



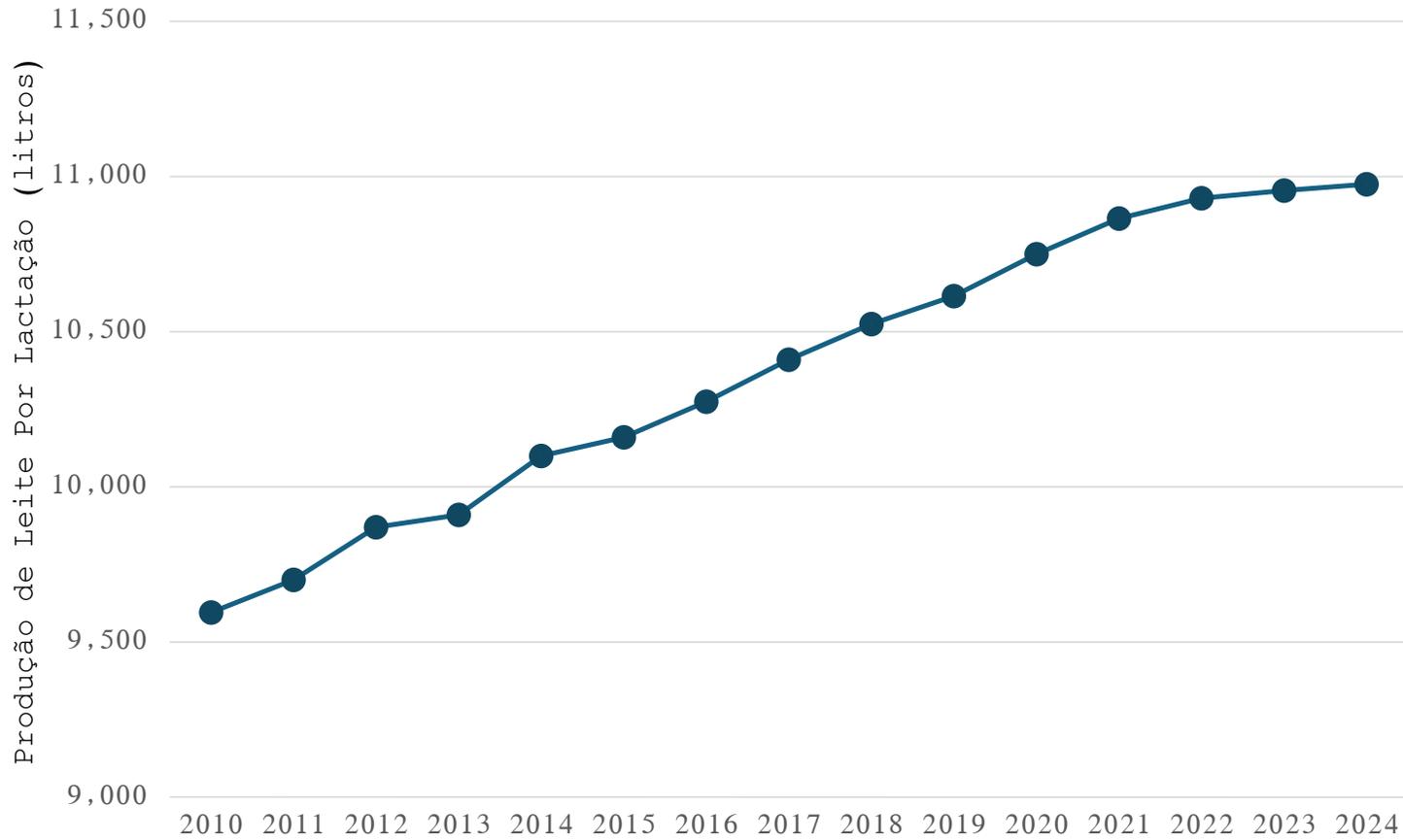
NUTRIENTES PROTEGIDOS PARA
RUMINANTES (VITAMINAS E GORDURAS)

PALESTRANTE: FREDERICO OSORIO VELASCO

Nutrientes protegidos para
ruminantes (Vitaminas e
Gordura)

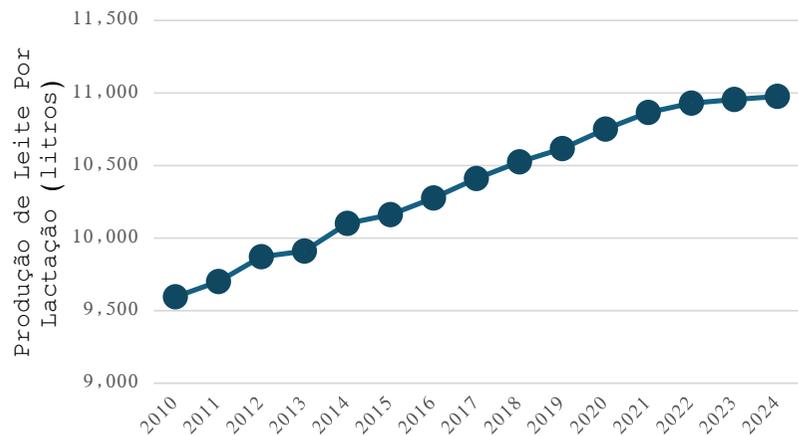


Evolução da Produção de Leite por Lactação em Vacas Americanas ao longo dos últimos 14 anos

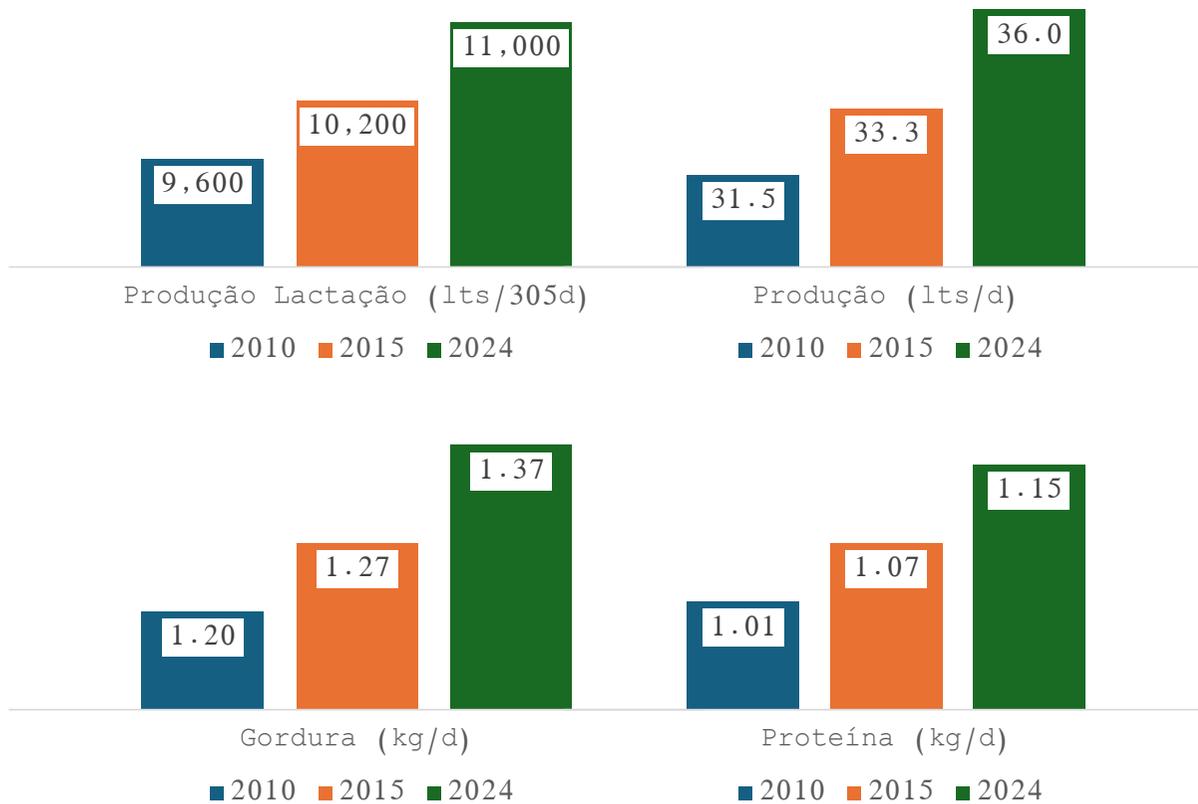


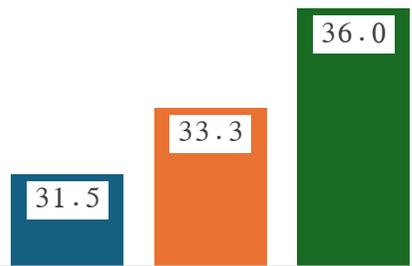
USDA (2025)

