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Session 6 – Equine milK for human health,
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Advances on *Equus asinus* as a dairy species

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“Hôpital des Enfants Assistés”
Paris, 19th century

Bulletin de l’Académie de médecine, 1882

Tolouse, 20th century

Clinical studies on tolerability of donkey's milk of children with food allergies *(cont)*

Authors	year	Exp. conditions	Tolerability %
Iacono et al.	1992	9 unweaned children with multiple food allergies	*100*
Carroccio et al	2000	21 children *(10d÷9 months)* with food allergies and eHP intolerant	86
Monti et al	2007	46 CMPA children *(12- 149mo)* intolerant to common CMP substitute	82.6
Vita et al	2007	26 CMA and AD children *(6 mo- 3yr)*, crossover design	88
Tesse et al	2009	30 children *(6mo-11yr)* with mild to moderate CMA	96

The successful results in treating complex cases of multiple food allergy encourage the use of donkey's milk in highly sensitive patients, when breastfeeding is not possible and hypoallergenic milk formulas are not tolerated (low palatability, cross-reactions, etc.)

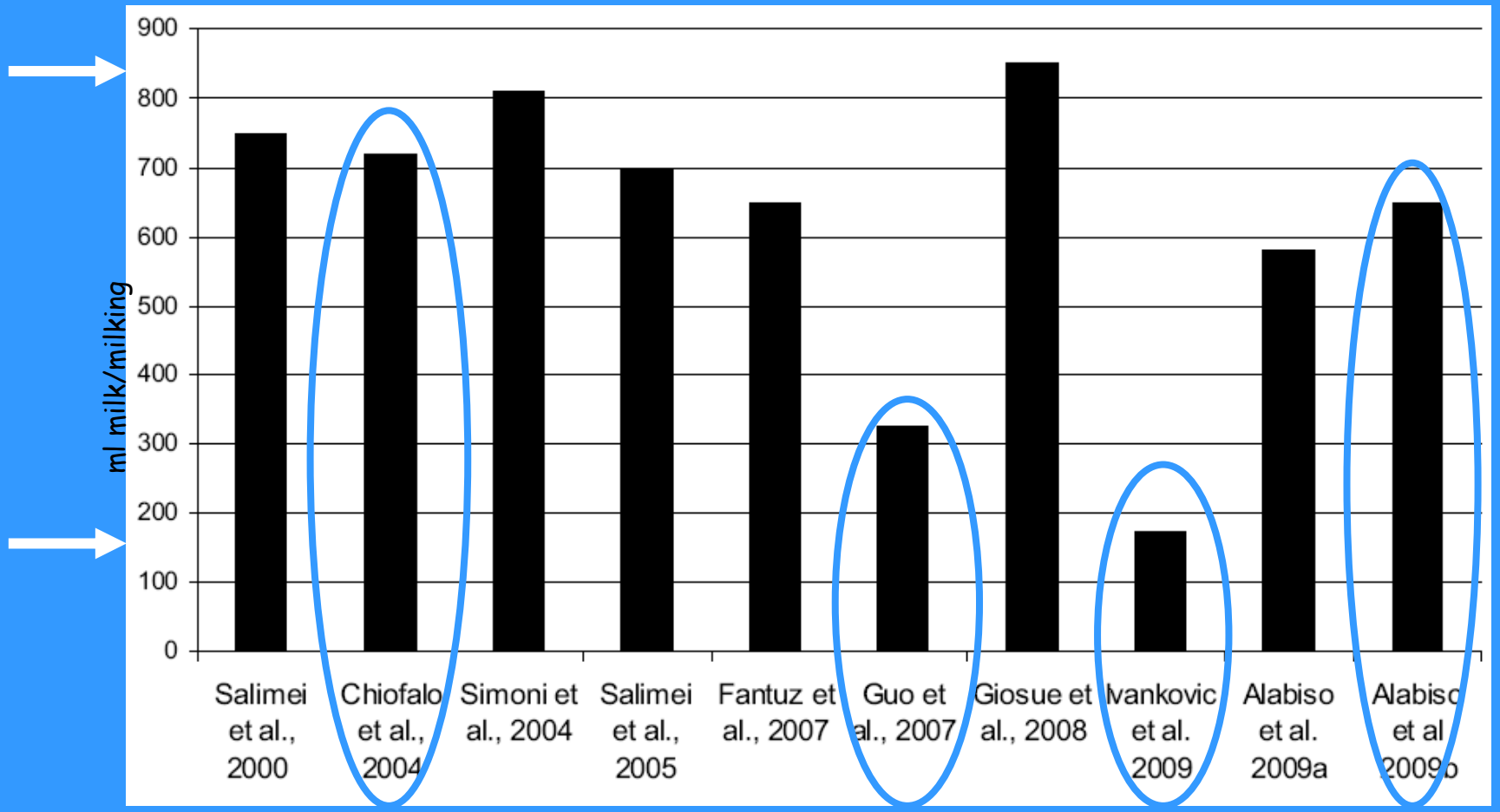
Immunological Properties of Donkey's Milk: Its Potential Use in the Prevention of Atherosclerosis

Authors: Tafaro, A.[1]; Magrone, T.[1]; Jirillo, F.[1]; Martemucci, G.[1]; D'Alessandro, A. G.[1]; Amati, L.[1]; Jirillo, E.[1]
Source: Current Pharmaceutical Design, Volume 13, Number 36, December 2007 , pp. 3711-3717(7)
Publisher: Bentham Science Publishers

Donkey's and Goat's Milk Consumption and Benefits to Human Health with Special Reference to the Inflammatory Status

Author(s): Jirillo F[1], Jirillo E[1], Magrone T[1]
Source: CURRENT PHARMACEUTICAL DESIGN Volume: 16 Issue: 7 Pages: 859-863
Published: MAR 2010
Times Cited: 2 References: 44

