

Association of Breed of Sheep or Goats with Somatic Cell Counts and Total Bacterial Counts of Bulk-Tank Milk

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Table S1. Zootechnical characteristics of 444 small ruminant farms in Greece, classified in accord to the breed of animals therein.

Breed	Origin of breed ¹	Farms (n)	Management system applied in the farms ²				Application of machine-milking		Average month into lactation period at sampling	Average no. of animals per farm ⁴	Average yearly milk production per animal (L) ⁴	Application of teat disinfection at milking	
			I ²	s-I	s-E	E	Y ³	N				Y ³	N
Sheep farms													
Assaf	imported	30	5	20	5	0	28	2	5.5	296±39	274±17	4	26
Awassi	imported	1	0	1	0	0	1	0	4.0	170	235	0	1
Boutsko	indigenous	2	0	0	2	0	0	2	5.5	587±414	107±3	0	2
Chios	indigenous	44	11	19	14	0	34	10	5.0	317±43	217±14	11	33
Crossbreds	cross	43	3	17	20	3	31	12	5.0	311±28	180±10	6	37
Friesarta	indigenous	12	2	5	4	1	11	1	6.5	259±41	242±19	1	11
Friesian	imported	13	0	7	6	0	6	7	5.0	220±51	223±31	2	11
Karagouniko	indigenous	5	0	3	1	1	4	1	4.0	190±55	185±43	1	4
Kefallinia	indigenous	1	0	0	1	0	1	0	4.0	120	150	0	1
Lacaune	imported	95	20	54	20	1	92	3	5.0	389±28	236±9	18	77
‘Local’ ⁵	indigenous	55	1	16	27	11	31	24	5.0	278±27	159±9	7	48
Mytilini	indigenous	18	1	9	5	3	15	3	7.0	322±34	168±12	2	16
Sfakia	indigenous	6	0	0	2	4	1	5	7.0	487±113	58±5	0	6
Goat farms													
Alpine	imported	9	1	1	7	0	6	3	6.0	122±42	280±53	0	9
Crossbreds	cross	18	1	3	14	0	15	3	4.5	132±39	190±19	4	14
Damascus	imported	18	0	9	8	1	10	8	5.5	345±81	233±24	2	16
Kefallinia	indigenous	1	0	0	1	0	1	0	2.0	250	140	0	1
Indigenous Greek (<i>Capra prisca</i>)	indigenous	50	1	5	27	17	18	32	5.0	262±26	147±11	1	49

Murciano-Granadina	imported	13	5	7	1	0	11	2	4.5	222±72	255±30	4	9
Saanen	imported	5	1	3	1	0	4	1	8.5	155±82	472±52	1	4
Skopelos	indigenous	5	0	1	2	2	1	4	3.5	313±95	117±15	0	5

¹ imported: breed brought into Greece from another country, indigenous: breed native of Greece or created in the country, cross: cross between imported or indigenous breeds; ² management system applied in farms classified according to the standards of the European Food Safety Authority [European Food Safety Authority. Scientific opinion on the welfare risks related to the farming of sheep for wool, meat and milk production. *EFSA J.* **2014**, *12*, 3933–4060] – I: intensive, s-I: semi-intensive, s-E: semi-extensive, E: extensive; ³ Y: yes, N: no; ⁴ mean±standard error of the mean; ⁵ the term, as used by the respective farmers, referred to a variety of small-scale breeds, not always related between them and each one prevailing only in some areas of the country with limited geographic dissemination.

Table S2. Details of multivariable models employed for the evaluation of "increased somatic cell counts in bulk-tank milk" (i.e., with SCC above 0.75×10^6 cells mL⁻¹) and "increased total bacterial counts in bulk-tank milk" (i.e., with TBC above 1500×10^3 cfu mL⁻¹) with the zootechnical characteristics of 444 small ruminant farms in Greece.

