# Supplementary File – for Online Publication Only

# Supplementary material S1 – List of publications used in the meta-analysis

Abecia L, Toral PG, Martín-García AI, Martínez G, Tomkins NW, Molina-Alcaide E, Newbold CJ and Yanez-Ruiz DR 2012. Effect of bromochloromethane on methane emission, rumen fermentation pattern, milk yield, and fatty acid profile in lactating dairy goats. Journal of Dairy Science 95, 2027-2036.

Animut G, Puchala R, Goetsch AL, Patra AK, Sahlu T, Varel VH and Wells J 2008. Methane emission by goats consuming diets with different levels of condensed tannins from lespedeza. Animal Feed Science and Technology 144, 212-227.

Animut G, Puchala R, Goetsch AL, Patra AK, Sahlu T, Varel VH and Wells J 2008. Methane emission by goats consuming different sources of condensed tannins. Animal Feed Science and Technology 144, 228-241.

Bayaru E, Kanda S, Kamada T, Itabashi H, Andoh S, Nishida T, Ishida M, Itoh T, Nagara K and Isobe Y 2001. Effect of fumaric acid on methane production, rumen fermentation and digestibility of cattle fed roughage alone. Animal Science Journal 72, 139-146.

Beauchemin KA, McGinn SM, Benchaar C and Holtshausen L 2009. Crushed sunflower, flax, or canola seeds in lactating dairy cow diets: Effects on methane production, rumen fermentation, and milk production. Journal of Dairy Science 92, 2118-2127.

Bird SH, Hegarty RS and Woodgate R 2008. Persistence of defaunation effects on digestion and methane production in ewes. Australian Journal of Experimental Agriculture 48, 152-155.

Carulla JE, Kreuzer M, Machmuller A and Hess HD 2005. Supplementation of Acacia mearnsii tannins decreases methanogenesis and urinary nitrogen in forage-fed sheep. Australian Journal of Agricultural Research 56, 961-970.

Chung YH, He ML, McGinn SM, McAllister TA and Beauchemin KA 2011. Linseed suppresses enteric methane emissions from cattle fed barley silage, but not from those fed grass hay. Animal Feed Science and Technology 166-167, 321-329.

Chung YH, Walker ND, McGinn SM and Beauchemin KA 2011. Differing effects of two active dried yeast (Saccharomyces cerevisiae) strains on ruminal acidosis and methane production in non lactating dairy cows. Journal of Dairy Science 94, 2431-2439.

Chung YH, Zhou M, Holtshausen L, Alexander TW, McAllister TA, Guan LL, Oba M and Beauchemin KA 2012. A fibrolytic enzyme additive for lactating Holstein cow diets: Ruminal fermentation, rumen microbial populations, and enteric methane emissions. Journal of Dairy Science 95, 1419-1427.

Doreau M, van der Werf HMG, Micol D, Dubroeucq H, Agabriel J, Rochette Y and Martin C 2011. Enteric methane production and greenhouse gases balance of diets differing in concentrate in the fattening phase of a beef production system. Journal of Animal Science 89, 2518-2528.

Doreau M, Ferlay A, Rochette Y and Martin C 2014. Effects of dehydrated lucerne and soya bean meal on milk production and composition, nutrient digestion, and methane and nitrogen losses in dairy cows receiving two different forages. Animal 8, 420-430.

Grainger C, Williams R, Clarke T, Wright ADG and Eckard RJ 2010. Supplementation with whole cottonseed causes long-term reduction of methane emissions from lactating dairy cows offered a forage and cereal grain diet. Journal of Dairy Science 93, 2612-2619.

Hart KJ, Martin PG, Foley PA, Kenny DA and Boland TM 2009. Effect of sward dry matter digestibility on methane production, ruminal fermentation, and microbial populations of zero-grazed beef cattle. Journal of Animal Science 87, 3342-3350.

Hegarty RS, Bird SH, Vanselow BA and Woodgate R 2008. Effects of the absence of protozoa from birth or from weaning on the growth and methane production of lambs. British Journal of Nutrition 100, 1220-1227.

Hess HD, Beuret RA, Lötscher M, Hindrichsen IK, Machmüller A, Carulla JE, Lascano CE and Kreuzer M 2004. Ruminal fermentation, methanogenesis and nitrogen utilization of sheep receiving tropical grass hay-concentrate diets offered with Sapindus saponaria fruits and Cratylia argentea foliage. Animal Science 79, 177-189.

Holtshausen L, Chaves AV, Beauchemin KA, McGinn SM, McAllister TA, Odongo NE, Cheeke PR and Benchaar C 2009. Feeding saponin-containing Yucca schidigera and Quillaja saponaria to decrease enteric methane production in dairy cows. Journal of Dairy Science 92, 2809-2821.

Hristov AN, Lee C, Cassidy T, Long M, Heyler K, Corl B and Forster R 2011. Effects of lauric and myristic acids on ruminal fermentation, production, and milk fatty acid composition in lactating dairy cows. Journal of Dairy Science 94, 382-395.