Donkey's milk yield per milking according quoted Authors

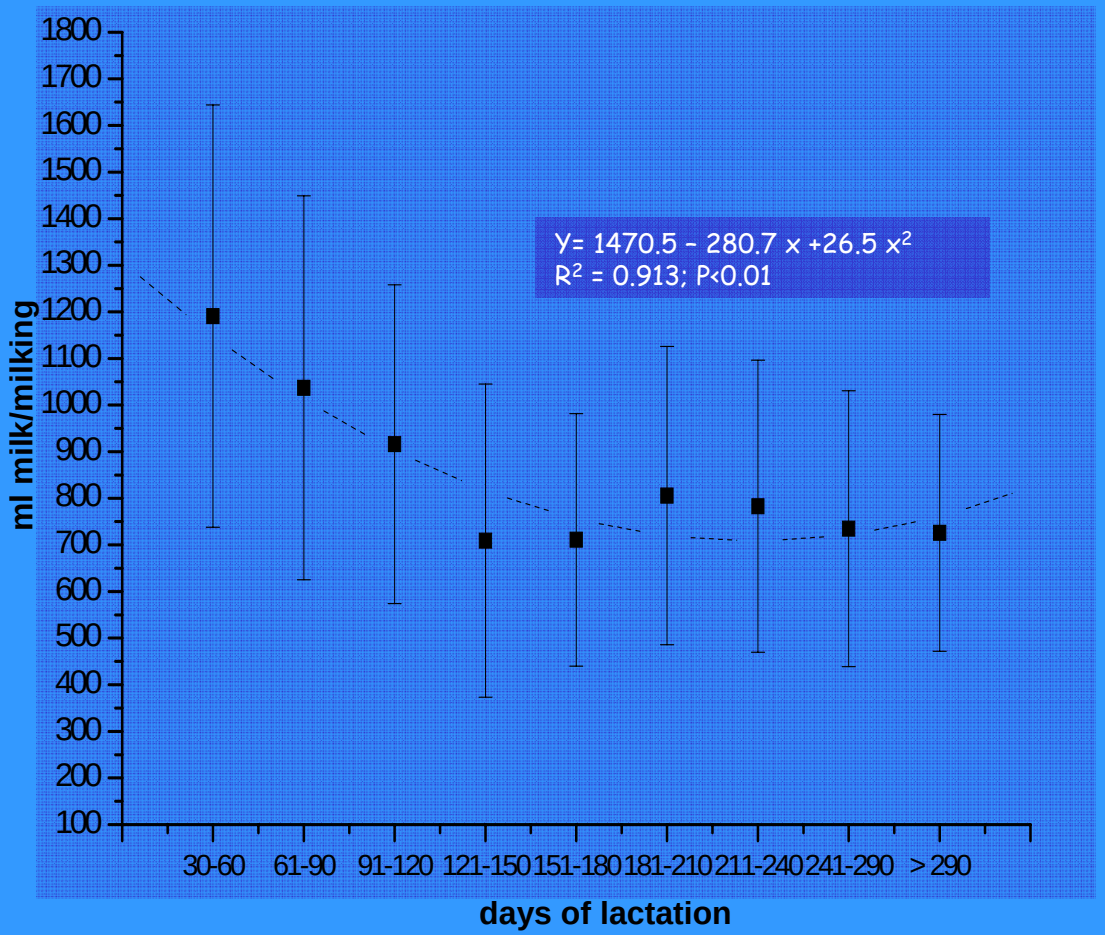


Salimei and Fantuz, 2010

Donkey's milk yield per milking

mean values ± sd

16 jennies MF deriv. , 240 d, 2 milkings/d



Salimei et al., 2005

Average total bacteria count (TBC)

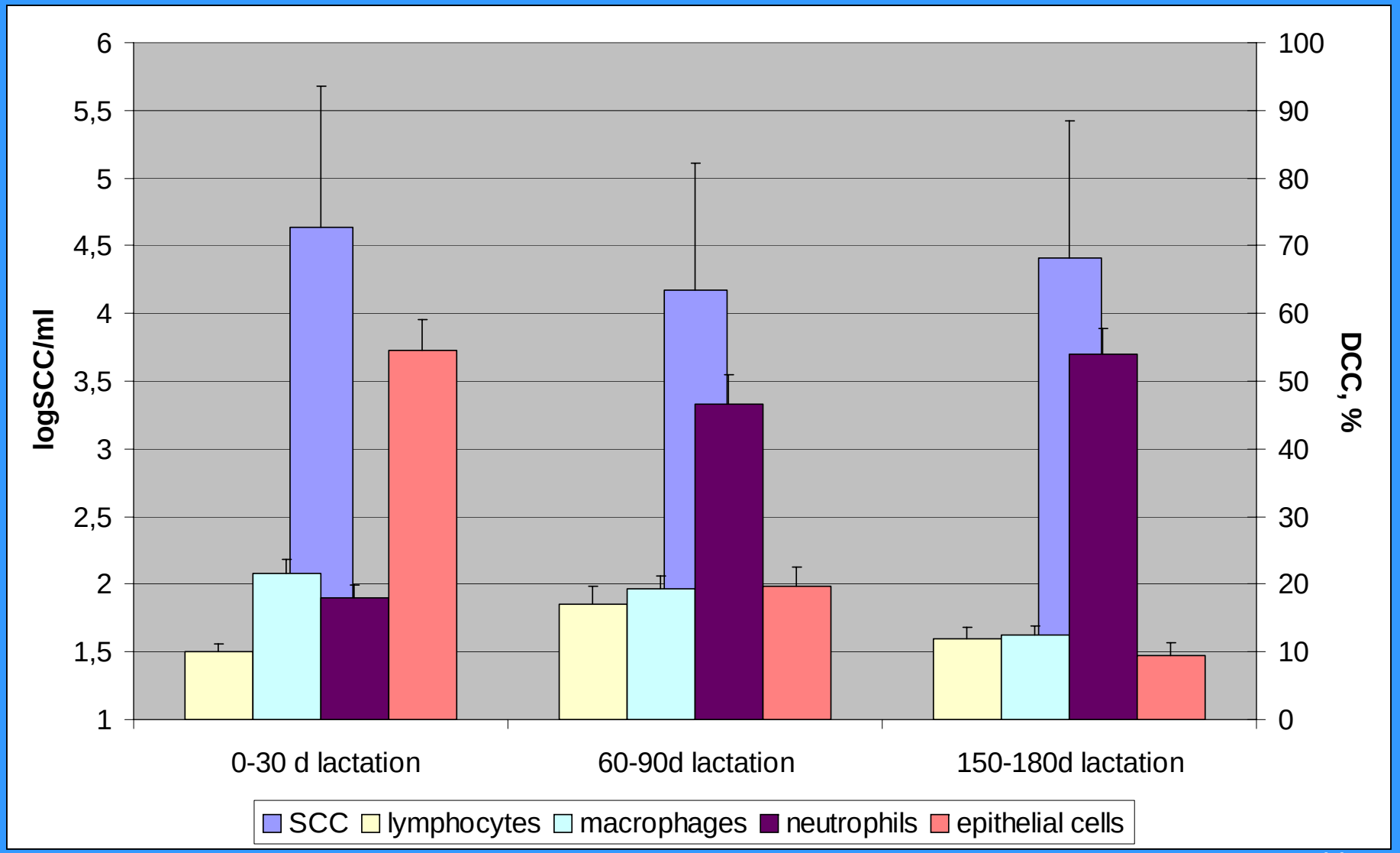
Author	year	milking technique	total bacteria count, logCFU/mL
Salimei et al.	2000	Mechanical	4.46
Coppola et al.	2002	Mechanical	4.60
Conte et al.	2003	Manual	3.66
Simoni et al.	2004	Mechanical	3.74
Salimei et al.	2004b	Mechanical	5.51
Conte et al.	2004	Manual	4.21
		Mechanical	**5.87**
Salimei et al.	2005	Mechanical	4.00
Sorrentino et al.	2005	Mechanical	3.95
Salimei et al.	2006	Mechanical	3.89
Alabiso et al.	2009	Manual	3.72
Ivankovic et al	2009	Manual	**3.58**