Evolução da Produção de Leite por Lactação em Vacas Americanas ao longo dos últimos 14 anos



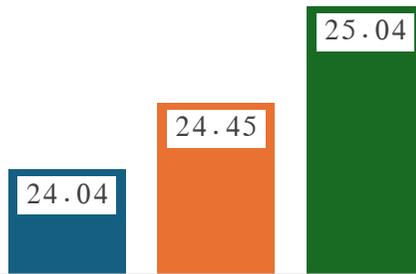
USDA (2025)





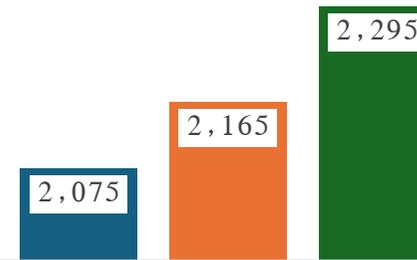
Produção (lts/d)

■ 2010 ■ 2015 ■ 2024



IMS (kg/d)

■ 2010 ■ 2015 ■ 2024



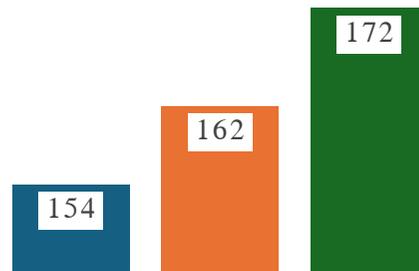
Pmet (kg/d)

■ 2010 ■ 2015 ■ 2024



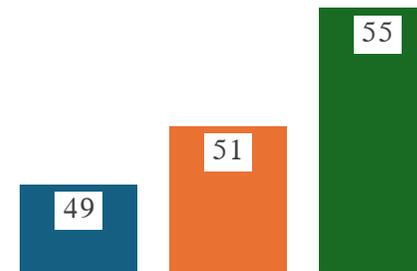
Gordura (kg/d)

■ 2010 ■ 2015 ■ 2024



Lis (g/d)

■ 2010 ■ 2015 ■ 2024



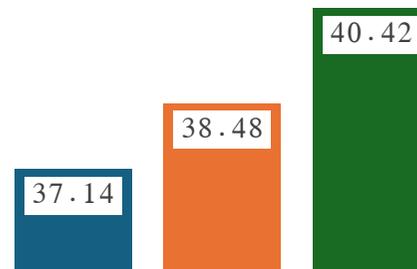
Met (g/d)

■ 2010 ■ 2015 ■ 2024



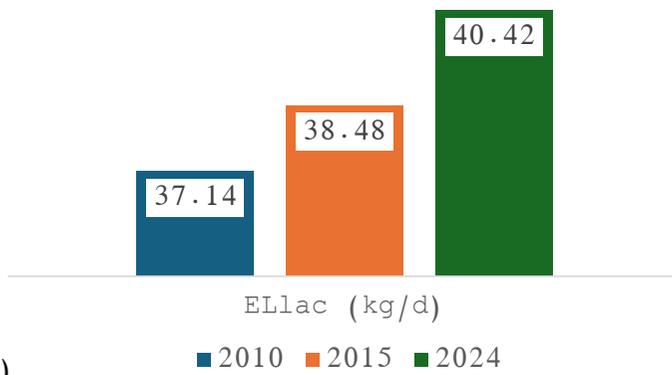
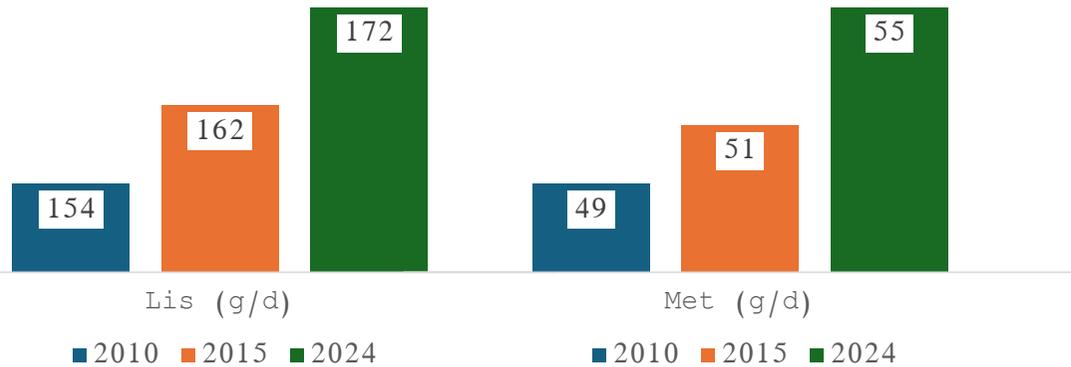
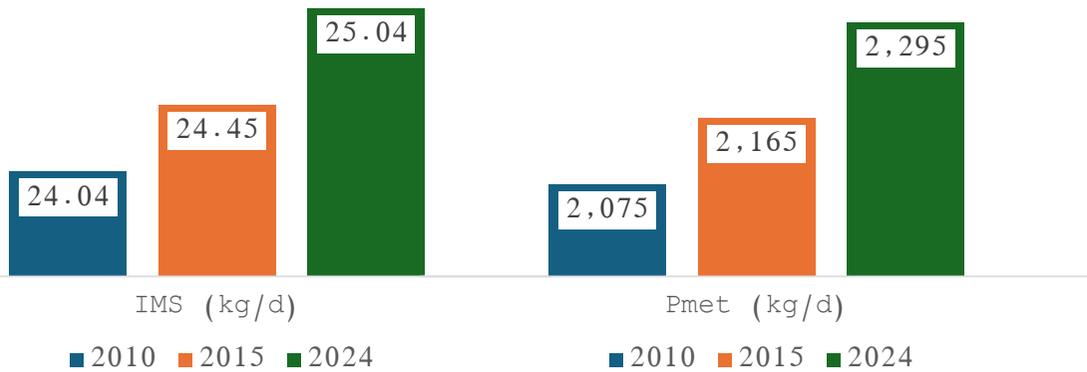
Proteína (kg/d)

■ 2010 ■ 2015 ■ 2024



ELLac (kg/d)

■ 2010 ■ 2015 ■ 2024



NASEM (2021)

	2010 x 2015	2015 x 2024	2010 x 2024
Produção (lts/dia)	5.89%	8.02%	14.38%
IMS (kg/dia)	1.71%	2.41%	4.16%
Pmet (g/dia)	4.34%	6.00%	10.60%
Lis (g/dia)	5.19%	6.17%	11.69%
Met (g/dia)	4.08%	7.84%	12.24%
ELlac (Mcal/d)	3.61%	5.04%	8.83%



A 100-Year Review: Identification and genetic selection of economically important traits in dairy cattle¹

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ABSTRACT

Over the past 100 yr, the range of traits considered for genetic selection in dairy cattle populations has progressed to meet the demands of both industry and society. At the turn of the 20th century, dairy farmers were interested in increasing milk production; however, a systematic strategy for selection was not available. Organized milk performance recording took shape, followed quickly by conformation scoring. Methodological advances in both genetic theory and statistics around the middle of the century, together with technological innovations in computing, paved the way for powerful multitrait analyses. As more sophisticated analytical techniques for traits were developed and incorporated into selection programs, production began to increase rapidly, and the wheels of genetic progress began to turn. By the end of the century, the focus of selection had moved away from being purely production oriented toward a more balanced breeding goal. This shift occurred partly due to increasing health and fertility issues and partly due to societal pressure and welfare concerns. Traits encompassing longevity, fertility, calving, health, and workability have now been integrated into selection indices. Current research focuses on fitness, health, welfare, milk quality, and environmental sustainability, underlying the concentrated emphasis on a more comprehensive breeding goal. In the future, on-farm sensors, data loggers, precision measurement techniques, and other technological aids will provide even more data for use in selection, and the difficulty will lie not in measuring phenotypes but rather in choosing which traits to select for.