Outcome		Variables offered to the multivariable models (<i>n</i>)	Variables required in the final models
Increased somatic cell counts	Sheep flocks all breeds	4	(a) sheep breed, (b) management system applied in farm, (c) application of machine-milking in farm, (d) month into lactation period at sampling
Increased somatic cell counts	Sheep flocks six most frequently recorded breeds	4	(a) sheep breed, (b) management system applied in farm, (c) application of machine-milking in farm, (d) number of animals in farm
Increased total bacterial counts	Sheep flocks all breeds	4	(a) management system applied in farm, (b) application of machine-milking in farm, (c) month into lactation period at sampling, (d) average yearly milk production per animal
Increased total bacterial counts	Sheep flocks six most frequently recorded breeds	3	(a) management system applied in farm, (b) month into lactation period at sampling, (c) average yearly milk production per animal
Increased somatic cell counts	Goat herds all breeds	1	(a) sheep breed
Increased somatic cell counts	Goat herds four most frequently recorded breeds	2	(a) sheep breed, (b) management system applied in farm
Increased total bacterial counts	Goat herds all breeds	2	(a) number of animals per farm, (b) application of teat disinfection at milking
Increased total bacterial counts	Goat herds four most frequently recorded breeds	2	(a) number of animals per farm, (b) application of teat disinfection at milking

Table S3. Associations of zootechnical characteristics with increased somatic cell counts in bulk-tank milk (i.e., above 0.75×10^6 cells mL⁻¹) in 325 sheep farms in Greece, as found in univariable analysis.

A) Analysis with all the farms, independently of the number of farms with each breed

Number of farms										
Farms with no increased somatic cell counts in bulk-tank milk (n = 236)					Farms with increased somatic cell counts in bulk-tank milk (n = 89)					p
Breed										
Assaf	Awassi	Boutsko	Chios	Crossbreds	Assaf	Awassi	Boutsko	Chios	Crossbreds	
21/30	1/1	2/2	26/44	26/43	9/30	0/1	0/2	18/44	17/43	
Friesarta	Friesian	Karagouniko	Kefallinia	Lacaune	Friesarta	Friesian	Karagouniko	Kefallinia	Lacaune	
9/12	11/13	3/5	1/1	77/95	3/12	2/13	2/5	0/1	18/95	
‘Local’	Mytilini	Sfakia			‘Local’	Mytilini	Sfakia			
39/55	16/18	4/6			16/55	2/18	2/6		0.18	
Management system applied in farm										
Intensive	Semi-intensive	Semi-extensive	Extensive		Intensive	Semi-intensive	Semi-extensive	Extensive		
28/43	118/151	76/107	14/24		15/43	33/151	31/107	10/24	0.11	
Application of machine-milking in farm										
Yes			No		Yes			No		
196/255			40/70		59/255			30/70		
0.001										
Month into lactation period at sampling										
Up to 3 rd		3 rd to 6 th		After 6 th		Up to 3 rd		3 rd to 6 th		
69/98		62/94		105/133		29/98		32/94		
								28/133		
0.08										
No. of animals in farm										
Up to 250		251-500		Over 500		Up to 250		251-500		
132/180		85/118		19/27		48/180		33/118		
								8/27		
0.93										

Yearly milk production per animal							
Up to 300 L		Over 300 L		Up to 300 L		Over 300 L	
202/281		34/44		79/281		10/44	
						0.46	
Application of teat disinfection at milking							
Yes		No		Yes		No	
35/52		201/273		17/52		72/273	
						0.35	
<u>B) Analysis with only the farms with the six most frequently recorded breeds</u>							
Number of farms							
Farms with no increased somatic cell counts in bulk-tank milk (n = 160)				Farms with increased somatic cell counts in bulk-tank milk (n = 52)			p
Breed							
Assaf		Chios		Friesarta		Friesarta	
21/30		26/44		9/12		3/12	
Friesian		Lacaune		Mytilini		Mytilini	
11/13		77/95		16/18		2/18	
				2/13		18/95	
						0.055	
Management system applied in farm							
Intensive	Semi-intensive	Semi-extensive	Extensive	Intensive	Semi-intensive	Semi-extensive	Extensive
25/39	92/114	40/54	3/5	14/39	22/114	14/54	2/5