Effects of heat treatments on donkey's milk N (g/100 g)

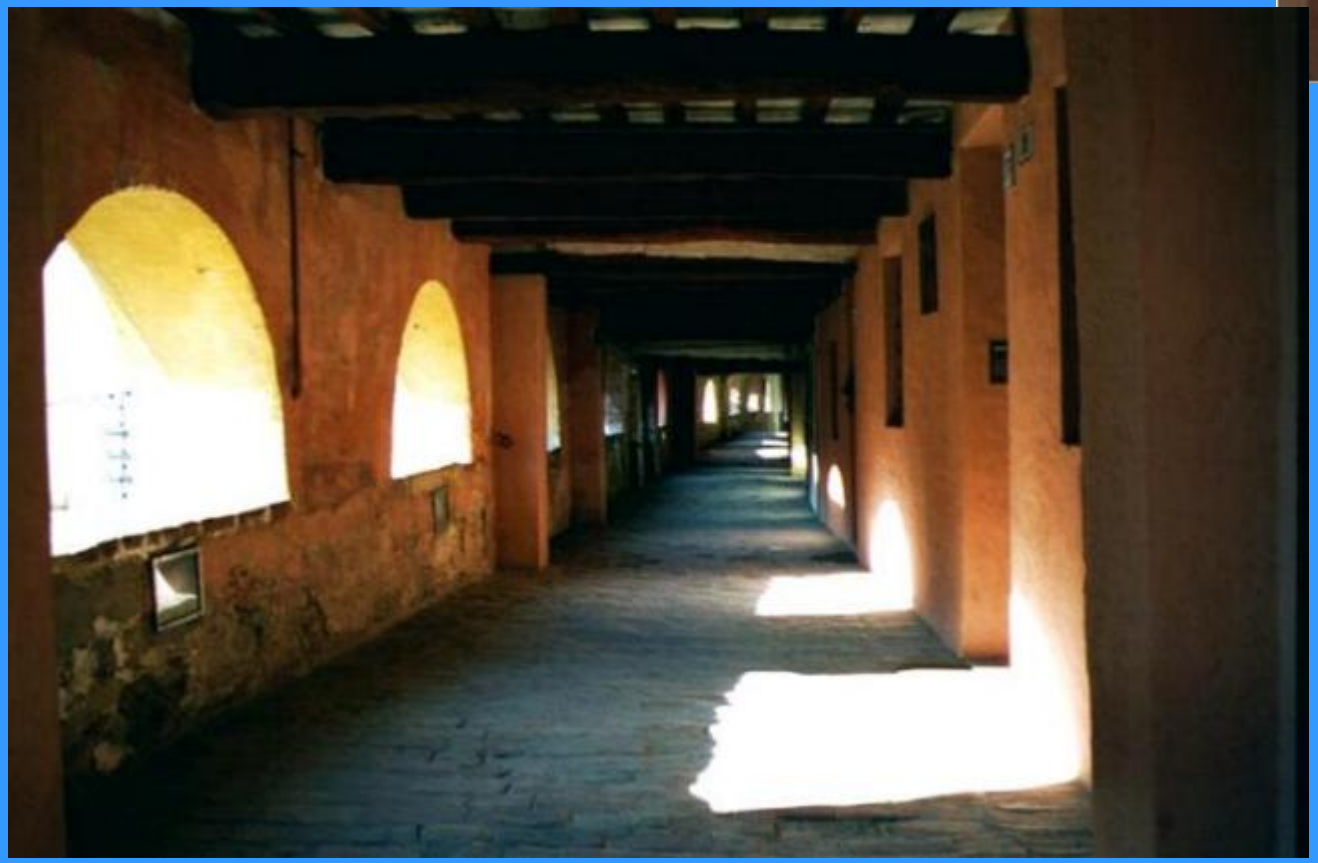
	Raw	66°C* 10 min	63°C*30 min	70°C*1 min	90°C*1min
N	0,21	0,22	0,22	0,22	0,22
NCN	0,13	0,13	0,12	0,12	0,06
Casein	0,08	0,09	0,09	0,10	0,16
NPN	0,03	0,03	0,03	0,03	0,03
Whey protein, WP	0,09	0,09	0,09	0,08	0,03
WP /N %	44,8	42,3	42,3	38,5	14,5