Key words: selection goal, production trait, functional trait, novel trait

INTRODUCTION

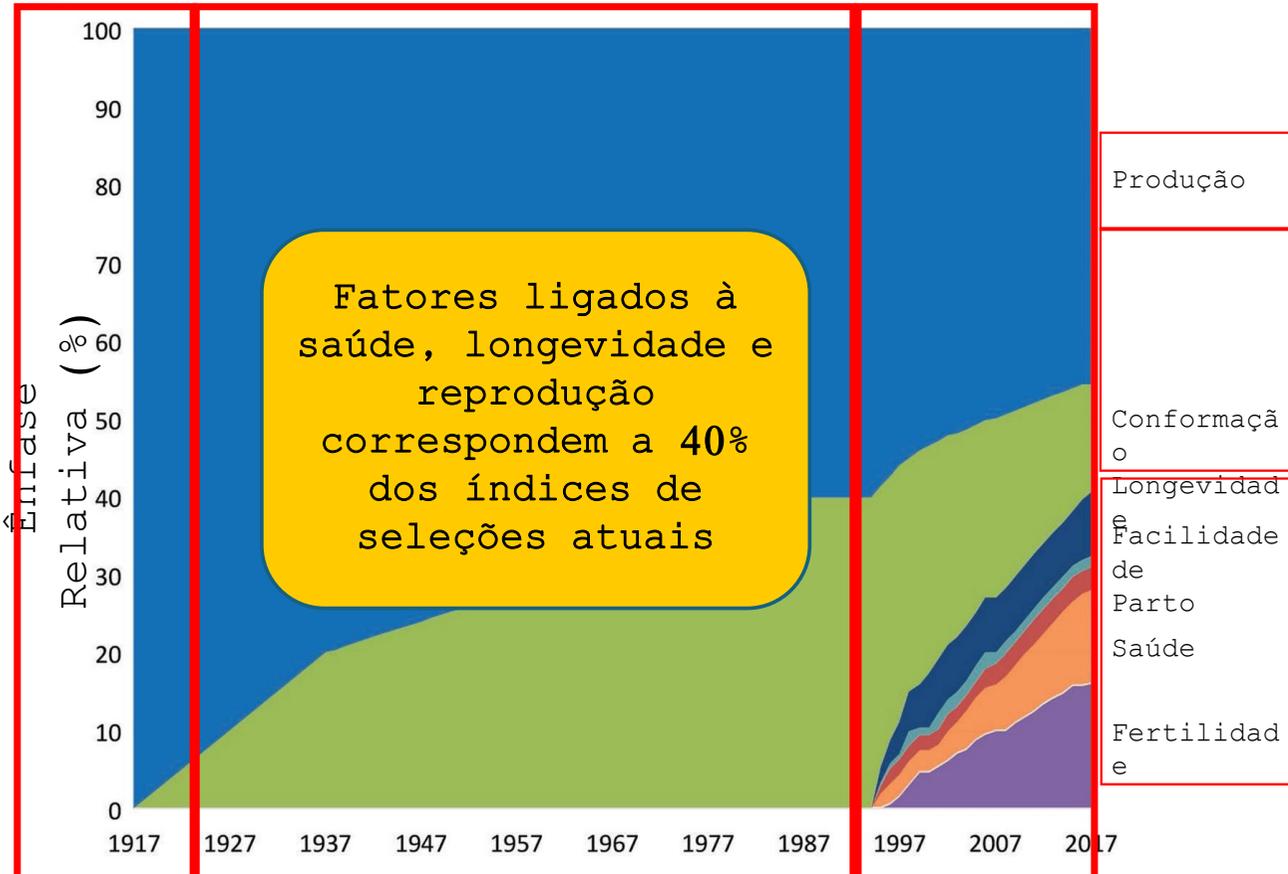
Genetic selection for important traits has helped transform and advance the dairy cattle industry. Specific traits considered for selection in dairy cattle populations have evolved with time as a response to changes to the needs of producers, consumers, and society with the aid of advances in technology and trait recording programs.

As outlined by Shook (1989), a potential trait must meet several criteria before it can be considered for selection in dairy cattle populations. First, either it should have an economic value as a marketable commodity or its improvement should reduce production costs. Second, the trait must have sufficiently large genetic variation and heritability. Third, the trait should be clearly defined, measurable at a low cost, and consistently recorded. Finally, an indicator trait may be favored if it has a high genetic correlation with the economically important trait, reduces recording costs, has a higher heritability, or can be measured earlier in life.

The economic value of traits has historically been the driver for genetic selection. From the 1930s to the 1970s, the focus of selection was solely on increasing milk production. Despite some early concern over selecting exclusively for yield, which was expected to cause a corollary decline in overall fitness, the industry strove to achieve maximum genetic change in the most financially lucrative area, which was production. The need to identify and select for additional traits emerged mainly from the recognition of the correlated genetic decline in other important traits. Many countries have shifted toward more balanced selection objectives by including more weight on previously undervalued nonyield traits (Miglior et al., 2005).

The second criterion concerns genetic variation and heritability of a trait, which are central to the rate of genetic progress possible within a selection program. Traits vary in the amount of phenotypic and genetic variation observed, and they may be more or less heritable. Traits may also be contingent on one another,

A



Received March 31, 2017.
 Accepted July 9, 2017.

¹This review is part of a special issue of the *Journal of Dairy Science* commissioned to celebrate 100 years of publishing (1917–2017).

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J. Dairy Sci. 104:4507–4515

<https://doi.org/10.3168/jds.2020-19399>

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Genetic parameters for stayability of Holsteins in US organic herds

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¹Department of Animal Science, Pennsylvania State University, University Park 16802

²Department of Animal Science, University of Minnesota, St. Paul 55108

‘She is the boss and just keeps going’ – meet 20-year-old dairy cow Lovely

News 23 Dec 2019 [Lauren Dean](#)

A dairy farmer is celebrating the 20th birthday of one of his milking cows on December 28.

Desafios

Animais Mais

Produtivos

Mais Exigentes

Mais Longevos

Mais Saudáveis

Sistemas Mais

Desafiadores



ÁCIDOS
GRAXOS



VITAMINAS



ÁCIDOS
GRAXOS



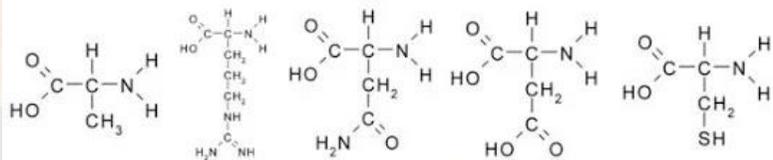
Por que suplementar com gordura os animais?

- Aumentar a Ingestão Calórica / Maior Densidade Energética
- Aumentar Eficiência de Formulação
- Aumentar a Produção de Leite e Seus Componentes
- Aumentar o Ganho de Peso / Reduzir Perda Corporal
- Combater Efeitos Negativos do Stress Térmico
- Melhoria de Índices Reprodutivos

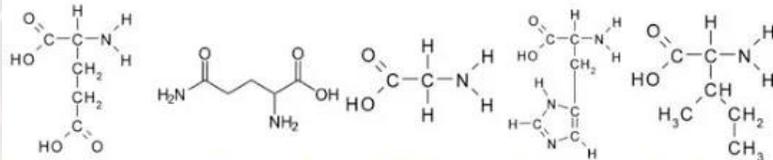


Mudança na visão da nutrição em relação aos AGs

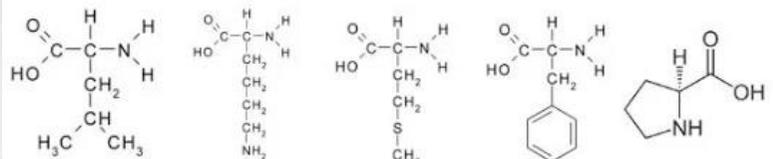
AMINOÁCIDOS



Alanina Arginina Asparagina Ácido aspártico Cisteína



Ácido glutâmico Glutamina Glicina Histidina Isoleucina



Leucina Lisina Metionina Fenilalanina Prolina



Serina Treonina Triptofano Tirosina Valina

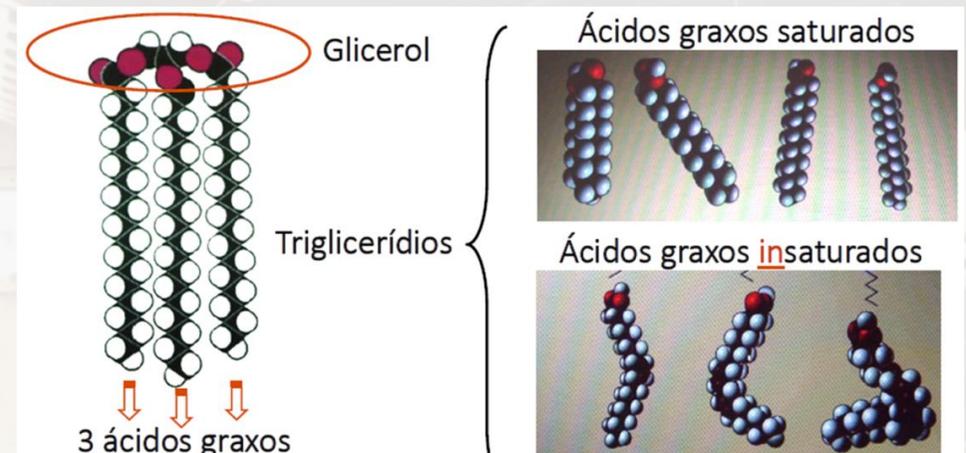
Ácidos Graxos

Nº C	Nome comum	Nome sistemático	Estrutura	Ponto de fusão °C
Saturados				
12	Láurico	Dodecanóico		44
14	Mirístico	Tetradecanóico		58
16	Palmitico	Hexadecanóico		63
18	Esteárico	Octadecanóico		69
20	Araquídico	Eicosanóico		77
Insaturados				
16	Palmitoléico	cis-9-Hexadecanóico		0
18	Oléico	cis-9-Octadecanóico		13
18	Linoléico	cis,cis,9,12-Octadecadienóico		-5
18	Linolênico	todo cis-9,12,15-Octadecatrienóico		-11
20	Araquidônico	todo cis-5,8,11,14-Eicosatetraenóico		-50
20	EPA	todo cis-5,8,11,14,17-Eicosapentaenóico		-50



