	6	1.2%	0.57 [-0.60, 1.73]	+-
Liu et al., 2020 (a) Penget al., 2019 (b)	0.593123	0.11927 0.10246	6 10	0.485673	0.084885	6 10	1.2% 1.1%	0.96 [-0.27, 2.18] -3.59 [-5.11 -2 07]	†=
Kapoor et al, 2022 (b)	0.60119	0.067725	3	0.628582	0.18476	3	1.1%	-0.16 [-1.76, 1.45]	-+-
Wangetal., 2020 (b) Kapooretal 2022 (n)	1.6 0.5147	0.1 0 1 2 3 5	12	2.5 0.628582	0.25	12	1.1% 1.1%	-4.56 [-6.19, -2.94] -0.58 [-2.28 -1.12]	
Nakano et al., 2020	0.3	0.22361	5	1.19	0.447214	5	1.1%	-2.27 [-4.06, -0.49]	
vvangetal., 2020 (a) Kapooretal, 2022 (d)	1.4 0.4685	0.1	12	2.5 1.07	0.25 0.359	12 3	1.0% 0.9%	-5.58 [-7.48, -3.68] -1.80 [-4.17, 0.56]	
Kapoor et al, 2022 (a)	0.368029	0.025413	3	1.07	0.359	3	0.8%	-2.21 [-4.87, 0.46]	
Heterogeneity: Tau ² = 3.74; Chi ² :	= 73.99, df=	10 (P < 0.0	0001);	l² = 86%		13	11.9%	-1.12 [-2.97, -0.46]	▼
Test for overall effect: Z = 2.69 (P	= 0.007)		_			_			
Total (95% CI) Heterogeneity: Tau ² = 2.95: Chi ² :	= 739.93. df:	= 87 (P < N	<mark>708</mark> 00001	; I² = 88%		708	100.0%	-1.15 [-1.55, -0.76]	<u></u>
Test for overall effect: Z = 5.77 (P	< 0.00001)	H-E/P-0	0.041	2-75.0%					-10 -5 0 5 10 Favours [experimental] Favours [control]
restion subdroup differences: Cl	m== 20.02, d	u = p (P = 0	.001), P	- /5.0%					

S Figure 3: Forest plot of the sub-group analysis after elimination of high-influencer studies, for understanding the effect of anthocyanin supplementation on the *Firmicutes* to *Bacteroidetes* ratio (Fir/Bac). Sub-grouping was on the basis of duration of the study, dose of the anthocyanin given and disease status of the subjects (animal models). Pooled effect estimates (diamonds) for Fir/Bac are shown. Values are standardized mean differences with 95% CIs determined with the use of random-effects models. Heterogeneity was quantified by I², inverse variance and standardised mean difference (SMD).

5		Bibl	Question:	Should Anthor vention] for [health	bcyanin Ric h problem]. Coch	h vs Normal Die Irane Database of Syst	t be us tematic Re	ed for Fir/Ba views [Year], Iss	ac? ue [Issue].		
			Quality asse	Summary of Findings							
Participants (studies) Follow up	Risk of	Inconsistency	Indirectness	Imprecision	Publication	Overall quality of	Study event rates (%)		Relative	Anticipated absolute effects	
	bias				bias	evidence	With With Normal Anthocyanin Diet Rich		effect (95% Cl)	Risk with Risk difference with Normal Diet Anthocyanin Rich (95% Cl)	
536 (34 studies)	etter indicated no serious risk of bias	l by higher values serious ¹	no serious indirectness	no serious imprecision	undetected	⊕⊕⊕⊕ HIGH ¹ due to inconsistency, large effect	268	268	-		The mean fir/bac in th intervention groups was 0.89 standard deviations lower (1.47 to 0.31 lower)

¹ High heterogeneity

S Figure 4: Fir/Bac data quality assessment using GRADE tool.