Sorrentino et al., 2005

Somatic cell count (SCC) and differential cell count (DCC) of donkey's milk (mean ± sem)

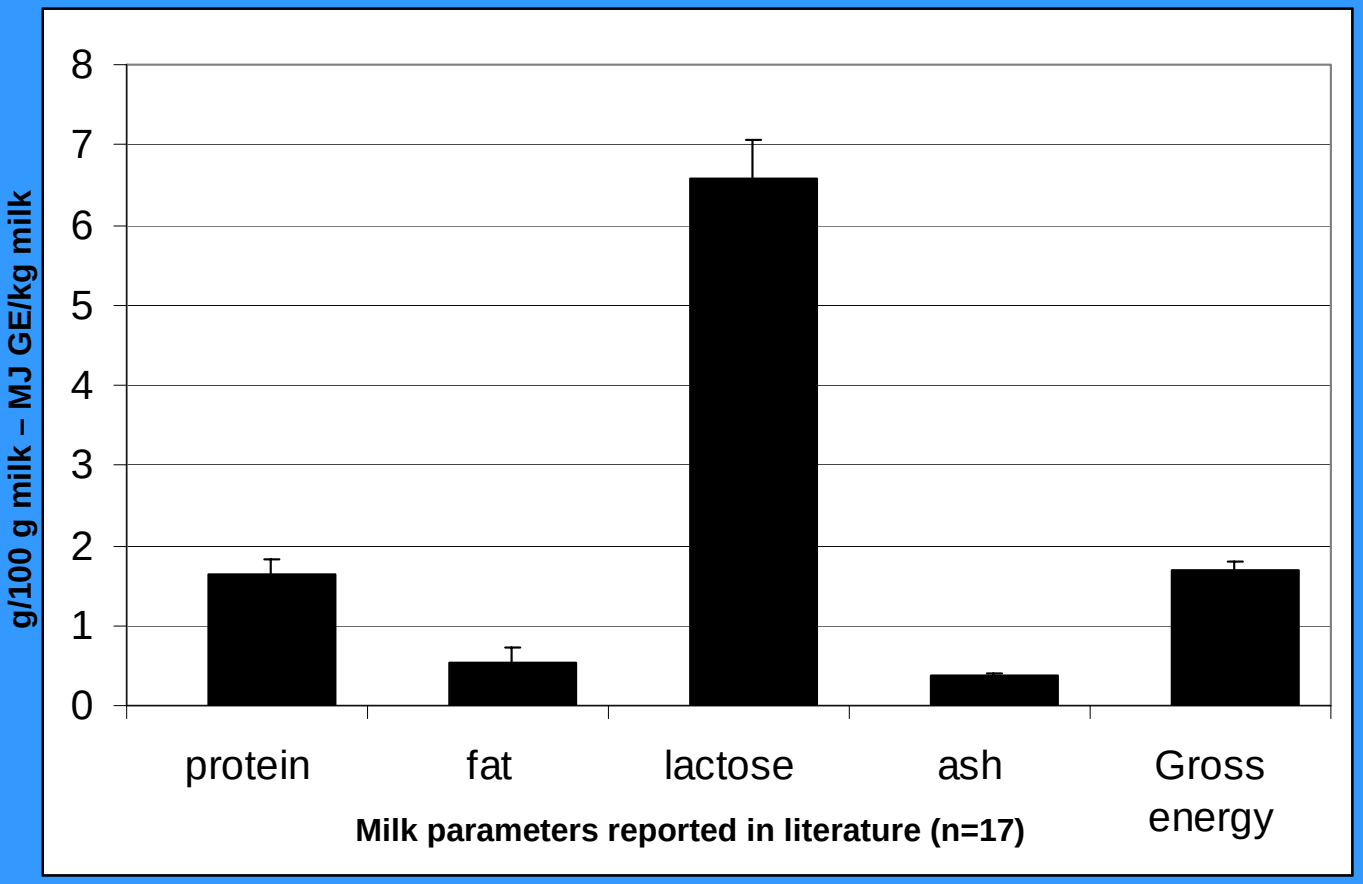


adapted from Beghelli et al., 2009



Brisighella (RA, Italy) – the ancient street of donkeys

Donkey's milk components and energy value *(mean ± s.d.)*



Salimei and Fantuz, 2010

Linear correlation coefficients among donkey's milk yield and chemical components

	Total solids	protein	fat	lactose	ash
Milk yield	**0.33****	0.13	**0.35****	0.17	0.09
Total solids		**0.50****	**0.40****	0.10	**0.35****
Protein			**0.53****	**-0.65****	**0.42****
Fat				**-0.61****	0.05
Lactose					-0.13

Fantuz et al., 2009

Ass's milk – the nitrogenous content

Ass's milk – Nitrogenous content

GUO ET AL.

Table 7. Amino acid compositions of donkey, mare,[1] and cow milk, and donkey, mare, cow, and human milk proteins