Estrutura Química dos Ácidos Graxos

- São os principais componentes dos lípides, aos quais conferem suas propriedades gerais;
- Sua característica fundamental é possuir uma função ácida, de natureza carboxílica e hidrófila, e uma cadeia parafínica, hidrófoba;

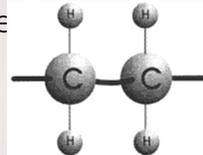


Cadeia parafínica (**hidrófoba**);
9,0 Mcal/kg, equivalente a cerca de 2,25 vezes a energia de carboidratos e proteínas.
Cadeia Carboxílica (**Hidrofílica**).



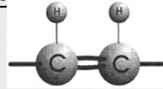
Constituição e diferenciações na estrutura química dos AG:

Ácidos Graxos Saturados: São aqueles que contêm uma única ligação entre

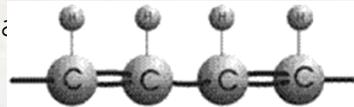


Ácidos graxos insaturados: São aqueles que contêm dupla ligação entre carbonos.

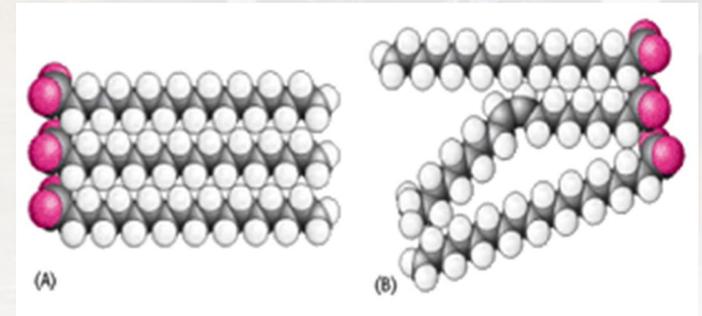
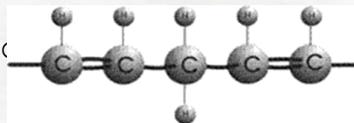
Quando um AG contiver uma dupla ligação é chamado monoinsaturado, já os que apresentam mais de uma dupla ligação são denominados de poliinsaturados.



Conjugada: Alternância de ligação simples;



Não Conjugada: Não possui uma ligação simples;



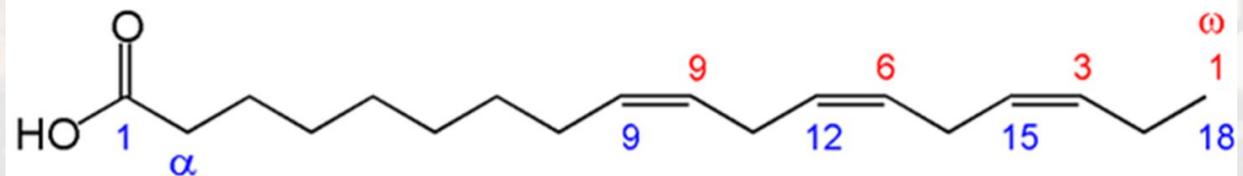


Lipídios - Nomenclatura

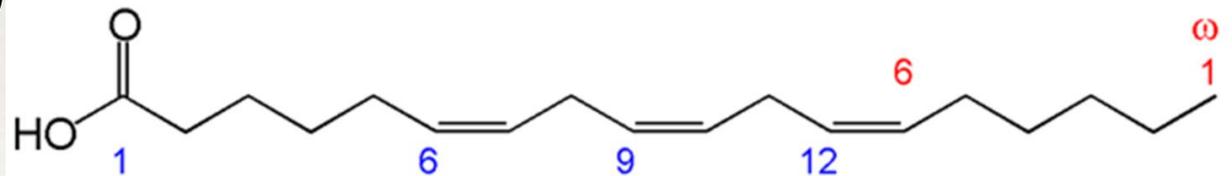
➤ Comum → 18:3

➤ Delta → 18:3 (Δ^9)

➤ Omega → Ω^3 Ω^6



Acido alfa linolenico (ALA; 18:3, ω -3)



Acido gamma linolenico (GLA; 18:3, ω -6)



Composição de Ácidos Graxos de Diferentes Alimentos Presentes na Dieta de Ruminantes

	Teor de cada Ácido Graxo (%TAG)							Total de Insaturados
	14:0 Mirístico	16:0 Palmítico	18:0 Estearico	18:1 Oléico	18:2 Linoléico	18:3 Linoênico	Outros	
Silagem de Milho	0.46	17.83	2.42	19.24	47.74	8.25	4.06	75.23
Tifton Feno	1.18	30.30	3.99	4.46	18.79	20.75	20.53	44.00
Alfafa Pre Secado	0.58	20.10	3.35	3.02	21.07	44.93	6.95	69.02
Milho Moído	2.33	13.21	1.99	24.09	55.70	1.62	1.06	81.41
Casca de Soja	1.47	16.22	7.03	16.60	42.66	13.11	2.91	72.37
Polpa Cítrica	0.56	26.85	4.93	23.30	34.92	6.42	3.02	64.64
Farelo de Soja	0.83	17.28	4.45	13.65	54.16	8.43	1.20	76.24
DDGs HP	0.14	14.05	2.39	24.58	56.11	1.68	1.05	82.37
Algodão Caroço	0.69	23.91	2.33	15.24	56.48	0.19	1.16	71.91
Oleo de Palma	3.00	24.42	17.92	45.61	1.09	0.53	7.43	47.23
Oleo de Soja	0.11	10.83	3.89	22.82	53.75	8.23	0.37	84.80



Diferença entre ácidos graxos

- Óleos vegetais: Insaturados
- Gorduras ruminantes: Saturados



Gorduras **insaturadas** são tóxicos para as bactérias ruminais:

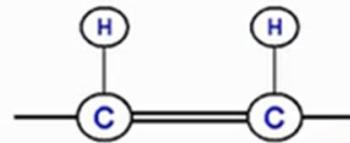
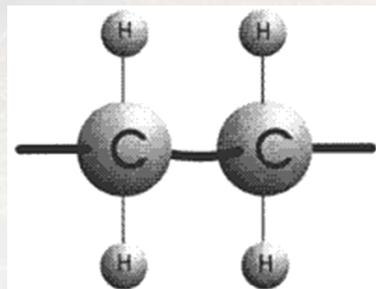
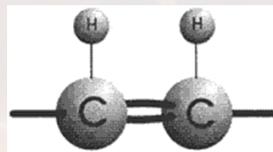
Participam de processos de **biohidrogenação**

Afetam a aderência bacteriana

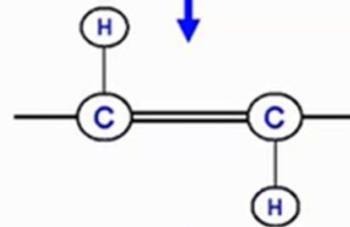
Penetra na parede celular e altera fluidez de membrana