Study on Sylvense	Exp	erimental	Tetal		Control	Tetal	Mainha	Std. Mean Difference	Std. Mean Difference
111 Acetic Acid	Mean	SD	Total	Mean	SD	Total	vveight	IV, Random, 95% CI	IV, Random, 95% CI
Livetal 2022 (c)	11 8792	0 1 2 1 4 9 2	12	4.05	0 809951	12	0.7%	13 05 [8 94 17 17]	
Liu et al., 2022 (b)	10.93434	0.121492	12	4.05	0.809951	12	0.7%	11.48 [7.84, 15.12]	
Kapooretal 2022 (a)	0.279591	0.076	з	0.05988	0.047	з	0.8%	2.78 [-0.34, 5.91]	+
Hu et al., 2019 (a)	10.58544	0.237	10	6.97785	0.522	10	0.8%	8.52 [5.45, 11.60]	
Hu et al., 2019 (c)	10.1	0.215	10	6.97785	0.522	10	0.9%	7.49 [4.76, 10.23]	
Han et al., 2021 (b)	20.5	3.012	10	6.07705	0.321	10	1.0%	5.98 [3.73, 8.22]	
Tian et al. 2013 (b)	5.75245 15.7	2 31	10	7 1 3 5	0.322	10	1.0%	4 97 [3 04 6 90]	
Tian et al., 2021 (c)	13	1.67	10	7.135	0.321	10	1.1%	4.67 [2.83, 6.51]	
Kapoor et al. 2002 (d)	0.123307	0.079	З	0.05988	0.047	з	1.1%	0.78 [-0.99, 2.55]	
Kapoor et al. 2022 (c)	0.272885	0.239	3	0.12096	0.085	3	1.1%	0.68 [-1.05, 2.41]	
Wu et al., 2018	24.59333	2.021	12	15.8341	1.348	12	1.1%	4.92 [3.20, 6.64]	
Kapooretal, 2022 (b)	0.163493	0.134	3	0.12095	0.085	3	1.1%	0.30 [-1.32, 1.93]	
Suetal, 2019 Liuetal, 2022 (a)	21.00003	1.075	12	17.0973	1.861	12	1.1%	2.38 [0.76, 4.00]	
Kaur et al., 2022 (a)	38.1	6	4	29.7	8.4	4	1.2%	1.00 [-0.55, 2.55]	+
Kaur et al., 2022 (b)	35.8	7.4	4	29.7	8.4	4	1.2%	0.67 [-0.79, 2.13]	
Silva-maia et al.,2018	121.6931	3.704	7	111.111	4.762	7	1.2%	2.32 [0.86, 3.78]	——
Wang et al.,2020 (a)	10.15786	0.999	12	6.99394	0.5	12	1.2%	3.87 [2.43, 5.31]	
Liu et al., 2020 (b)	15.2518	1.583	6	17.554	2.014	6	1.2%	-1.17 [-2.44, 0.10]	
Wang et al.,2020(b) Livet al. 2020 (a)	8.99	0.834	12	17 554	0.5 2.014	12	1.2%	2.80 [1.62, 3.98]	
Lee et al. 2018	0.042315	0.007	7	0.03724	0.004	7	1.2%	0.83 [-0.28, 1.94]	
da Silva-Maia et al., 2019 (a)	131	4.054	7	134	4.28	7	1.2%	-0.67 [-1.76, 0.41]	
Peng et al., 2020	20.69444	1.806	10	16.3889	2.778	10	1.2%	1.76 [0.69, 2.83]	
da Silva-Maia et al., 2019 (b)	134	4.154	7	134	4.28	7	1.2%	0.00 [-1.05, 1.05]	+
Peng et al., 2019 (a)	61.79641	6.707	10	50.3	7.186	10	1.2%	1.58 [0.55, 2.62]	
Wang et al., 2019 (b)	57.96407	2.874	10	6.0020A	7.186	10	1.2%	1.34 [0.35, 2.33]	
Morissette et al. 2020	2 868214	1 419	14	3 46082	1.33	14	1.3%	-0.42 [-1.17 0.33]	
Subtotal (95% CI)			254			254	33.3%	2.69 [1.88, 3.50]	◆
Heterogeneity: Tau ² = 4.29; Ch	ni² = 276.89,	df= 29 (P <	0.0000	1); I² = 90%	,				
Test for overall effect: Z = 6.52	(P < 0.0000	1)							
1 1 2 Putanoic Acid									
Wu et al. 2019	64 75004	3.346	40	10 2075	2005	4.2	0.00	14 15 10 70 10 601	
Huetal., 2018 Huetal., 2019 (c)	04.75091	3.215	10	2.11679	∠.985 ∩ ∩ 30	12	0.0% N 2%	-8,931-1214 -5721	
Tian et al., 2021 (c)	6.4	0.21	10	2.1.020	0.622	10	0.8%	8.87 [5.68, 12.06]	
Tian et al., 2021 (b)	9	0.92	10	2.1	0.622	10	0.9%	8.42 [5.38, 11.46]	
Hu et al., 2019 (a)	2.503876	0.054	10	2.11628	0.039	10	0.9%	7.88 [5.02, 10.74]	
Kapoor et al. 2022 (c)	0.586665	0.184	3	0.18935	0.032	3	0.9%	2.41 [-0.41, 5.23]	
Kapoor et al. 2022 (a)	0.571131	0.119	3	0.35506	0.105	3	1.0%	1.54 [-0.64, 3.73]	
Han et al., 2021 (a) Kapoor et al. 2002 (d)	0 201600	0.821	10	2.1	0.622	10	1.1%	5.13 [3.15, 7.11]	
Kapoor et al. 2002 (u) Kapoor et al. 2022 (h)	0.261609	0.057	3	0.35506	0.105	3	1.150	-0.70 [-2.43, 1.04] 0.25 [-1.37, 1.87]	
da Silva-Maia et al., 2019 (b)	63	1.823	7	77	6.414	7	1.1%	-2.78 [-4.38, -1.18]	
Kaur et al., 2022 (b)	1.21	0.51	4	0.71	0.32	4	1.2%	1.02 [-0.53, 2.58]	+
da Silva-Maia et al., 2019 (a)	65	2.534	7	77	6.414	7	1.2%	-2.30 [-3.76, -0.85]	
Hu et al., 2019 (b)	2.2215	0.021569	10	2.11628	0.039	10	1.2%	3.20 [1.79, 4.61]	
Kaur et al., 2022 (a)	0.69	0.16	4	0.71	0.32	4	1.2%	-0.07 [-1.46, 1.32]	
Wang et al.,2020(b)	9.6583	0.83261	12	5.828286	1.1656	12	1.2%	3.65 [2.27, 5.04]	
Liuetal 2022 (b)	12 82423	2 5648	12	6 15562	0.944943	12	1.2%	3 33 [2 03 4 64]	
Liu et al., 2020 (a)	4.163424	2.412	6	2.56809	0.584	6	1.2%	0.84 [-0.36, 2.04]	+