	Milk, g of AA/100 g			Protein, g of AA/100 g			
AA	Donkey	Mare	Cow	Donkey	Mare	Cow	Human
Asp	0.140	0.246	0.26	8.9	10.4	7.8	8.3
Ser	0.098	0.147	0.16	6.2	6.2	4.8	5.1
Glu	0.358	0.474	0.77	22.8	20.1	23.2	17.8
Gly	0.019	0.045	0.06	1.2	1.9	1.8	2.6
His	0.036	0.056	0.1	2.3	2.4	3.0	2.3
Arg	0.072	0.123	0.11	4.6	5.2	3.3	4.0
Thr	0.056	0.101	0.15	3.6	4.3	4.5	4.6
Ala	0.055	0.076	0.10	3.5	3.2	3.0	4.0
Pro	0.138	0.197	0.32	8.8	8.4	9.6	8.6
Cys	0.007	0.014	0.02	0.4	0.6	0.6	1.7
Tyr	0.058	0.101	0.15	3.7	4.3	4.5	4.7
Val	0.102	0.097	0.16	6.5	4.1	4.8	6.0
Met	0.028	0.035	0.06	1.8	1.5	1.8	1.8
Lys	0.115	0.189	0.27	7.3	8.0	8.1	6.2
Ile	0.087	0.09	0.14	5.5	3.8	4.2	5.8
Leu	0.135	0.229	0.29	8.6	9.7	8.7	10.1
Phe	0.068	0.111	0.16	4.3	4.7	4.8	4.4
Try	—	0.028	0.05	—	1.2	1.5	1.8
Essential AA	0.600	0.866	1.25	38.2	36.7	37.5	40.7
Total	1.572	2.359	3.33	100	100	100	99.8

[1]Csapó-Kiss et al. (1995).

H.Y. Guo *et al.*, 2007

Nitrogenous components in donkey's milk

Fraction	Mean values observed
N total, mg/100g	241,56 - 242,05
NPN, mg/100g	34,33 - 34,86
NCN, mg/100g	135,23 - 138,00
N casein, mg/100g	103,48 - 106,74
N wheyprotein, mg/100g	103,44 - 105,01
N casein : N wheyprotein	0.95 – 1.03
Casein index	42,44 - 43,81
NPN/TN	0,14
Urea, mg/100g	33,50 - 34,96
Urea, mmol/L	*5.56 – 5.80*

Human milk: ~0.53

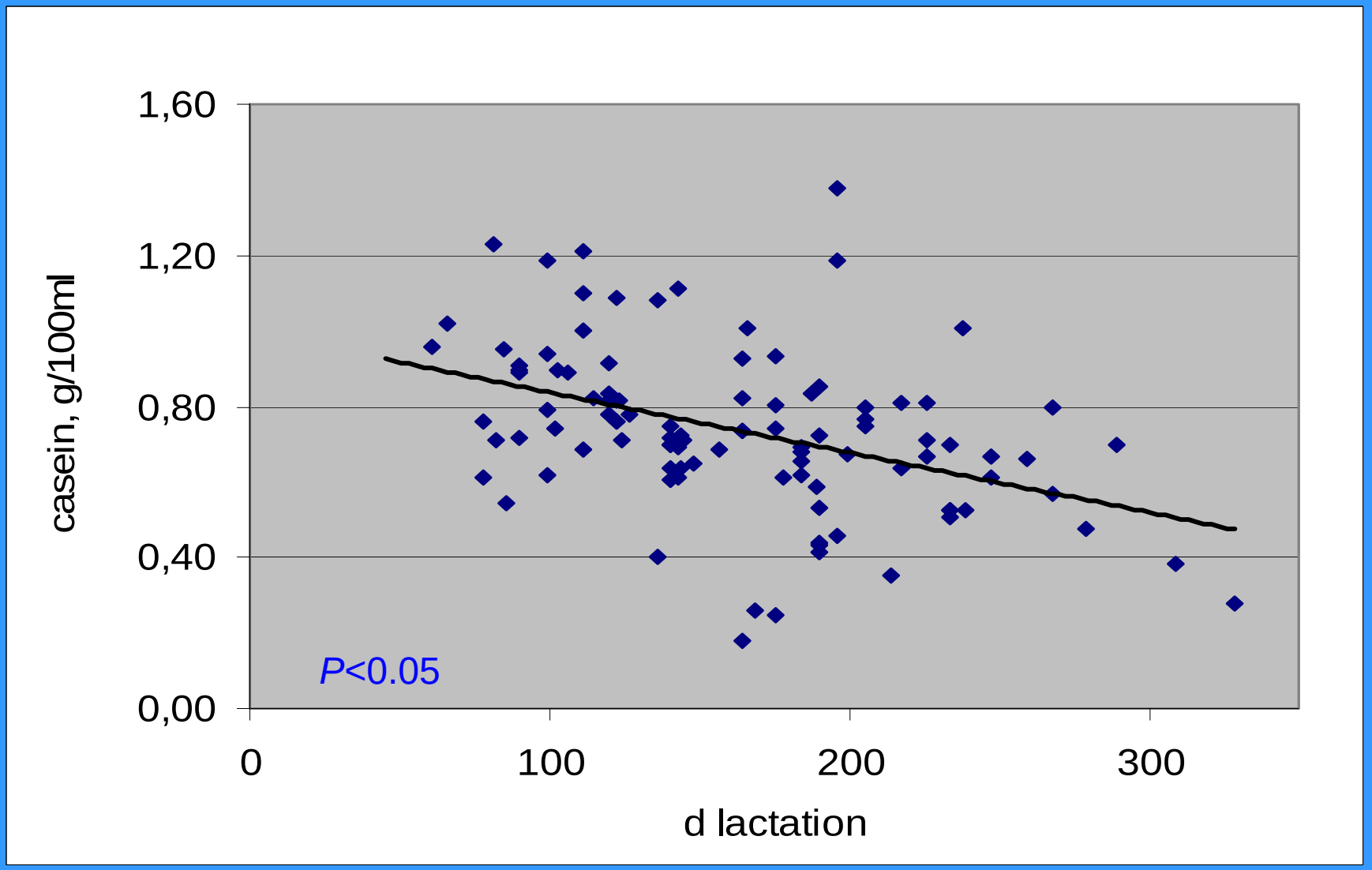
Human milk: 0.20

Legenda:

N casein= N tot. – NCN; N wheyprotein= (NCN – NPN); Casein index= (N casein tot.) x 100

Fantuz et al., 2006

Donkey's milk casein content during lactation



Fantuz et al., 2009

Casein fractions in donkey's milk

-casein	Vincenzetti et al, 2008	Criscione et al., 2009
α_{s1}	Y	Y (except 1 lacking)
α_{s2}	not found	not found
β	Y	Y
κ	not found	not found
γ	not found	