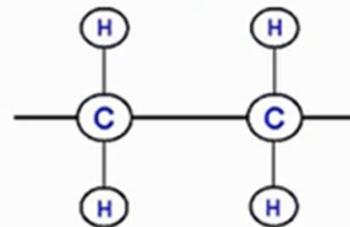
BIOHIDROGENAÇÃO



Bacterial isomerases



H⁺ + Bacterial hydrolyases





J. Dairy Sci. 103:7655–7681
<https://doi.org/10.3168/jds.2019-17662>

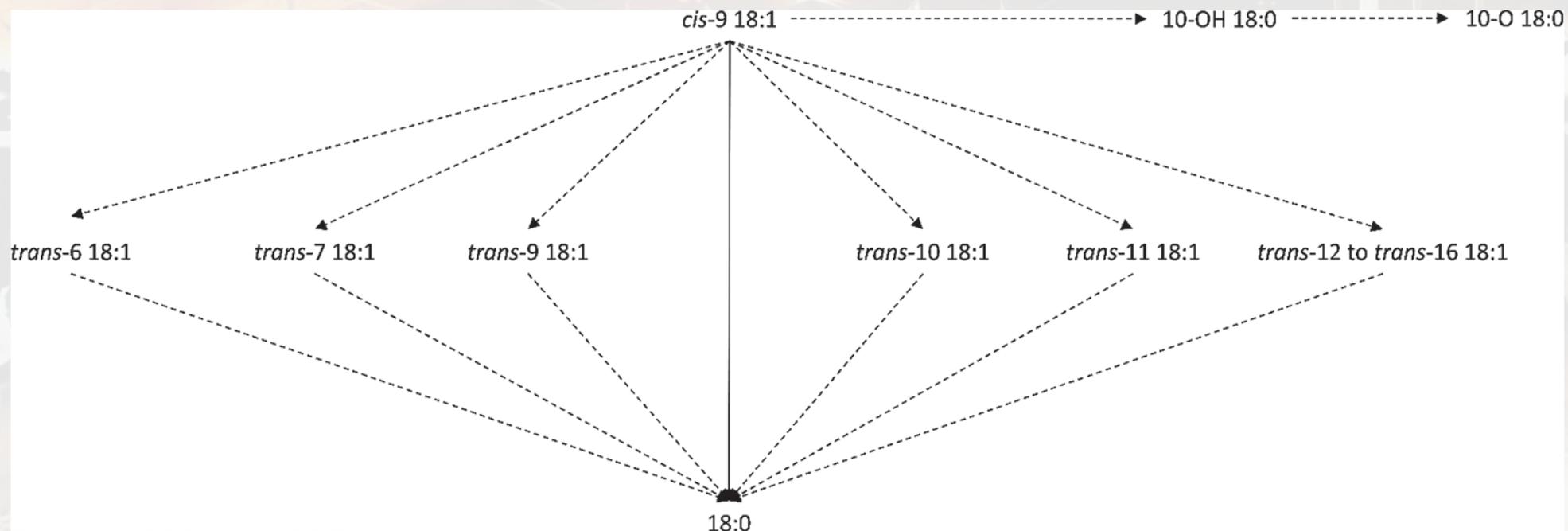
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Invited review: Role of rumen biohydrogenation intermediates and rumen microbes in diet-induced milk fat depression: An update

L. Dewanckele,¹ P. G. Toral,² B. Vlaeminck,^{1*} and V. Fievez^{1†}

¹Laboratory for Animal Nutrition and Animal Product Quality (Lanupro), Department of Animal Sciences and Aquatic Ecology, Ghent University, 9000 Gent, Belgium

²Instituto de Ganadería de Montaña (CSIC-University of León), Finca Marzanas s/n, 24346 Grulleros, León, Spain





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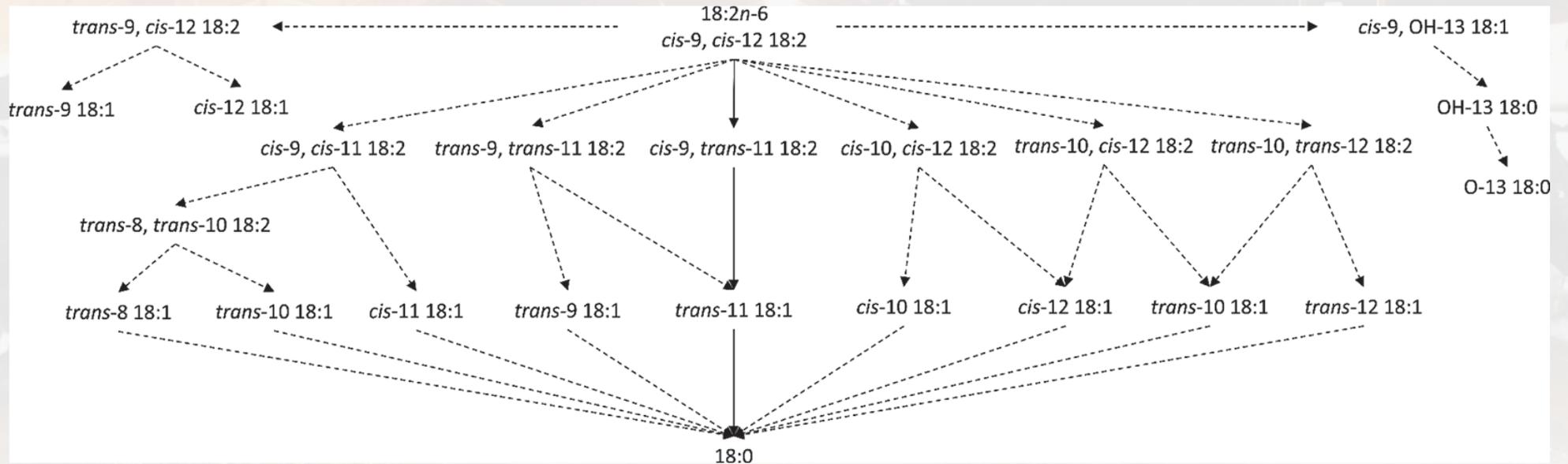
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Depressão da Síntese da Gordura do Leite (Milk Fat Depression – MFD)

Intermediário	Origem metabólica	Efeito sobre genes lipogênicos	Evidência científica	Referência
trans-10,cis-12 CLA	Isomerização alternativa do C18:2 no rúmen	Inibe FASN, ACACA, SREBP1 , reduz lipogênese mamária	Forte (infusão abomasal mostra efeito direto inibidor)	Baumgard et al. (2000); Harvatine et al. (2009)
trans-10 C18:1	Desvio da via de biohidrogenação do trans-11	Supressão parcial de FASN, SCD1 (in vitro)	Alta correlação com MFD, efeito direto ainda em debate	Shingfield et al. (2009); Dewanckele et al. (2020)
trans-10,cis-15 C18:2	Produto de biohidrogenação alterada	Suspeita de inibição da lipogênese (sem validação funcional)	Emergente: observado em vacas com MFD induzida, sem ensaios com infusão direta	Ventto et al. (2017); Leskinen et al. (2019)
trans-10,trans-12 CLA	Derivado secundário em dietas com alta insaturação	Sem efeito significativo sobre lipogênese mamária	Fraca: infusão abomasal não reduziu gordura do leite	Perfield et al. (2006); Saebo et al. (2005)
trans-9,cis-11 CLA	Via alternativa do CLA no rúmen	Redução moderada de FASN e SREBF1 em modelos celulares	Moderada: evidência limitada a modelos in vitro	Peterson et al. (2002); Dewanckele et al. (2020)



Depressão da Síntese da Gordura do Leite (Milk Fat Depression – MFD)

Alguns Intermediários (Principalmente os que possuem posição Trans no carbono 10) estão relacionados a queda da síntese de gordura do leite.

Condições que favorecem a produção desses intermediários

- Alto teor de concentrados
- Baixo teor de forragens
- Forragens finamente picadas
- Excesso de ácidos graxos na dieta
- Adição de ionóforos

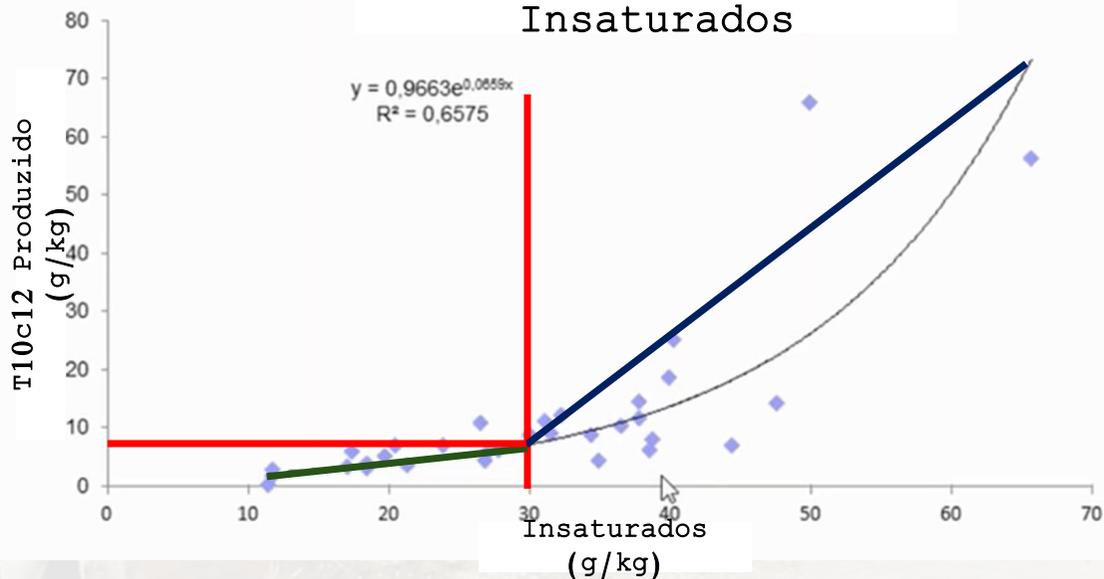
Shingfield et al., 2009; Dewanckele et al., 2020