Silva-maia et al. 2018	30.30303	3.207	7	37.5758	6.414	7	1.2%	-1.34 [-2.54, -0.14]	
Liu et al., 2022 (a)	8.63947	0.80995	12	6.15562	0.944943	12	1.2%	2.73 [1.56, 3.89]	
Su et al., 2019	14.31818	6.309	6	11.7424	6.309	6	1.2%	0.38 [-0.77, 1.52]	+-
Liu et al., 2020 (b)	2.918288	1.323	6	2.56809	0.584	6	1.2%	0.32 [-0.83, 1.46]	T
Pengletal, 2020	20.40400	3.840	10	6 1 5 5 6 2	4.190	10	1.2%	1.02 [0.38, 2.00]	
Lee et al. 2018	0.011497	0.002	8	0.01217	0.004	8	1.2%	-0.20 [-1.18, 0.78]	
Peng et al., 2019 (b)	14.37126	2.395	10	11.018	3.353	10	1.3%	1.10 [0.15, 2.06]	
Peng et al., 2019 (a)	14.8503	4.79	10	11.018	3.353	10	1.3%	0.89 [-0.04, 1.82]	
Wang et al.,2020(c)	6.660898	1.16565	12	5.828286	1.1656	12	1.3%	0.69 [-0.14, 1.52]	
Morissette et al., 2020	1.884899	0.177	14	1.83817	0.266	14	1.3%	0.20 [-0.54, 0.94]	
Hotorogopoity: Touž = 4.07: Ch	iii - 204 20	df = 20 /P ~	200	11118 - 0.00		255	33.5%	1.60 [0.82, 2.39]	
Test for overall effect: 7 = 3.99	$P \leq 0.0001$	ui = 29 (F <)	0.0000	(1), I= 90%	,				
	(, , , , , , , , , , , , , , , , , , ,	/							
1.1.3 Propanoic Acid									
Liu et al., 2022 (c)	11.74429	1.079934	12	2.15987	0.27	12	0.7%	11.76 [8.03, 15.48]	
Tian et al., 2021 (c)	8.5	0.921	10	1.8	0.246	10	0.8%	9.52 [6.11, 12.93]	· · · · · · · · · · · · · · · · · · ·
manietal., 2021 (b) Liu etal., 2022 (b)	7 660544	1.56	10	2 16007	0.246	10	0.8%	8.75 (5.60, 11.90) 8 64 6 96 44 421	
Kapoor et al. 2022 (0)	0,303184	0.009901	3	0.03512	0.27	3	0.9%	2,26 [-0.45 4 97]	<u> </u>
Kapoor et al. 2002 (d)	0.029368	0.01	3	0.00979	0.007	3	1.0%	1.81 [-0.56, 4.19]	+
Wang et al.,2020(b)	5.9396	0.5399	12	2.15983	0.54	12	1.0%	6.76 [4.52, 9.00]	
Liu et al., 2022 (a)	5.6696	0.674959	12	2.15987	0.27	12	1.0%	6.59 [4.40, 8.78]	
da Silva-Maia et al., 2019 (a)	22.31313	0.256	7	26	1.138	7	1.0%	-4.18 [-6.29, -2.08]	
Napouretal 2022 (a)	0.17168	0.135	10	0.00979	0.007	10	1.1%	1.35 [-0.71, 3.42] 5 65 (3 64, 7 66)	T
Tian et al., 2020 (a)	1.424400	1 741	10	∠.iu903 1.8	0.94	10	1.170	3.33 [3.34, 7.30] 4.98 [3.04, 6.91]	
Kapoor et al. 2022 (b)	0.094367	0.071	3	0.03512	0.002	3	1.1%	0.94 [-0.90, 2.79]	
Hu et al., 2019 (a)	6.098765	0.395	10	4.54321	0.321	10	1.1%	4.14 [2.46, 5.82]	
Hu et al., 2019 (b)	6.1	0.4253	10	4.54321	0.321	10	1.1%	3.96 [2.33, 5.58]	
Hu et al., 2019 (c)	6.2	0.5214	10	4.54321	0.321	10	1.2%	3.67 [2.12, 5.21]	
Kauretal, 2022 (a) Kauretal, 2022 (b)	1.7	0.38	4	2.2	0.88	4	1.2%	-0.64 [-2.10, 0.81]	
Liu et al., 2020 (a)	3.923954	0.00 0.889	4 6	4.92776	0.66	4 6	1.2%	-1.48 [-2.83 -0.14]	
Su et al., 2019	18.10606	2.598	6	13.1061	3.711	6	1.2%	1.44 [0.11, 2.77]	<u> </u>
Liu et al., 2020 (b)	4.228137	0.943	6	4.92776	0.578	6	1.2%	-0.83 [-2.03, 0.38]	+
Wang et al. 2020(c)	3.914	0.6749	12	2.15983	0.54	12	1.2%	2.77 [1.60, 3.94]	
da Silva-Maia et al., 2019 (b)	25.123	0.623	7	26	1.138	7	1.2%	-0.89 [-2.01, 0.22]	
Silva-maia et al.,2018	8.695652	3.704	7	10.4348	4.762	7	1.2%	-0.38 [-1.44, 0.68]	- <u></u>
Pendietal 2019 (a)	0.201015	0.037	8 10	0.23998	0.051	8 10	1.2%	0.00 [-0.10, 1.92] 1.21 [0.24.2.19]	
Peng et al., 2019 (b)	11.97605	1.437	10	10.5389	3.832	10	1.3%	0.48 [-0.42, 1.37]	+-
Wu et al., 2018	15.02047	1.092	12	12.5626	2.458	12	1.3%	1.25 [0.36, 2.14]	
Peng et al., 2020	3.055556	0.833	10	3.19444	0.694	10	1.3%	-0.17 [-1.05, 0.71]	+
Morissette et al., 2020	0.592058	0.177	14	0.73889	0.266	14	1.3%	-0.63 [-1.39, 0.13]	
Subtoregonolity Touring C.O.C. C.		df = 20.70	255	11.12 - 000		255	33.2%	2.33 [1.45, 3.22]	-
Test for overall effect: 7 – 5.45	<pre>n*= 341.42, (P < 0.0000</pre>	ui= ∠9 (P ≺ 1)	0.0000	n), if = 92%	,				
. Social overall ellect Z = 3.15	. 0.0000	./							
Total (95% CI)			764			764	100.0%	2.20 [1.73, 2.67]	◆
Heterogeneity: Tau ² = 4.41; Ch	ni² = 922.22,	df = 89 (P <	0.0000	1); I² = 90%	,				-10 -5 0 5 10
Test for subgroup differences	(r < 0.0000 ∙ Chi² = 3.71	1) df=2/P-	0.16) 🖻	= 46 1%					Favours [experimental] Favours [control]