No. of animals in farm						
Up to 250	251-500	Over 500	Up to 250	251-500	Over 500	
91/120	63/79	6/13	29/120	16/79	7/13	0.033
Yearly milk production per animal						
Up to 300 L		Over 300 L	Up to 300 L		Over 300 L	
130/177		30/39	43/177		9/39	0.82
Application of teat disinfection at milking						
Yes		No	Yes		No	
27/38		133/174	11/38		41/174	0.48

Table S4. Associations of zootechnical characteristics with increased total bacterial counts in bulk-tank milk (i.e., above 1500×10^3 cfu mL⁻¹) in 325 sheep farms in Greece, as found in univariable analysis.

A) Analysis with all the farms, independently of the number of farms with each breed

Number of farms										
Farms with no increased total bacterial counts in bulk-tank milk (n = 267)					Farms with increased total bacterial counts in bulk-tank milk (n = 58)					P
Breed										
Assaf	Awassi	Boutsko	Chios	Crossbreds	Assaf	Awassi	Boutsko	Chios	Crossbreds	
27/30	1/1	2/2	35/44	31/43	3/30	0/1	0/2	9/44	12/43	
Friesarta	Friesian	Karagouniko	Kefallinia	Lacaune	Friesarta	Friesian	Karagouniko	Kefallinia	Lacaune	
10/12	13/13	3/5	1/1	76/95	2/12	0/13	2/5	0/1	19/95	
‘Local’	Mytilini	Sfakia			‘Local’	Mytilini	Sfakia			
46/55	16/18	6/6			9/55	2/18	0/6		0.44	
Management system applied in farm										
Intensive	Semi-intensive	Semi-extensive	Extensive		Intensive	Semi-intensive	Semi-extensive	Extensive		
32/43	131/151	86/107	18/24		11/43	20/151	21/107	6/24	0.17	
Application of machine-milking in farm										
Yes			No		Yes			No		
210/255			57/70		45/255			13/70		
Month into lactation period at sampling										
Up to 3 rd		3 rd to 6 th		After 6 th	Up to 3 rd		3 rd to 6 th		After 6 th	
73/98		74/94		120/133	25/98		20/94		13/133	
No. of animals in farm										
Up to 250		251-500		Over 500	Up to 250		251-500		Over 500	
146/180		98/118		23/27	34/180		20/118		4/27	
Yearly milk production per animal										
Up to 300 L			Over 300 L		Up to 300 L			Over 300 L		
235/281			32/44		46/281			12/44		
0.08										

Application of teat disinfection at milking				
Yes	No	Yes	No	
41/52	226/273	11/52	47/273	0.50

B) Analysis with only the farms with the six most frequently recorded breeds

Number of farms							
Farms with no increased total bacterial counts in bulk-tank milk (n = 177)				Farms with increased total bacterial counts in bulk-tank milk (n = 35)			P
Breed							
Assaf	Chios	Friesarta		Assaf	Chios	Friesarta	
27/30	35/44	10/12		3/30	9/44	2/12	
Friesian	Lacaune	Mytilini		Friesian	Lacaune	Mytilini	
13/13	76/95	16/18		0/13	19/95	2/18	0.39
Management system applied in farm							
Intensive	Semi-intensive	Semi-extensive	Extensive	Intensive	Semi-intensive	Semi-extensive	Extensive
28/39	101/114	45/54	3/5	11/39	13/114	9/54	2/5
Application of machine-milking in farm							
Yes	No			Yes	No		
155/186	22/26			31/186	4/26		0.87
Month into lactation period at sampling							
Up to 3 rd	3 rd to 6 th	After 6 th		Up to 3 rd	3 rd to 6 th	After 6 th	
50/64	42/52	85/94		14/64	12/52	9/94	0.05
No. of animals in farm							
Up to 250	251-500	Over 500		Up to 250	251-500	Over 500	
99/120	66/79	12/13		21/120	13/79	1/13	0.66