Composição da Gordura do Leite		
Ác. Graxo	%	Nome
4:0	4	Butírico
6:0	3	Caprôico
8:0	2	Caprílico
10:0	3	Cáprico
12:0	4	Láurico
14:0	11	Mirístico
16:0	29	Palmitico
16:1	3	Palmitoeico
18:0	12	Esteárico
18:1	25	Oleico
18:2	3	Linoleico
18:3	1	Linolênico

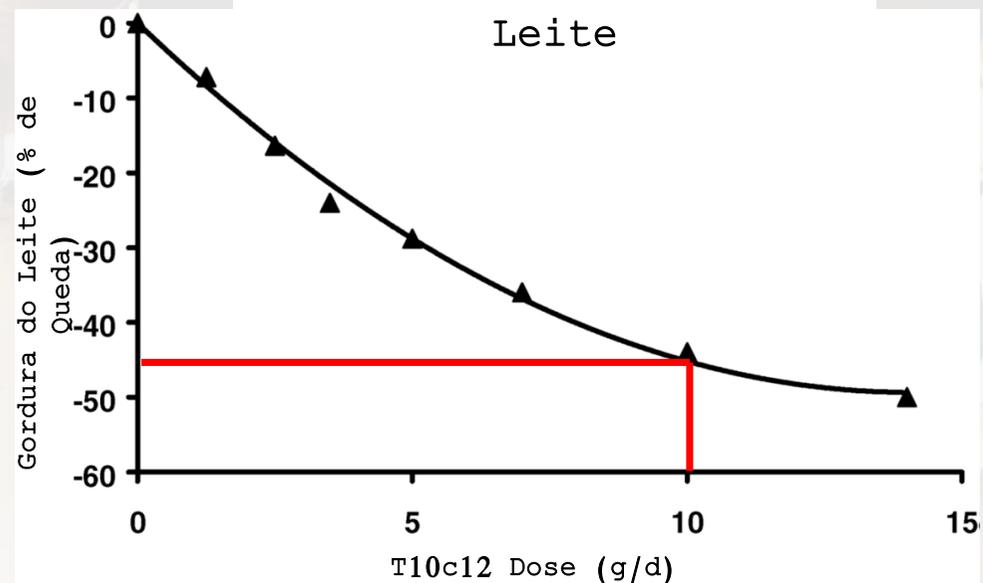


Depressão da Síntese da Gordura do Leite (Milk Fat Depression - MFD)

T10C12 CL x
Insaturados



T10C12 CL x % Gordura do
Leite





2.2 Diet Ingredients

Ingredient	As Fed kg/d	% As Fed	DM kg/d	% of DM
01 *Silagem Milho MS 37 AM 32	30.748663	65.820048	11.500000	45.275591
02 *Tifton Feno	1.070973	2.292507	1.000000	3.937008
03 *Milho Moido Fino	3.336900	7.142910	2.900000	11.417323
04 *Milho Silagem <u>Grao Umido MS 72</u>	2.559951	5.479787	1.850000	7.283465
05 *Casca Soja	0.995884	2.131771	0.900000	3.543307
06 *Soja Farelo 46P	3.920822	8.392842	3.500000	13.779528
07 *DDGS PB 40 FS ESSENTIAL	1.667649	3.569740	1.500000	5.905512
08 *Caroco Algodao	1.915415	4.100104	1.750000	6.889764
09 * <u>Núcleo Lactação</u>	0.500000	1.070291	0.500000	1.968504
Totals	46.716	100.00	25.400	100.00

Report 5. Fatty Acid Supply

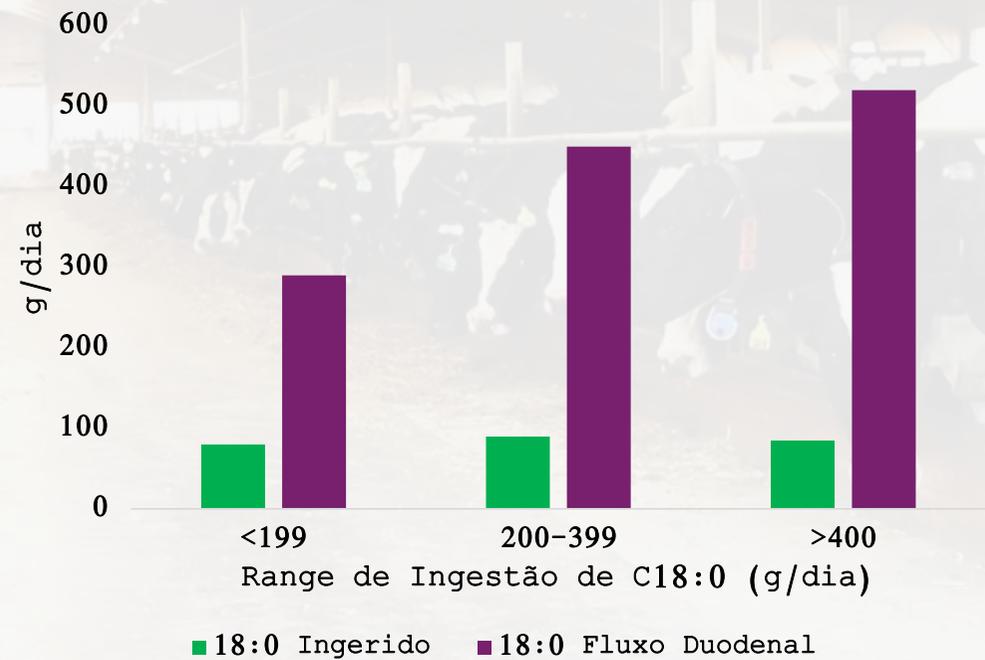
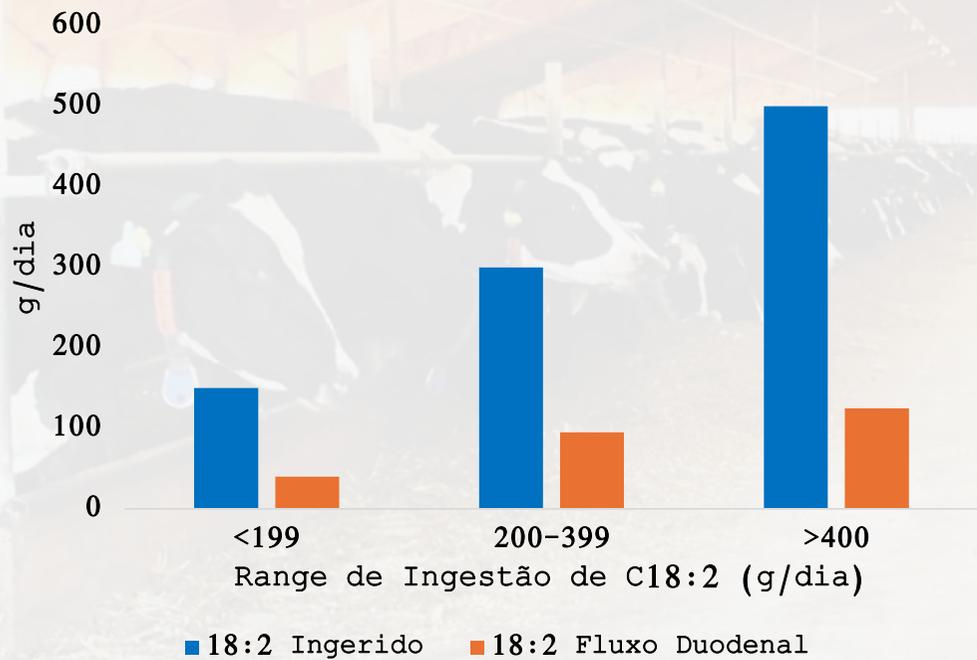
Fatty Acid	Profile % of Total FA	Concentration % of DM	Intake g/d
C12:0	0.14	0.01	1.4
C14:0	0.86	0.03	8.5
C16:0	18.51	0.72	181.8
C16:1	0.34	0.01	3.4
C18:0	2.47	0.10	24.3
C18:1 trans	0.04	0.00	0.4
C18:1 cis	19.14	0.74	188.0
C18:2	53.10	2.05	521.6
C18:3	3.66	0.14	36.0
Others	1.72	0.07	16.9
Saturated Fatty Acids	23.70	0.92	232.8
Mono-Unsaturated Fatty Acids	19.53	0.76	191.9
Poly-Unsaturated Fatty Acids	56.77	2.20	557.6
Fatty Acids	100.00	3.87	982.3

Peso: 700 kg
 DEL: 110
 Produção: 40
 Gordura: 3,8
 Proteína: 3,
 NASEM (2021)

Dieta:
 Total AG =
 3,87%
 Total AG_{ins} =
 2,95%



Diferenças entre perfil de Ac. Graxo Consumido e Fluxo duodenal



Rabiee et al
(2012)



Gorduras Protegidas





Gorduras Protegidas

1. Sabões de cálcio de ácidos graxos (Ca-soaps)

Composição: Mistura de ácidos graxos (geralmente de origem vegetal, como óleo de Palma ou Soja) reagidos com **hidróxido de cálcio**, formando sais cálcicos de ácidos graxos.