S Figure 5: Forest plot of studies investigating the sub-grouped based effect of anthocyanin supplementation on the SCFA profile. Sub-grouping was on the basis of proportion of acetic acid, butanoic acid and propionic acid. Pooled effect estimates are shown by diamonds. Values are standardized mean differences with 95% CIs determined with the use of random-effects models. Heterogeneity was quantified by I², inverse variance and standardised mean difference (SMD).

Study or Subgroup	Exper	imental SD Tota	l Mean	Control	Total	Weight	Std. Mean Difference	Std. Mean Difference
1.1.1 Study less than 4 weeks	i	30 1014	mean	30	Total	Weight	10, 10, 10, 10, 10, 10, 10, 10, 10, 10,	
Hulet al., 2019 (a)	10.58544304	0.237 10	0 6.97785	0.522	10	1.0%	8.52 [5.45, 11.60]	
Hu et al., 2019 (c)	9.75245	0.412 10	0.97785	0.522	10	1.1%	7.49 [4.76, 10.23]	
Liu et al., 2020 (a)	17.41007194	6.043 6	17.554	2.014	6	1.5%	-0.03 [-1.16, 1.10]	+
Liuetal., 2020 (b) Pengetal., 2019 (a)	15.25179856	1.583 8 6.707 10) 17.554) 50.3	2.014	б 10	1.4%	-1.17 [-2.44, 0.10] 1.58 [0.55, 2.62]	
Peng et al., 2019 (b)	57.96407186	2.874 10	50.3	7.186	10	1.5%	1.34 [0.35, 2.33]	
Subtotal (95% CI) Heterogeneity: Tau ² = 6.09: Ch	i≊ = 76 87 df = 6	נס אויר (P < 0 00001).	: = 92%		62	9.2%	2.97 [1.01, 4.93]	-
Test for overall effect: Z = 2.98	(P = 0.003)	(1 ~ 0.00001),1	- 32 10					
1 1 2 Study equal to or more t	han 4 weeks							
da Silva-Maia et al., 2019 (a)	131	4.054 7	134	4.28	7	1.5%	-0.67 [-1.76, 0.41]	
da Silva-Maia et al., 2019 (b)	134	4.154 7	134	4.28	7	1.5%	0.00 [-1.05, 1.05]	<u>+</u>
Kapoor et al.,2022 (a) Kapoor et al.,2022 (b)	0.279591	0.134 3	0.05988	0.047	3	1.4%	2.78 [-0.34, 5.91] 0.30 [-1.32, 1.93]	
Kapoor et al., 2022 (c)	0.272885	0.239 3	0.12096	0.085	3	1.3%	0.68 [-1.05, 2.41]	+
Kapooretal, 2022 (d) Kauretal, 2022 (a)	0.123307	0.079 3	0.05988	0.047	3	1.3%	0.78 [-0.99, 2.55]	
Kaur et al., 2022 (b)	35.8	7.4 4	29.7	8.4	4	1.4%	0.67 [-0.79, 2.13]	+
Lee et al., 2018 Livet al., 2022 (a)	0.042315	0.007 8	0.03724	0.004	12	1.5%	0.84 [-0.19, 1.88]	<u> </u>
Liu et al., 2022 (a) Liu et al., 2022 (b)	10.93434	0.121492 12	2 4.05	0.809951	12	0.9%	11.48 [7.84, 15.12]	
Liu et al., 2022 (c)	11.8792	0.121492 12	4.05	0.809951	12	0.8%	13.05 [8.94, 17.17]	
Morissette et al., 2020 Penglet al., 2020	2.868214 20.694	1.419 14	3.46082 1.16.3889	1.33 2.778	14	1.5%	-0.42 [-1.17, 0.33] 1.76 [0.69, 2.83]	Τ
Silva-maia et al., 2018	121.6931	3.704 7	' 111.111	4.762	7	1.4%	2.32 [0.86, 3.78]	
Suletial., 2019 Tian et al., 2021 (a)	21.65653	1.675 6	i 17.0973	1.861	6 10	1.4%	2.38 [0.76, 4.00] 4 97 [3 04 6 90]	
Tian et al., 2021 (b)	20.5	3.012 10	7.135	0.321	10	1.2%	5.98 [3.73, 8.22]	
Tian et al., 2021 (c)	13	1.67 10	7.135	0.321	10	1.3%	4.67 [2.83, 6.51]	
Wang et al.,2020(a) Wang et al.,2020(b)	8.99	0.834 12	2 6.99394	0.5	12	1.4%	2.80 [1.62, 3.98]	
Wang et al.,2020(c)	7.993	0.66 12	6.99394	0.5	12	1.5%	1.65 [0.70, 2.60]	
Subtotal (95% CI)	24.59333	2.021 12 193	15.8341	1.348	12 193	1.3% 30.7%	4.92 [3.20, 6.64] 2.63 [1.73, 3.54]	•
Heterogeneity: Tau ² = 4.08; Ch	i² = 199.69, df =	22 (P < 0.00001)	; I² = 89%					
rest for overall effect: Z = 5.71	(r < 0.00001)							
1.1.3 Lower Dose								
Huletial., 2019 (a) Kanooretial. 2022. (a)	10.1 n 279591	0.215 10) 6.97785) 0.05988	0.522	10	1.1%	7.49 [4.76, 10.23] 2.78 L0 34 -5 911	
Kapoor et al., 2022 (c)	0.123307	0.079 3	0.05988	0.047	3	1.3%	0.78 [-0.99, 2.55]	
Kaur et al., 2022 (a)	35.8	7.4 4	29.7	8.4	4	1.4%	0.67 [-0.79, 2.13]	
Liu et al., 2022 (a)	9.5844	1.499 12	4.05	0.809951	12	1.4%	4.44 [2.85, 6.02]	
Tian et al., 2021 (a)	15.7	2.31 10	7.135	0.321	10	1.3%	4.97 [3.04, 6.90]	
Subtotal (95% CI)	7.993	0.00 12	0.99394	0.5	60	10.5%	2.65 [1.12, 4.19]	▲
Heterogeneity: $Tau^2 = 4.00$; Ch	i ² = 51.58, df = 7 (D = 0.0007)	' (P < 0.00001); I²	= 86%					