β-lactoglobulin polimorphism in donkey's milk

	Authors
β-lg I (var A and B)	Godovac-Zimmermann et al., 1988
β-lg I I (var A, B, C)	Godovac-Zimmermann et al., 1990 Herrouin et al., 2000
β-lg I I D	Cunsolo et al., 2007
β-lg I I – lacking	Criscione et al., 2009

Ass's milk – Nitrogenous content

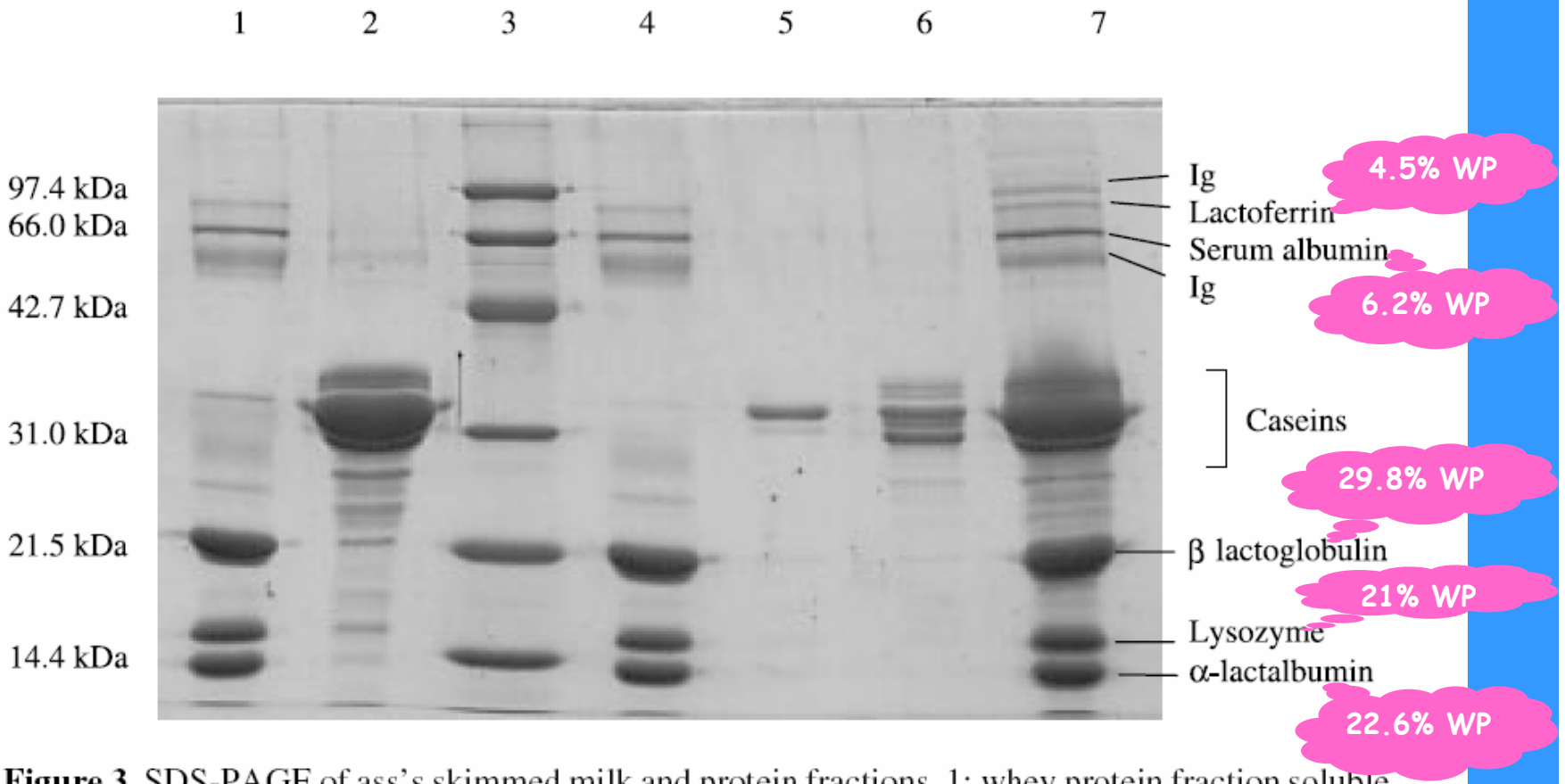


Figure 3. SDS-PAGE of ass's skimmed milk and protein fractions. 1: whey protein fraction soluble at pH 4.6 and 22 °C; 2: casein precipitated at pH 4.6 and 22 °C; 3: mol. weight markers; 4: resulting whey protein fraction after the first centrifuging at 4 °C and the second at 30 °C; 5: residual casein precipitated at 30 °C but soluble at 4 °C; 6: casein obtained by the first centrifuging at 4 °C; 7: skimmed milk (See Materials and Methods for details).