Hristov AN, Vander Pol M, Agle M, Zaman S, Schneider C, Ndegwa P, Vaddella VK, Johnson K, Shingfield KJ and Karnati SKR 2009. Effect of lauric acid and coconut oil on ruminal fermentation, digestion, ammonia losses from manure, and milk fatty acid composition in lactating cows. Journal of Dairy Science 92, 5561-5582.

Hristov AN, Varga G, Cassidy T, Long M, Heyler K, Karnati SKR, Corl B, Hovde CJ and Yoon I 2010. Effect of Saccharomyces cerevisiae fermentation product on ruminal fermentation and nutrient utilization in dairy cows. Journal of Dairy Science 93, 682-692.

Jordan E, Kenny D, Hawkins M, Malone R, Lovett DK and O'Mara FP 2006. Effect of refined soy oil or whole soybeans on intake, methane output, and performance of young bulls. Journal of Animal Science 84, 2418-2425.

Jordan E, Lovett DK, Monahan FJ, Callan J, Flynn B and O'Mara FP 2006. Effect of refined coconut oil or copra meal on methane output and on intake and performance of beef heifers. Journal of Animal Science 84, 162-170.

Klevenhusen F, Zeitz JO, Duval S, Kreuzer M and Soliva CR 2011. Garlic oil and its principal component diallyl disulfide fail to mitigate methane, but improve digestibility in sheep. Animal Feed Science and Technology 166-167, 356-363.

Klita PT, Mathison GW, Fenton TW and Hardin RT 1996. Effects of alfalfa root saponins on digestive function in sheep. Journal of Animal Science 74, 1144-1156.

Lila ZA, Mohammed N, Kanda S, Kurihara M and Itabashi H 2005. Sarsaponin effects on ruminal fermentation and microbes, methane production, digestibility and blood metabolites in steers. Asian-Australasian Journal of Animal Sciences 18, 1746-1751.

Lila ZA, Mohammed N, Tatsuoka N, Kanda S, Kurokawa Y and Itabashi H 2004. Effect of cyclodextrin diallyl maleate on methane production, ruminal fermentation and microbes in vitro and in vivo. Animal Science Journal 75, 15-22.

Liu H, Vaddella V and Zhou D 2011. Effects of chestnut tannins and coconut oil on growth performance, methane emission, ruminal fermentation, and microbial populations in sheep. Journal of Dairy Science 94, 6069-6077.

Lovett D, Lovell S, Stack L, Callan J, Finlay M, Conolly J and O’Mara FP 2003. Effect of forage/concentrate ratio and dietary coconut oil level on methane output and performance of finishing beef heifers. Livestock Production Science 84, 135-146.

Machmüller A and Kreuzer M 1999. Methane suppression by coconut oil and associated effects on nutrient and energy balance in sheep. Canadian Journal of Animal Sciences 79, 65-72.

Machmüller A, Ossowski DA and Kreuzer M 2000. Comparative evaluation of the effects of coconut oil, oilseeds and crystalline fat on methane release, digestion and energy balance in lambs. Animal Feed Science and Technology 85, 41-60.

Machmüller A, Soliva CR and Kreuzer M 2003. Methane-suppressing effect of myristic acid in sheep as affected by dietary calcium and forage proportion. British Journal of Nutrition 90, 529-540.

Mao HL, Wang JK, Zhou YY and Liu JX 2010. Effects of addition of tea saponins and soybean oil on methane production, fermentation and microbial population in the rumen of growing lambs. Livestock science 129, 56-62.

Martin C, Ferlay A, Chilliard Y and Doreau M 2007. Rumen methanogenesis of dairy cows in response to increasing levels of dietary extruded linseeds. In Energy and protein metabolism and nutrition, EAAP publication (eds I Ortigues-Marty, N Miraux and W Brand-Williams), pp. 609-610. Wageningen Academic Publishers, Wageningen, The Netherlands.

Martin C, Pomiès D, Ferlay A, Rochette Y, Martin B, Chilliard Y, Morgavi DP and Doreau M 2011. Methane output and rumen microbiota in dairy cows in response to long-term supplementation with linseed or rapeseed of grass silage- or pasture-based diets. Proceedings of the New Zealand Society of Animal Production. 71, 243-247.

Mohammed N, Ajisaka N, Lila ZA, Hara. K, Mikuni K, Hara K, Kanda S and Itabashi H 2004. Effect of Japanese horseradish oil on methane production and ruminal fermentation in vitro and in steers. Journal of Animal Science 82, 1839-1846.

Mohammed N, Lila ZA, Tatsuoka N, Hara K, Mikuni K, Hara K, Kanda S and Itabashi H 2004. Effects of cyclodextrin-iodopropane complex on methane production, ruminal fermentation and microbes, digestibility and blood metabolites in steers. Animal Science Journal 75, 131-137.