Test for overall effect. $Z = 3.39$	(F = 0.0007)							
1.1.4 Higher Dose	40.000.00	0.007 44	0.07705	0.500	40	4.00	0.5215.45.44.60	
Hu et al., 2019 (c) Kapoor et al.,2022 (b)	0.272885	0.237 10	0.12096	0.522	3	1.0%	8.52 [5.45, 11.60] 0.68 [-1.05, 2.41]	·
Kapoor et al., 2022 (d)	0.279591	0.076 3	0.05988	0.047	3	1.0%	2.78 [-0.34, 5.91]	+
Kauretal., 2022 (b) Livetal 2020 (b)	38.1 15.2518	6 4 1583 P	29.7	2 014	4	1.4%	1.00 [-0.55, 2.55] -1 17 [-2 44 0 10]	
Liu et al., 2022 (c)	11.8792	0.121492 12	4.05	0.809951	12	0.8%	13.05 [8.94, 17.17]	
Tian et al., 2021 (c) Wang et al. 2020(c)	13 10 15786	1.67 10 0.999 13) 7.135) 6.99394	0.321	10	1.3%	4.67 [2.83, 6.51] 3.87 [2.43, 5.31]	
Subtotal (95% CI)		60)		60	9.7%	3.81 [1.41, 6.20]	-
Heterogeneity: Tau ² = 10.49; C Test for overall effect: 7 = 3.12	hi ^z = 87.56, df = (P = 0.002)	7 (P < 0.00001);	* = 92%					
1.1.5 High Fat/cholesterol Mod	1el 0.04231523	0.007 8	0.03724	0.004	8	1.5%	0.84 [-0.19.1.88]	
Liu et al., 2022 (a)	9.5844	1.499 12	4.05	0.809951	12	1.4%	4.44 [2.85, 6.02]	
Liu et al., 2022 (b)	10.93434	0.121492 12	2 4.05	0.809951	12	0.9%	11.48 [7.84, 15.12]	
Morissette et al., 2020	2.8682141	1.419 14	3.46082	1.33	14	1.5%	-0.42 [-1.17, 0.33]	
Tian et al., 2021 (a)	15.7	2.31 10	7.135	0.321	10	1.3%	4.97 [3.04, 6.90]	
Tian et al., 2021 (b) Tian et al., 2021 (c)	20.5	1.67 10	7.135	0.321	10	1.2%	5.98 [3.73, 8.22] 4.67 [2.83, 6.51]	
Wang et al.,2020(a)	10.15786	0.999 12	6.99394	0.5	12	1.4%	3.87 [2.43, 5.31]	
Wang et al.,2020(b) Wang et al.,2020(c)	7.993	0.834 12	2 6.99394	0.5	12	1.5%	2.80 [1.62, 3.98] 1.65 [0.70, 2.60]	
Wu et al., 2018	24.59332933	2.021 12	15.8341	1.348	12	1.3%	4.92 [3.20, 6.64]	
Heterogeneity: Tau ² = 6.63° Ch	i² = 155.47. df =	130 11 (P < 0.00001)	, ¦i≊ = 93%		136	15.0%	4.30 [2.80, 5.92]	-
Test for overall effect: Z = 5.47	(P < 0.00001)							
1.1.6 Other Animal Models								
da Silva-Maia et al., 2019 (a)	131	4.054 7	134	4.28	7	1.5%	-0.67 [-1.76, 0.41]	<u> </u>
da Silva-Mala et al., 2019 (b) Hu et al., 2019 (a)	134 10.58544	4.154 /	0.97785	4.28	10	1.5%	0.00 [-1.05, 1.05] 8.52 [5.45, 11.60]	Τ ——
Hu et al., 2019 (b)	9.75245	0.412 10	6.97785	0.522	10	1.2%	5.65 [3.51, 7.79]	
Hulet al., 2019 (c) Kapooriet al., 2022 (a)	10.1 0.163493	0.215 10 0.134 3) 6.97785 0.12095	0.522	10	1.1%	7.49 [4.76, 10.23] 0.30 [-1.32, 1.93]	
Kapoor et al.,2022 (b)	0.272885	0.239 3	0.12096	0.085	3	1.3%	0.68 [-1.05, 2.41]	+
Kapoor et al., 2022 (c) Kapoor et al., 2022 (d)	0.123307	0.079 3	0.05988	0.047	3	1.3%	0.78 [-0.99, 2.55] 2 78 F0 34 -6 01	<u>+</u>
Kaur et al., 2022 (a)	38.1	6 4	29.7	8.4	4	1.4%	1.00 [-0.55, 2.55]	+
Kauretal., 2022 (b)	35.8	7.4 4	29.7	8.4	4	1.4%	0.67 [-0.79, 2.13]	<u>+</u>
Liu et al., 2020 (a) Liu et al., 2020 (b)	15.2518	0.043 b 1.583 b) 17.554) 17.554	2.014 2.014	ю 6	1.5%	-0.03 [-1.16, 1.10] -1.17 [-2.44, 0.10]	
Pengetal., 2019 (a)	61.79641	6.707 10	50.3	7.186	10	1.5%	1.58 [0.55, 2.62]	
Pengietal., 2019 (b) Pengietal., 2020	57.96407 20.694	2.874 10 1.806 10) 50.3) 16.3889	7.186 2.778	10 10	1.5% 1.5%	1.34 [0.35, 2.33] 1.76 [0.69, 2.83]	<u> </u>
Silva-maia et al., 2018	121.6931	3.704 7	111.111	4.762	7	1.4%	2.32 [0.86, 3.78]	
Sulet al., 2019 Subtotal (95% CI)	21.65653	1.675 6 119	17.0973	1.861	6 119	1.4% 24.3%	2.38 [0.76, 4.00] 1.63 [0.80, 2.47]	
Heterogeneity: Tau ² = 2.55; Ch	i ² = 101.59, df =	17 (P < 0.00001)	; I≊ = 83%					
Test for overall effect: Z = 3.83	(P = 0.0001)							
Total (95% CI)	B- 607 00 10	630)		630	100.0%	2.77 [2.26, 3.29]	• •
 meterogeneity: Tau* = 4.36; Ch Test for overall effect: Z = 10.55 	⊢= ๒⊎7.39, df= 5 (P < 0.00001)	≀∋(⊢≺∪∪0001)	, 17 = 89%				-	-10 -5 0 5 10
Test for subgroup differences:	Chi ² = 11.10, df	= 5 (P = 0.05), I ² :	= 55.0%					. avours [experimental] - r avours [control]