Fantuz et al., 2001

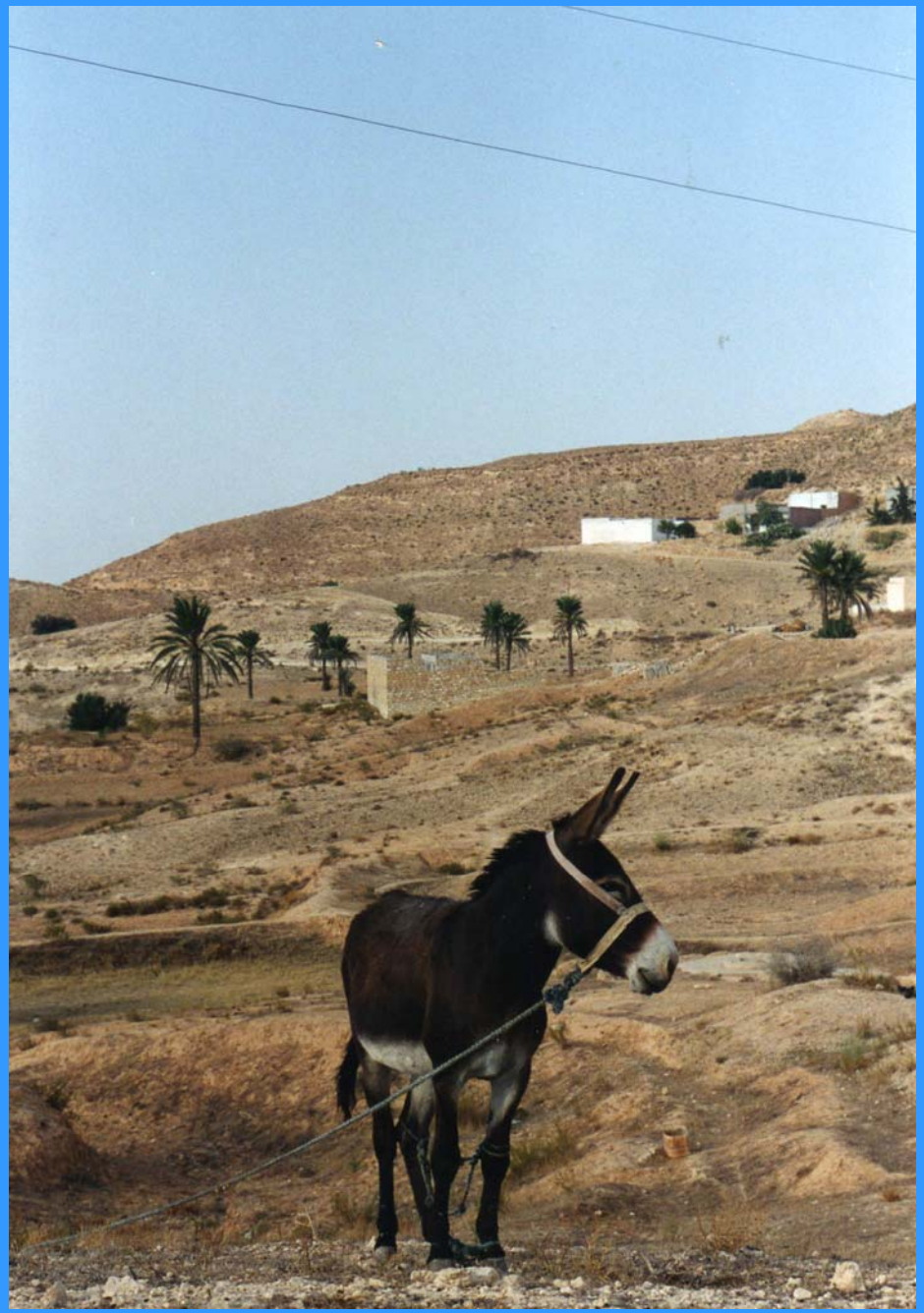
Lysozyme in milk from different species

	Lysozyme, mg $100ml^{-1}$
Human	10 – 12
Horse	79
Camel	0.5
Donkey	84 (150) - 375

Adapted from various Authors

The related antimicrobial activity is not effective on lactic bacteria, coliforms, Enterobacteria, yeast and molds.

Great attention to milking hygiene!



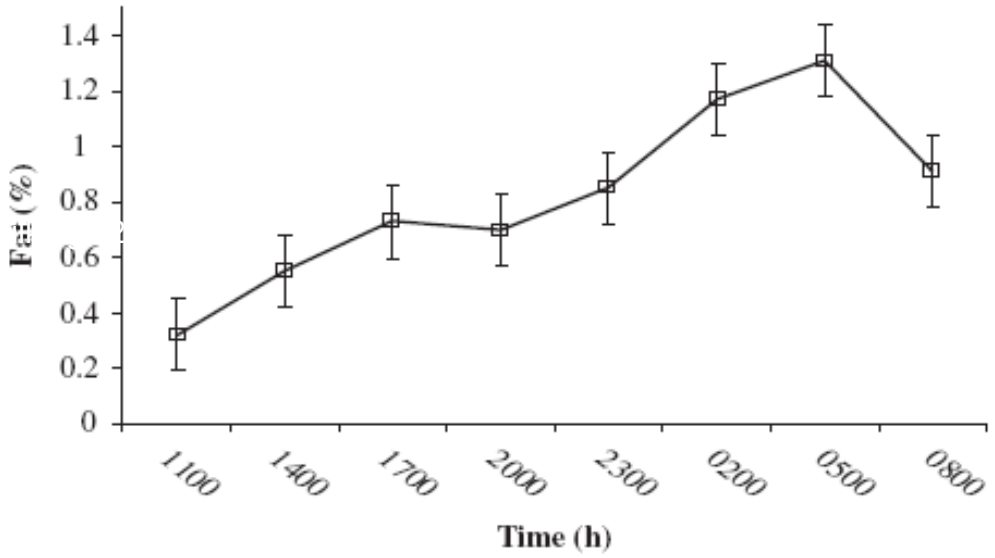
Human-like bioactive peptides determined in donkey's milk

Leptin, ng HE/ml milk Leptin, ngHE/ml milk	3.35 ± 0.11 4.78 ÷ 5.32	Salimei et al., 2005 Salimei et al., 2007
Ghrelin, pg/ml milk	4.26 ÷ 4.63	Magistrelli et al., 2008
IGF-1, ng/ml milk	9.81 ÷ 13.50	Magistrelli et al., 2008
T3, ng/ml milk	4.0 ± 0.2	Todini et al., 2010 *EAAP*

Ass's milk – the lipid content

Donkey's milk fat content .....and strategies of machine milking

Frequencies: 8 milkings/24 hr (*Alabiso et al., 2009)*



Interval between 2 consecutive milkings/24 hr (*Salimei et al., 2006)*

	20 hrs interval	4 hrs. interval	*sem*	*P*
Fat, g/100 ml milk	0.62	0.41	0.05	*< 0.05*