Yearly milk production per animal				
Up to 300 L	Over 300 L	Up to 300 L	Over 300 L	
148/177	29/39	29/177	10/39	0.17
Application of teat disinfection at milking				
Yes	No	Yes	No	
33/38	144/174	5/38	30/174	0.54

Table S5. Associations of zootechnical characteristics with increased somatic cell counts in bulk-tank milk (i.e., above 0.75×10^6 cells mL⁻¹) in 119 goat farms in Greece, as found in univariable analysis.

A) Analysis with all the farms, independently of the number of farms with each breed

Number of farms								
Farms with no increased somatic cell counts in bulk-tank milk (n = 42)				Farms with increased somatic cell counts in bulk-tank milk (n = 77)				<i>p</i>
Breed								
Alpine	Crossbreds	Damascus	Kefallinia	Alpine	Crossbreds	Damascus	Kefallinia	
6/9	7/18	5/18	0/1	3/9	11/18	13/18	1/1	
Indigenous Greek (<i>Capra prisca</i>)	Murciano-Granadina	Saanen	Skopelos	Indigenous Greek (<i>Capra prisca</i>)	Murciano-Granadina	Saanen	Skopelos	
10/50	9/13	2/5	3/5	40/50	4/13	3/5	2/5	0.012
Management system applied in farm								
Intensive	Semi-intensive	Semi-extensive	Extensive	Intensive	Semi-intensive	Semi-extensive	Extensive	
5/9	11/29	22/61	4/20	4/9	18/29	39/61	16/20	0.29
Application of machine-milking in farm								
Yes		No		Yes		No		
24/66		18/53		42/66		35/53		0.79
Month into lactation period at sampling								
Up to 3 rd	3 rd to 6 th	After 6 th		Up to 3 rd	3 rd to 6 th	After 6 th		
14/36	19/50	9/33		22/36	31/50	24/33		0.52
No. of animals in farm								
Up to 250	251-500	Over 500		Up to 250	251-500	Over 500		
30/78	8/28	4/13		48/78	20/28	9/13		0.60
Yearly milk production per animal								
Up to 300 L		Over 300 L		Up to 300 L		Over 300 L		
35/100		7/19		65/100		12/19		0.88

Application of teat disinfection at milking				
Yes	No	Yes	No	
4/12	38/107	8/12	69/107	0.88

B) Analysis with only the farms with the six most frequently recorded breeds

Number of farms								
Farms with no increased somatic cell counts in bulk-tank milk (n = 30)				Farms with increased somatic cell counts in bulk-tank milk (n = 60)				p
Breed								
Alpine	Damascus	Indigenous Greek (<i>Capra prisca</i>)	Murciano-Granadina	Alpine	Damascus	Indigenous Greek (<i>Capra prisca</i>)	Murciano-Granadina	
6/9	5/18	10/50	9/13	3/9	13/18	40/50	4/13	0.001
Management system applied in farm								
Intensive	Semi-intensive	Semi-extensive	Extensive	Intensive	Semi-intensive	Semi-extensive	Extensive	
5/7	9/22	13/43	3/18	2/7	13/22	30/43	15/18	0.06
Application of machine-milking in farm								
Yes		No		Yes		No		
16/45		14/45		29/45		31/45		0.65
Month into lactation period at sampling								
Up to 3 rd		3 rd to 6 th		Up to 3 rd		3 rd to 6 th		After 6 th
11/27		13/36		6/27		16/27		23/36
21/27								0.32
No. of animals in farm								
Up to 250		251-500		Over 500		Up to 250		251-500
20/55		7/24		3/11		35/55		17/24
8/11								0.74

Yearly milk production per animal				
Up to 300 L	Over 300 L	Up to 300 L	Over 300 L	
25/78	5/12	53/78	7/12	0.51
Application of teat disinfection at milking				
Yes	No	Yes	No	
3/7	27/83	4/7	56/83	0.58

Table S6. Associations of zootechnical characteristics with increased total bacterial counts in bulk-tank milk (i.e., above 1500×10^3 cfu mL⁻¹) in 119 goat farms in Greece, as found in univariable analysis.