S Figure 6: Forest plot of the sub-group analysis to study effect of anthocyanin supplementation on the acetic acid, SCFA. Sub-grouping was on the basis of duration of the study, dose of the anthocyanin given and disease status of the subjects (animal models). Values are standardized mean differences with 95% CIs determined with the use of random-effects models. Heterogeneity was quantified by I², inverse variance and standardised mean difference (SMD).



S Figure 7: Forest plot of the sub-group analysis after elimination of high-influencer studies, for understanding the effect of anthocyanin supplementation on the acetic acid, SCFA type. Sub-grouping was on the basis of duration of the study, dose of the anthocyanin given and disease status of the subjects (animal models). Values are standardized mean differences with 95% CIs determined with the use of random-effects models. Heterogeneity was quantified by I², inverse variance and standardised mean difference (SMD).

Study or Subgroup	Exp	erimental	Total	C	ontrol	Total	Weight	Std. Mean Difference	Std. Mean Difference
3.1.1 Study less than 4 week: Hu et al., 2019 (a) Hu et al., 2019 (b) Hu et al., 2019 (c) Liu et al., 2020 (a) Liu et al., 2020 (b) Peng et al., 2019 (b) Put et al., 2019 (c) Subtotal (95% C1) Heterogeneity: Tau ² = 4.66; Cf Tact for overall offect Z = 1.06	2.503876 2.2215 1.8235 4.163424 2.918288 14.8503 14.37126 hi ^z = 69.72, d	0.054 0.021569 0.021234 2.412 1.323 4.79 2.395 f= 6 (P < 0.0	10 10 10 6 10 10 62 0001);	2.11628 2.11628 2.11628 2.56809 2.56809 11.018 11.018 11.018	0.039 0.039 0.584 0.584 3.353 3.353	10 10 10 6 10 10 10 62	1.0% 1.4% 0.9% 1.4% 1.5% 1.5% 1.5% 9.3%	7.88 [5.02, 10.74] 3.20 [1.79, 4.61] -8.93 [-12.14, -5.72] 0.84 [-0.36, 2.04] 0.32 [-0.83, 1.46] 0.89 [-0.04, 1.82] 1.10 [0.15, 2.06] 0.93 [-0.80, 2.66]	
3.1.2 Study more than 4 weel da Silva-Maia et al., 2019 (a) kapoor et al., 2022 (a) kapoor et al., 2022 (b) kapoor et al., 2022 (c) kapoor et al., 2022 (c) kaur et al., 2022 (c) kaur et al., 2022 (c) kaur et al., 2022 (c) Liu et al., 2022 (c) Liu et al., 2022 (c) bil et al., 2022 (c) liu et al., 2022 (c) Bilva-maia et al., 2020 Peng et al., 2020 Silva-maia et al., 2020 Ping et al., 2021 (c) Tian et al., 2021 (c) Tian et al., 2021 (c) Wang et al., 2020 (c) Wu et al., 2018 Subtotal (95% CI) Heterogeneity: Tau [±] = 4.20; Ch Test for overall effect: Z = 3.89	(r = 0.23) (s 65 0.571131 0.216875 0.58665 0.281609 0.281609 0.281609 0.281609 1.21 0.011497 8.63947 12.82423 13.90416 1.884899 20.45455 30.30303 14.31818 14.31818 6.6743 9.6583 6.660898 64.75091	2.534 1.823 0.119 0.121 0.184 0.057 0.160 0.002 0.80995 2.5648 5.39 0.177 3.846 5.39 0.821 0.8207 6.309 0.821 0.821 0.826 1.16565 3.215 df = 22 (P < 0	7 3 3 3 4 4 8 12 12 12 12 12 10 7 6 10 10 10 12 12 12 12 12 12 3,00000	77 77 0.36506 0.18935 0.36506 0.35606 0.35606 0.35606 6.15662 6.15662 6.15662 1.33817 1.38364 37.5758 1.7424 2.1 2.1 5.826286 5.828286 5.828286 5.828286 5.828286 119.2875	6.414 6.414 0.105 0.032 0.032 0.32 0.32 0.944943 0.944945 0.9452 0.94566 0.94566 0.94566 0.94566 0.945666 0.945666666666666666666666666666666666666	7733 3344 8212212 140776 10012 12212 12212 123	1.4% 1.4% 1.2% 1.3% 1.3% 1.4% 1.5% 1.5% 1.5% 1.5% 1.5% 1.5% 1.5% 1.5	$\begin{array}{c} -2.30 \ [-3.76, -0.85]\\ -2.78 \ [-4.38, -1.18]\\ 1.54 \ [-0.64, 3.73]\\ 0.25 \ [-1.37, 1.87]\\ 2.41 \ [-0.41, 5.23]\\ -0.70 \ [-2.43, 1.04]\\ -0.07 \ [-1.46, 1.32]\\ 1.02 \ [-0.53, 2.58]\\ -0.20 \ [-1.18, 0.78]\\ 2.73 \ [1.56, 3.89]\\ 2.73 \ [1.56, 3.89]\\ 2.73 \ [1.56, 3.89]\\ 0.20 \ [-1.18, 0.78]\\ 1.93 \ [0.33, 2.93]\\ 0.20 \ [-0.54, 0.94]\\ 1.62 \ [0.58, 2.66]\\ -1.34 \ [-2.54, -0.14]\\ 0.38 \ [-0.77, 1.52]\\ 5.13 \ [3.15, 7, 11]\\ 8.42 \ [5.38, 11.46]\\ 8.87 \ [5.68, 12.06]\\ 3.47 \ [2.13, 4.81]\\ 3.65 \ [2.27, 5.04]\\ 0.69 \ [-0.74, 1.52]\\ 14.15 \ [0.70, 18.60]\\ 1.81 \ [0.90, 2.73] \end{array}$	
3.1.3 Lower Dose Hu et al., 2019 (b) Kapoor et al., 2022 (a) Kapoor et al., 2022 (c) Kaur et al., 2022 (a) Liu et al., 2020 (a) Liu et al., 2021 (a) Wang et al., 2021 (a) Wang et al., 2020 (a) Subtotal (95% CI) Heterogeneilty: Tau ² = 4.44; CH Test for overall effect Z = 0.39	1.8235 0.216875 0.281609 0.69 4.163424 8.63947 6 6.660898 hi ^a = 69.02, d (P = 0.70)	0.021234 0.121 0.057 0.16 2.412 0.80995 0.821 1.16565 f= 7 (P < 0.0	10 3 4 12 12 12 60 0001);	2.11628 0.18935 0.35506 0.71 2.56809 6.15562 2.1 5.828286 * = 90%	0.039 0.032 0.105 0.32 0.584 0.944943 0.622 1.1656	10 3 4 6 12 10 12 60	0.9% 1.4% 1.3% 1.4% 1.5% 1.3% 1.3% 1.5% 10.7%	-8.93 [-12.14, -5.72] 0.25 [-1.37, 1.87] -0.70 [-2.43, 1.04] -0.07 [-1.46, 1.32] 0.84 [-0.36, 2.04] 2.73 [1.56, 3.89] 5.13 [3.15, 7.11] 0.69 [-0.14, 1.52] 0.31 [-1.27, 1.89]	