Produção: Reação de saponificação entre ácidos graxos livres e Ca(OH)_2 sob calor, gerando compostos insolúveis em pH neutro.

Vantagens:

- Econômicos e amplamente disponíveis.
- Fonte eficiente de energia, especialmente **C16:0**, **C18:1** e **C18:2**

Jenkins; Palmquist (1984); (NRC, 2001)





Gorduras Protegidas

2. Gordura encapsulada (spray cooling / spray chilling)

Composição: Alta concentração de ácido palmítico (C16:0) ou misturas com C18:0, encapsuladas em matriz lipídica sólida (ex.: gordura de palma hidrogenada).

Produção: Gotas de gordura são solidificadas por resfriamento instantâneo (spray cooling), formando microcápsulas lipídicas protegidas contra ação ruminal.

Vantagens:

- Proteção ruminal mais estável (não afeta microbiota).
- Liberação controlada no intestino delgado.
- Alta digestibilidade e estabilidade oxidativa.
- Pode ser formada de acordo com o perfil de ácido graxo desejado (Gorduras Fracionadas: Ex - Ricas em C16:0)

Desvantagens:





Gorduras Protegidas

3. Gorduras inertes hidrogenadas (hard fats)

Composição: Mistura sólida de ácidos graxos saturados, principalmente **C18:0**, com quantidades variáveis de **C16:0**.

Produção: Processos de hidrogenação e fracionamento de gorduras animais ou vegetais, resultando em gordura com alto ponto de fusão ($>50^{\circ}\text{C}$), naturalmente insolúvel no rúmen.

Vantagens:

- Alta estabilidade térmica e oxidativa.
- Menor interferência na fermentação ruminal.

Desvantagens:

- Menor efeito sobre teor de gordura do leite em comparação ao **C16:0**.
- Digestibilidade intestinal inferior ao **C16:0**



Piantoni e Lock (2015); NRC, 2001



Efeito do pH sobre a proteção dos sais de cálcio

NUTRITION, FEEDING, AND CALVES

Dissociation of Calcium Soaps of Long-Chain Fatty Acids in Rumen Fluid¹

PRITAM S. SUKHJIA and D. L. PALMQUIST²
 Department of Dairy Science
 Ohio Agricultural Research and Development Center
 The Ohio State University
 Wooster 44691

ABSTRACT

Dissociation of 5% solutions of calcium soaps of soya, tallow, stearic acid, and palm fatty acid distillate was studied by titration with 1 N HCl. Release of calcium ions was directly correlated with decrease in pH value. Estimated pKa values were 5.6, 4.6, 4.5, and 4.5 for calcium soaps of soya, palm fatty acid distillate, tallow, and stearic acid, respectively. Dissociation of 5% solutions in acetate buffer at pH values of 5.0, 5.5, 6.0, and 6.5 was measured in terms of release of soluble calcium. Dissociation was maximum at pH 5.0, minimum at pH 6.5, and dependent on unsaturation of fatty acids in the soaps. Soluble calcium in the acetate-buffered rumen fluid was higher than predicted from pKa of calcium soaps, due to formation of soluble calcium acetate; however, the relative patterns were similar to their pKa values. Unsaturated soaps are less satisfactory for maintaining normal rumen function, because dissociation is relatively higher. Calcium soaps of palm fatty acid distillate were satisfactorily stable to pH 5.5.
 (Key words: calcium soap, dissociation, rumen, fatty acids, saturated, unsaturated)

INTRODUCTION

Received September 25, 1989.
 Accepted January 11, 1990.

¹Salaries and research support provided by state and federal funds appropriated to the Ohio Agricultural Research and Development Center, The Ohio State University; by Grant Number 222135 from The Office of Research and Graduate Studies, The Ohio State University; and from Church and Dwight Co., Inc., Princeton, NJ, 08540. Manuscript Number 275-89.

²Reprints.

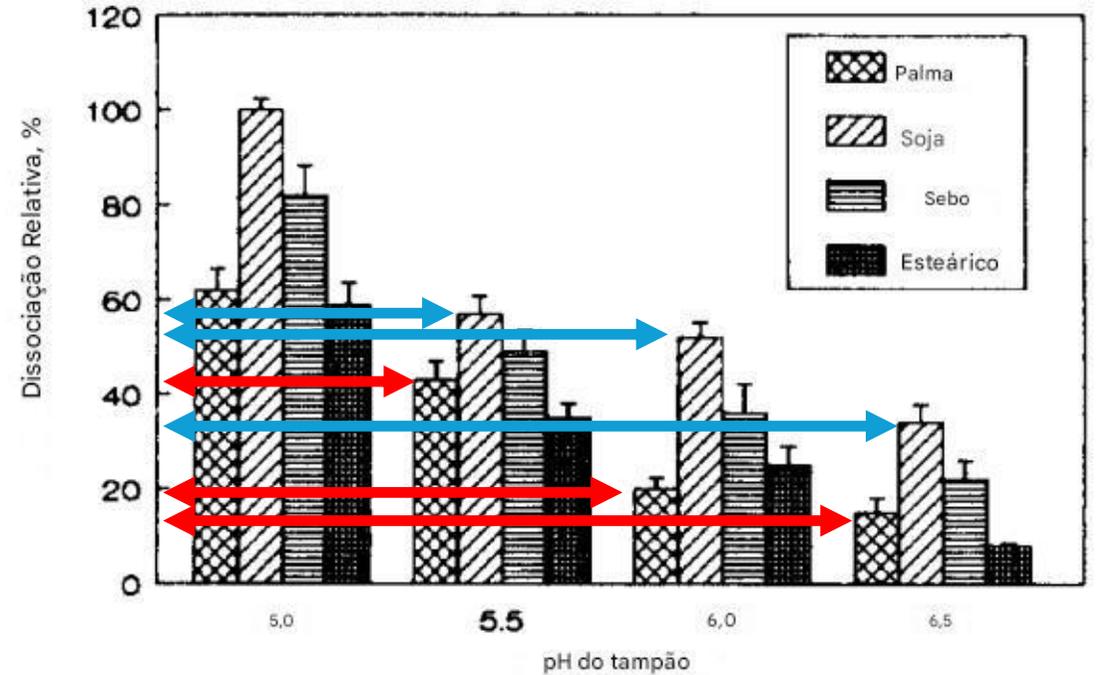
Fat supplementation has become more prevalent as a means to increase energy density of the diet of high producing dairy cows. Because free fats in the rumen have inhibitory effects on ruminal bacteria (4, 7), calcium soaps were developed that overcome this effect (2, 3). Palmquist (6) observed less satisfactory performance of some calcium soaps and postulated that the dissociation pattern of saturated and unsaturated soaps might be different. Detailed information on dissociation of different calcium soaps at different pH was lacking; therefore, this communication describes the dissociation pattern of calcium soaps of fatty acids from various fat sources - tallow, soya, palm fatty acid distillate (Megalac[®] Church and Dwight, Inc., Princeton, NJ) - and stearic acid in rumen fluid buffered at pH of 5.0, 5.5, 6.0, and 6.5. The studies included also the titration curves of these soaps with 1 N HCl to more completely describe the dissociation process.

MATERIALS AND METHODS

Calcium soaps were prepared in the laboratory using the double decomposition method (5). Tallow and soya fatty acids were a gift from Emery Chemicals, Cincinnati, OH, and stearic acid was from ICN Pharmaceuticals, Cleveland, OH. Calcium soap of palm fatty acid distillate (Megalac[®]) was prepared commercially. The solvents used for the extraction of fatty acids were either of analytical grade or were redistilled.