Morgavi DP, Jouany JP and Martin C 2008. Changes in methane emission and rumen fermentation parameters induced by refaunation in sheep. Australian Journal of Experimental Agriculture 48, 69-72.

Morgavi DP, Martin C and Boudra H 2013. Fungal secondary metabolites from Monascus spp. reduce rumen methane production in vitro and in vivo. Journal of Animal Science 91, 848-860.

Morgavi DP, Martin C, Jouany JP and Ranilla MJ 2012. Rumen protozoa and methanogenesis: not a simple cause-effect relationship. British Journal of Nutrition 107, 388-397.

Mwenya B, Santoso B, Sar C, Pen B, Morikawa R, Takaura K, Umetsu K, Kimura K and Takahashi J 2005. Effects of Yeast Culture and Galacto-Oligosaccharides on Ruminal Fermentation in Holstein Cows. Journal of Dairy Science 88, 1404-1412.

Nolan JV, Hegarty RS, Hegarty J, Godwin IR and Woodgate R 2010. Effects of dietary nitrate on fermentation, methane production and digesta kinetics in sheep. Animal Production Science 50, 801-806.

Pen B, Takaura K, Yamaguchi S, Asa R and Takahashi J 2007. Effects of Yucca schidigera and Quillaja saponaria with or without β 1-4 galacto-oligosaccharides on ruminal fermentation, methane production and nitrogen utilization in sheep. Animal Feed Science and Technology 138, 75-88.

Popova M, Martin C, Eugène M, Mialon MM, Doreau M and Morgavi DP 2011. Effect of fibre- and starch-rich finishing diets on methanogenic Archaea diversity and activity in the rumen of feedlot bulls. Animal Feed Science and Technology 166, 113-121.

Popova M, Martin C and Morgavi DP 2013. Methanogens and Methanogenesis in the Rumens and Ceca of Lambs Fed Two Different High-Grain-Content Diets. Applied and Environmental Microbiology 79, 1777-1786.

Puchala R, Animut G, Patra AK, Detweiler GD, Wells JE, Varel VH, Sahlu T and Goetsch AL 2012. Methane emissions by goats consuming Sericea lespedeza at different feeding frequencies. Animal Feed Science and Technology 175, 76-84.

Schonhusen U, Zitnan R, Kuhla S, Jentsch W, Derno M and Voigt J 2003. Effects of protozoa on methane production in rumen and hindgut of calves around time of weaning. Archives of Animal Nutrition 57, 279-295.

Shinkai T, Enishi O, Mitsumori M, Higuchi K, Kobayashi Y, Takenaka A, Nagashima K, Mochizuki M and Kobayashi Y 2012. Mitigation of methane production from cattle by feeding cashew nut shell liquid. Journal of Animal Science 95, 5308-5316.

Sliwinski BJ, Kreuzer M, Wettstein HR and Machmüller A 2002. Rumen fermentation and nitrogen balance of lambs fed diets containing plant extracts rich in tannins and saponins, and associated emissions of nitrogen and methane. Archives of Animal Nutrition 56, 379-392.

Staerfl SM, Zeitz JO, Kreuzer M and Soliva CR 2012. Methane conversion rate of bulls fattened on grass or maize silage as compared with the IPCC default values, and the long-term methane mitigation efficiency of adding acacia tannin, garlic, maca and lupine. Agriculture, ecosystems and environment 148, 111-120.

Sun XZ, Hoskin SO, Zhang GG, Molano G, Muetzel S, Pinares-Patiño CS, Clark H and Pacheco D 2012. Sheep fed forage chicory (Cichorium intybus) or perennial ryegrass (Lolium perenne) have similar methane emissions. Animal Feed Science and Technology 172, 217-225.

Tekippe JA, Hristov AN, Heyler KS, Cassidy TW, Zheljazkov VD, Ferreira JFS, Karnati SK and Varga GA 2011. Rumen fermentation and production effects of Origanum vulgare L. leaves in lactating dairy cows. Journal of Dairy Science 94, 5065-5079.

Tiemann TT, Lascano CE, Wettstein HR, Mayer AC, Kreuzer M and Hess HD 2008. Effect of the tropical tannin-rich shrub legumes Calliandra calothyrsus and Flemingia macrophylla on methane emission and nitrogen and energy balance in growing lambs. Animal 2, 790-799.

Van Zijderveld SM, Gerrits WJJ, Apajalahti JA, Newbold JR, Dijkstra J, Leng RA and Perdok HB 2010. Nitrate and sulfate: Effective alternative hydrogen sinks for mitigation of ruminal methane production in sheep. Journal of Dairy Science 93, 5856-5866.

Zhou YY, Mao HL, Jiang F, Wang JK, Liu JX and McSweeney CS 2011. Inhibition of rumen methanogenesis by tea saponins with reference to fermentation pattern and microbial communities in Hu sheep. Animal Feed Science and Technology 166-167, 93-100.