3.1.4 Higher Dose Hu et al., 2019 (c) Kapoor et al., 2022 (b) Kapoor et al., 2022 (d) Liu et al., 2020 (c) Morissette et al., 2020 Tian et al., 2021 (c) Wang et al., 2020(c) Subtotal (95% CI) Heterogeneity: Tau ^a = 4.10; CF Test for overall effect Z = 3.82	2.503876 0.58665 0.571131 1.21 2.918288 13.90416 6.4 10.65743 ni ² = 48.62, d (P = 0.0001)	0.054 0.184 0.119 0.51 1.323 5.39 0.21 1.4987 f = 7 (P < 0.0	10 3 4 12 10 12 60 0001);	2.11628 0.18935 0.35506 0.71 2.56809 6.15562 2.1 5.828286 ² = 86%	0.039 0.032 0.105 0.32 0.584 0.944943 0.622 1.1656	10 3 4 12 10 12 60	1.0% 1.2% 1.4% 1.5% 1.5% 0.9% 1.4% 9.9%	$\begin{array}{c} 7.88 \ [5.02, 10.74] \\ 2.41 \ [-0.41, 5.23] \\ 1.54 \ [-0.64, 3.73] \\ 1.02 \ [-0.53, 2.58] \\ 0.32 \ [-0.53, 1.46] \\ 1.93 \ [0.93, 2.93] \\ 8.87 \ [5.68, 12.06] \\ 3.47 \ [2.13, 4.86] \\ 3.08 \ [1.50, 4.66] \end{array}$	
3.1.5 High Fat/Cholesterol Mo Lee et al., 2018 Liu et al., 2022 (a) Liu et al., 2022 (b) Liu et al., 2022 (b) Morissette et al., 2020 Tian et al., 2021 (a) Tian et al., 2021 (b) Tian et al., 2021 (c) Wang et al., 2020 (c) Wang et al., 2020 (c) Wang et al., 2020 (c) Wu et al., 2018 Subtotal (95% CI) Heterogeneily: Tau ^e = 4.87; CF Test for overall effect. Z = 5.36	del 0.011497 8.63947 12.82423 13.90416 1.884899 6.4 10.6573 9.6583 6.660898 64.75091 hi [#] = 138.78, (P < 0.0000	0.002 0.80995 2.5648 5.39 0.177 0.821 0.92 0.21 1.4987 0.83261 1.16565 3.215 df = 11 (P < (8 12 12 14 10 10 12 12 12 12 136 0.00007	0.01217 6.15562 6.15562 1.83817 2.1 2.1 5.828286 5.828286 19.2875 1); I [#] = 92%	0.004 0.944943 0.944943 0.944943 0.266 0.622 0.622 0.622 1.1656 1.1656 1.1656 2.985	8 12 12 14 10 10 12 12 12 12 12 136	1.5% 1.4% 1.5% 1.5% 1.3% 1.0% 0.9% 1.4% 1.5% 0.7% 15.6%	$\begin{array}{c} -0.20 \ [-1.18, 0.78] \\ 2.73 \ [1.56, 3.89] \\ 3.33 \ [2.03, 4.64] \\ 1.93 \ [0.33, 2.93] \\ 0.20 \ [-0.54, 0.94] \\ 5.13 \ [3.16, 7.11] \\ 8.42 \ [5.38, 11.46] \\ 8.87 \ [5.68, 12.06] \\ 3.47 \ [2.13, 4.81] \\ 3.65 \ [2.27, 5.04] \\ 0.69 \ [-0.14, 1.52] \\ 14.16 \ [9.70, 18.60] \\ 3.64 \ [2.31, 4.97] \end{array}$	
3.1.6 Other Animal Model da Silva-Maia et al., 2019 (a) da Silva-Maia et al., 2019 (b) Hu et al., 2019 (a) Hu et al., 2019 (b) Hu et al., 2019 (c) Kapoor et al., 2022 (a) Kapoor et al., 2022 (c) Kapoor et al., 2022 (c) Kaur et al., 2022 (c) Kaur et al., 2022 (c) Liu et al., 2022 (c) Haur et al., 2022 (c) Silva-maia et al., 2019 (a) Peng et al., 2019 (b) Peng et al., 2019 (b) Peng et al., 2019 Silva-maia et al., 2018 Su et al., 2019 Subtotal (95% CI) Heterogeneity: Tau ² = 3.14; CH	65 63 2.503876 2.2216 0.571131 0.216875 0.58665 0.281609 0.69 1.21 4.163424 2.918288 14.37126 20.45455 30.30303 14.31818	2.534 1.823 0.054 0.021569 0.021234 0.119 0.121 0.184 0.057 2.412 1.323 4.79 2.395 3.846 3.207 6.309 df = 17 (P < 0	7 7 10 10 3 3 3 4 4 6 10 10 10 7 6 10 7 6 9 0.00007	77 77 2.11628 2.11628 2.11628 0.35506 0.35506 0.35506 0.355600 0.71 2.56809 11.018 13.6364 37.5758 11.7424 1); F= 86%	6.414 6.414 0.039 0.039 0.105 0.032 0.105 0.32 0.584 0.584 3.353 3.353 3.353 3.353	7 7 10 10 3 3 3 4 4 6 10 10 10 7 6 119	1.4% 1.4% 1.4% 0.9% 1.2% 1.4% 1.4% 1.4% 1.4% 1.5% 1.5% 1.5% 1.5% 1.5% 1.5%	$\begin{array}{c} -2.30 \ [-3.76, -0.85] \\ -2.78 \ [-4.38, -1.18] \\ 7.88 \ [5.02, 10.74] \\ 3.20 \ [1.79, 4.61] \\ 1.54 \ [-0.64, 3.73] \\ 0.25 \ [-1.37, 1.87] \\ 0.25 \ [-1.37, 1.87] \\ -0.70 \ [-2.43, 1.04] \\ -0.07 \ [-1.46, 1.32] \\ 1.02 \ [-0.33, 2.58] \\ 0.84 \ [-0.36, 2.04] \\ 0.32 \ [-0.83, 1.46] \\ 0.89 \ [-0.04, 1.82] \\ 1.10 \ [-0.58, 2.06] \\ 1.62 \ [0.58, 2.66] \\ 1.64 \ [-0.75, 1.52] \\ 0.33 \ [-0.57, 1.24] \end{array}$	
Total (95% CI) Heterogeneity: Tau ² = 3.94; Ch Test for overall effect: Z = 6.44 Test for subgroup differences:	ni² = 720.47, (P ≤ 0.0000) : Chi² = 23.13	df= 75 (P < (1) 3. df= 5 (P =	630 0.0000° 0.0003	1); I ^z = 90%), I ^z = 78.49	6	<mark>630</mark>	100.0%	1.61 [1.12, 2.10]	-10 -5 0 5 10 Favours [experimental] Favours [control]