A) Analysis with all the farms, independently of the number of farms with each breed

Number of farms								
Farms with no increased total bacterial counts in bulk-tank milk (n = 90)				Farms with increased total bacterial counts in bulk-tank milk (n = 29)				<i>p</i>
Breed								
Alpine	Crossbreds	Damascus	Kefallinia	Alpine	Crossbreds	Damascus	Kefallinia	
7/9	15/18	11/18	0/1	2/9	3/18	7/18	1/1	
Indigenous Greek (<i>Capra prisca</i>)	Murciano-Granadina	Saanen	Skopelos	Indigenous Greek (<i>Capra prisca</i>)	Murciano-Granadina	Saanen	Skopelos	
38/50	10/13	5/5	4/5	12/50	3/13	0/5	1/5	0.38
Management system applied in farm								
Intensive	Semi-intensive	Semi-extensive	Extensive	Intensive	Semi-intensive	Semi-extensive	Extensive	
7/9	19/29	48/61	16/20	2/9	10/29	13/61	4/20	0.54
Application of machine-milking in farm								
Yes		No		Yes		No		
51/66		39/53		15/66		14/53		0.64
Month into lactation period at sampling								
Up to 3 rd	3 rd to 6 th	After 6 th		Up to 3 rd	3 rd to 6 th	After 6 th		
27/36	36/50	27/33		9/36	14/50	6/33		0.59
No. of animals in farm								
Up to 250	251-500	Over 500		Up to 250	251-500	Over 500		
63/78	19/28	8/13		15/78	9/28	5/13		0.18
Yearly milk production per animal								
Up to 300 L		Over 300 L		Up to 300 L		Over 300 L		
74/100		16/19		26/100		3/19		0.34

Application of teat disinfection at milking				
Yes	No	Yes	No	
7/12	83/107	5/12	24/107	0.14

B) Analysis with only the farms with the six most frequently recorded breeds

Number of farms								
Farms with no increased total bacterial counts in bulk-tank milk (n = 66)				Farms with increased total bacterial counts in bulk-tank milk (n = 24)				p
Breed								
Alpine	Damascus	Indigenous Greek (<i>Capra prisca</i>)	Murciano-Granadina	Alpine	Damascus	Indigenous Greek (<i>Capra prisca</i>)	Murciano-Granadina	
7/9	11/18	38/50	10/13	2/9	7/18	12/50	3/13	0.63
Management system applied in farm								
Intensive	Semi-intensive	Semi-extensive	Extensive	Intensive	Semi-intensive	Semi-extensive	Extensive	
5/7	14/22	33/43	14/18	2/7	8/22	10/43	4/18	0.68
Application of machine-milking in farm								
Yes		No		Yes		No		
33/45		33/45		12/45		12/45		1.00
Month into lactation period at sampling								
Up to 3 rd	3 rd to 6 th		After 6 th	Up to 3 rd	3 rd to 6 th		After 6 th	
20/27	25/36		21/27	7/27	11/36		6/27	0.76
No. of animals in farm								
Up to 250	251-500		Over 500	Up to 250	251-500		Over 500	
44/55	16/24		6/11	11/55	8/24		5/11	0.15

Yearly milk production per animal				
Up to 300 L	Over 300 L	Up to 300 L	Over 300 L	
57/78	9/12	21/78	3/12	0.89
Application of teat disinfection at milking				
Yes	No	Yes	No	
3/7	63/83	4/7	20/83	0.06