Quality indices of some products for human consumption

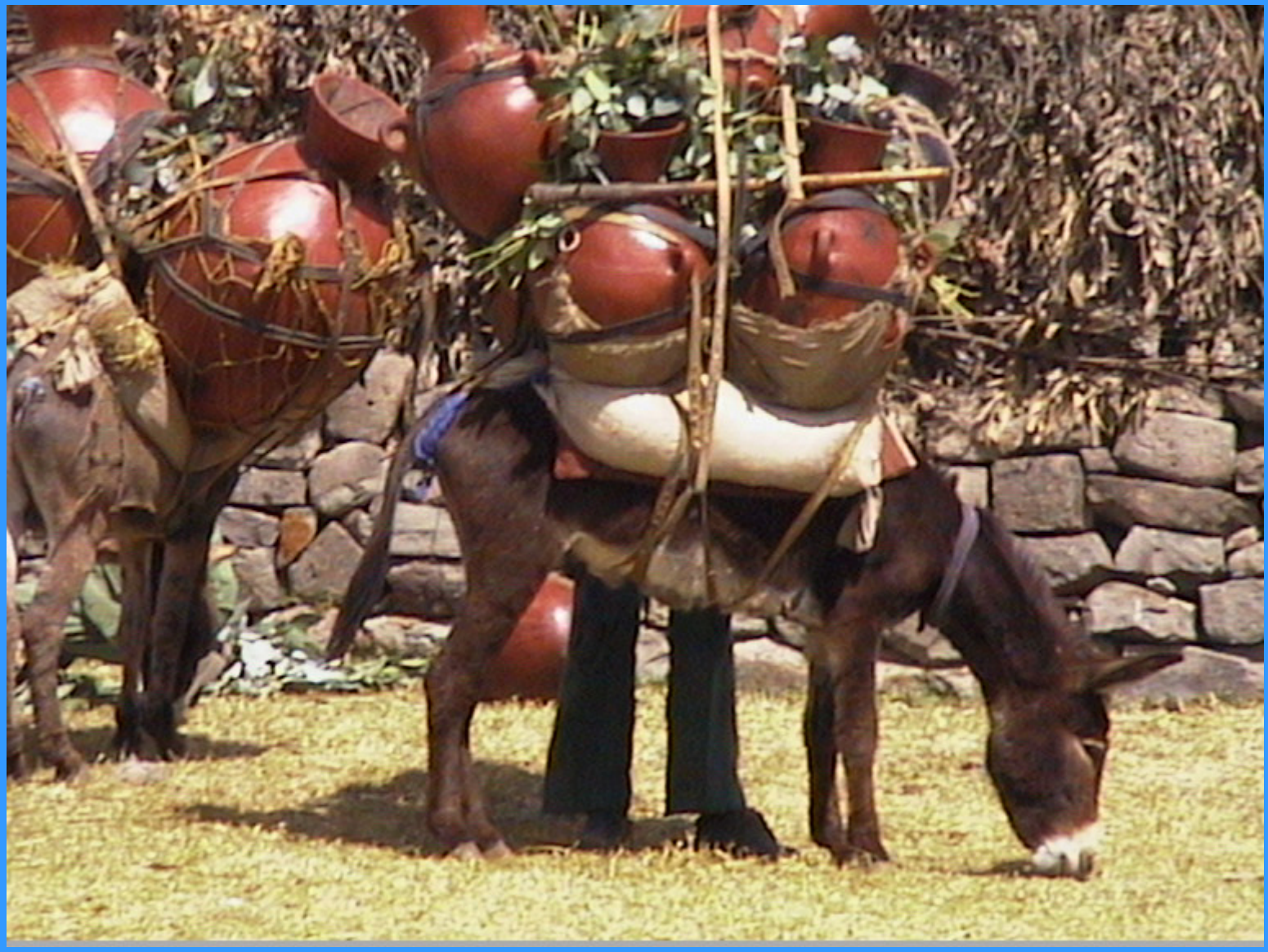
Feed	Atherogenic index*	Thrombogenic index*
Ass's milk**	0.80	0.32
Olive oil***	0.14	0.31
Butter***	2.07	2.42
Lard***	0.47	1.20
Pork***	0.83	0.68
White meat***	0.51	1.06
Trout fillet***	0.50	0.35

(Chiofalo et al., 2006 mod)

Trans retinol and α tocopherol in ass's milk *(µg/100g milk)*

	trans retinol	α tocopherol
Raw milk	1,67 ± 0,15	5,14 ± 0,35
63°C·30min	1,64 ± 0,01	4,73 ± 0,24
66°C·10min	1,39 ± 0,10	4,35 ± 0,00
70°C·1min	1,42 ± 0,08	4,67 ± 0,00
90°C·1min	1,41 ± 0,00	3,03 ± 0,02

Sorrentino et al., 2005



Donkey's milk – the mineral content

Mineral composition of ass's milk (mg/kg milk)

Mineral	mean	sd	Min.	Max.
Ca	676.7	62.8	360	1140
P	487.0	29.2	320	650
Ca/P	*1.48*	*0.12*	*0.93*	*2.37*
K	497.2	57.6	244	640
Na	218.3	26.2	100	268
Cloride	336.7	55.5	140	500
Mg	55.1	5.46	48.55	69.0
Fe	0.93	0.41	0.43	1.88
Cu	0.15	0.06	0.08	0.27
Mn	tr.	–	–	–

Salimei and Fantuz, 2010

CONCLUSIONS

1. DM represents a recent niche product in human nutrition
2. The organoleptic characteristics have certainly contributed to the success of ass's milk used as infant food
3. In addition to its tolerability by infants with CMPA, DM may help to upregulate the immune response of the aged consumers
4. The 'virtues' attributed to DM could be referable to its health-promoting properties, related to the presence of hypoallergenic proteins and functional and bioactive components
5. In this agro-medical chain, dairy jenny nutrition and management of animals and milk should be considered by specific traceability systems
6. Food scientists may exploit its natural attributes and help expand the dairy donkey enterprise, especially for those marginal and hilly areas that are increasingly abandoned with advantages for both environment and animal biodiversity.

Thank you

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