S Figure 8: Forest plot of the sub-group analysis to study effect of anthocyanin supplementation on the butanoic acid, SCFA type. Sub-grouping was on the basis of duration of the study, dose of the anthocyanin given and disease status of the subjects (animal models). Values are standardized mean differences with 95% CIs determined with the use of random-effects models. Heterogeneity was quantified by I², inverse variance and standardised mean difference (SMD).



S Figure 9: Forest plot of the sub-group analysis after elimination of high-influencer studies, for understanding the effect of anthocyanin supplementation on the butanoic acid, SCFA type. Sub-grouping was on the basis of duration of the study, dose of the anthocyanin given and disease status of the subjects (animal models). Values are standardized mean differences with 95% CIs determined with the use of random-effects models. Heterogeneity was quantified by I², inverse variance and standardised mean difference (SMD).



S Figure 10: Forest plot of the sub-group analysis to study effect of anthocyanin supplementation on the propionic acid, SCFA type. Sub-grouping was on the basis of duration of the study, dose of the anthocyanin given and disease status of the subjects (animal models). Values are standardized mean differences with 95% CIs determined with the use of random-effects models. Heterogeneity was quantified by I², inverse variance and standardised mean difference (SMD).



S Figure 11: Forest plot of the sub-group analysis after elimination of high-influencer studies, for understanding the effect of anthocyanin supplementation on the propionic acid, SCFA type. Sub-grouping was on the basis of duration of the study, dose of the anthocyanin given and disease status of the subjects (animal models). Values are standardized mean differences with 95% CIs determined with the use of random-effects models. Heterogeneity was quantified by I², inverse variance and standardised mean difference (SMD).

		Que	stion: Should Bibliograph	d Anthocyani	in Rich vs N or. Cochrane Da	Normal Diet be u tabase of Systematic	used fo	r SCFA (Ace Year), Issue (Issu	tic Acid)	?		
			Quality asse	ssment					Summary	of Findings		
Participants	Participants Risk of Incons		Indirectness	Imprecision	Publication	Overall quality of	Study event rates (%)		Relative	Anticipated absolute effects		
(studies) Follow up	bias				bias	evidence	With Normal Diet	With Anthocyanin Rich	effect (95% CI)	Risk with Normal Die	Risk difference with et Anthocyanin Rich (95% CI)	
Acetic Aci	d (Better ind	icated by lower va	alues)			•						
1060 (23 studies)	no serious risk of bias	serious ¹	no serious indirectness	no serious imprecision	undetected	⊕⊕⊕⊕ HIGH ¹ due to inconsistency, large effect	530	530			The mean acetic acid in the intervention groups was 1.52 standard deviations higher (0.86 to 2.17 higher)	
¹ High heteroge	eneity	s		4.	- 12)		- 5-		-20	121		
		Quest	ion: Should	Anthocyanin	Rich vs No	rmal Diet be us	ed for	SCFA (Prop	Dinic Acid	1)?		
0	_		Quality asse	sment	or. coomane ba	tabase of Systematic	iteviews [rearl, issue [issu	Summary	of Findinas		
Participants	Risk of	Inconsistency	Indirectness	Imprecision	Publication	Overall quality of	Study event rates (%		Relative	Anticipated absolute effects		
(studies) Follow up	bias	5			bias	evidence	With Normal Diet	With Anthocyanin Rich	effect (95% CI)	Risk with Normal Diet	Risk difference with Anthocyanin Rich (95% CI)	
Propoinic	Acid (Bette	er indicated by low	/er values)			•						
1048 (25 studies)	no serious risk of bias	serious ¹	no serious indirectness	no serious imprecision	undetected	⊕⊕⊕⊕ HIGH ¹ due to inconsistency, large effect	524	524	-		The mean propoinic acid in the intervention groups was 1.44 standard deviations higher (0.56 to 2.23 higher)	
¹ High heteroge	eneity					6				3		
		Quest	tion: Should	Anthocyanin	Rich vs No	ormal Diet be us	ed for	SCFA (Buta	noic Acid	I)?		
	_		Bibliograph	y: . [Intervention] f	or. Cochrane Da	tabase of Systematic	Reviews [Year], Issue [Issu	ie].			
	D : 1 - 6		Quality asses	sment	D 1 F F				Summary	of Findings		
(studies)	bias	Inconsistency	Indirectness	Imprecision	bias	evidence	Study ev	ent rates (%)	effect	Anticipate	ed absolute effects	
Follow up							Normal Diet	Anthocyanin Rich	(95% CI)	Normal Diet	Anthocyanin Rich (95% CI)	
Butanoic	Acid (Better	r indicated by low	er values)	*								
1048 (23 studies)	no serious risk of bias	serious ¹	no serious indirectness	no serious imprecision	undetected	⊕⊕⊕⊕ HIGH ¹ due to inconsistency, large effect	524	524	70		The mean butanoic acid in the intervention groups was 1.15 standard deviations higher (0.41 to 1.9 higher)	

¹ High heterogeneity

S Figure 12: SCFA data quality assessment using GRADE tool.



S Figure 13: **Funnel plots for publication bias assessment(A)** For *Fir/Bac*using data from 41 studies. **(B)**For Acetic acid using data from 29 studies. **(C)** For Butanoic acid using data from 25 studies. **(D)**For Propionic acid using data from 30 studies.

The plot was created by putting the standard error on the y-axis and SMD on the x-axis





S Figure 14: Bibliographic coupling of leading researchers in anthocyanin, gut microbiota and SCFA research (A) Network visualization (**B**) Overlay visualization (year wise)

department of medical microbiology, university medical center groningen, university of groningen, gr ti food and nutrition, wageningen, the netherlands laboratory of microbiology, wageningen university, wageningen, the netherlands biomathematics and statistics scotland, aberdeen, uk rowett institute of nutrition and health, university of aberdeen, aberdeen, uk department of soil, plant and food sciences, university of bari aldo moro, bari, italy department of agricultural and food sciences, university of bologna, bologna, italy

A



S Figure 15: Institutional collaborations for anthocyanin, gut microbiota and SCFA research (A) Network visualization (B) Overlay visualization (year wise)

A





S Figure 16: Independent institutional collaborations for anthocyanin, gut microbiota and SCFA research (A) Network visualization (B) Overlay visualization (year wise)