Titration of Soap Solutions

Titration curves for the dissociation of soaps were generated by measuring the pH change on titrating with 1 N HCl. In a 50-ml beaker, a 40-ml soap solution (5% soap in 50% ethanol) was mixed with a magnetic stirrer while the Ca ion specific electrode, the standard reference



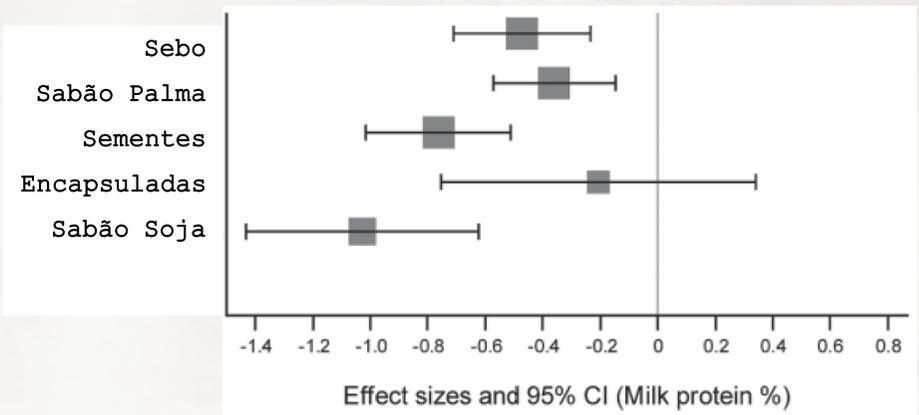
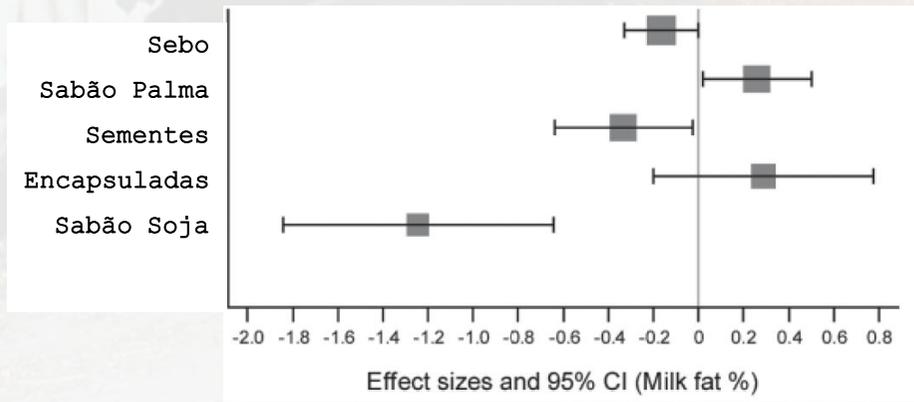
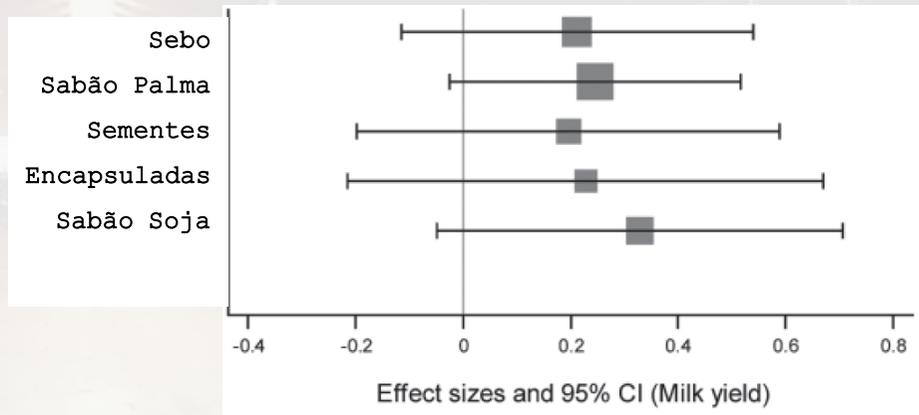
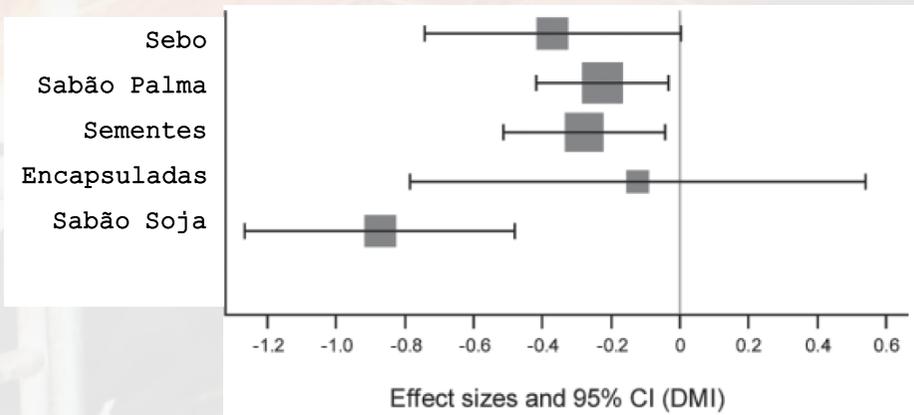
Dissociação relativa de sabões em fluido ruminal tamponado com acetato em diferentes pHs. Calculado a partir da concentração de cálcio solúvel determinada por espectrometria de absorção atômica. Cada barra é a média ± desvio padrão de três



J. Dairy Sci. 95:3225–3247
<http://dx.doi.org/10.3168/jds.2011-4895>
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Effect of fat additions to diets of dairy cattle on milk production and components: A meta-analysis and meta-regression

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 †Church and Dwight Co. Inc., 469 North Harrison Street, Princeton, NJ 08543





Efeito do Tipo de AG Digestibilidade da FDN e Produção de Ácidos



J. Dairy Sci. 107:902–916
<https://doi.org/10.3168/jds.2023-23568>

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Supply of palmitic, stearic, and oleic acid changes rumen fiber digestibility and microbial composition

Austin Sears,¹ Fernanda Hentz,² Jonas de Souza,³ Benjamin Wenner,⁴ Robert E. Ward,⁵ and Fernanda Batistel^{2*}

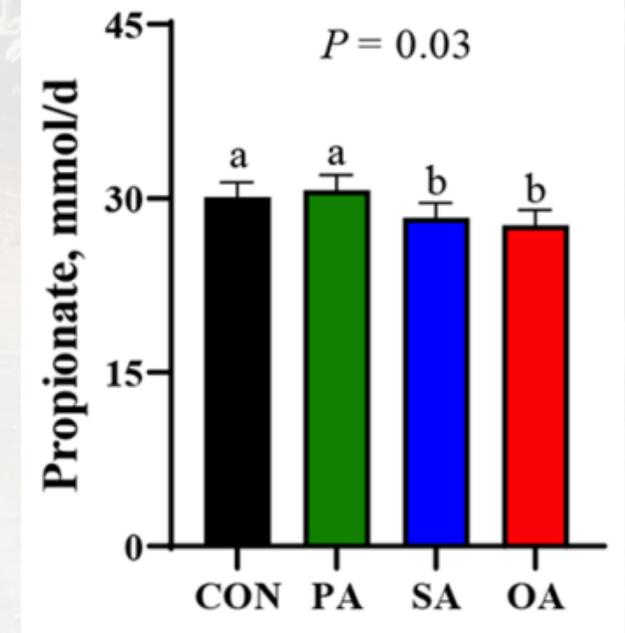
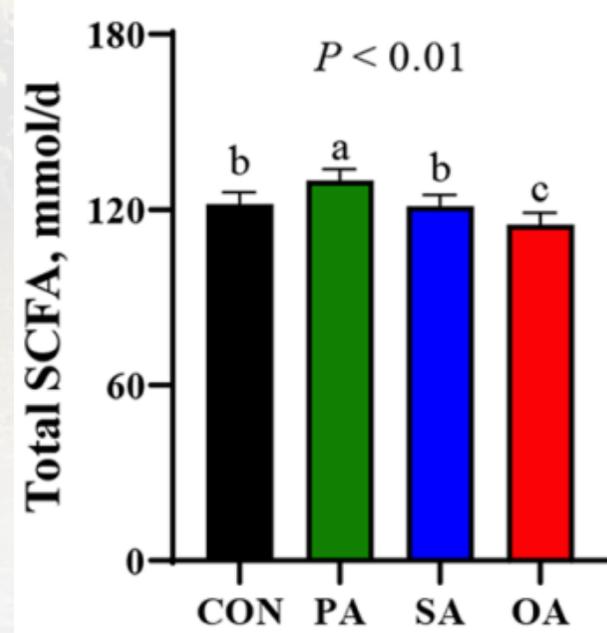
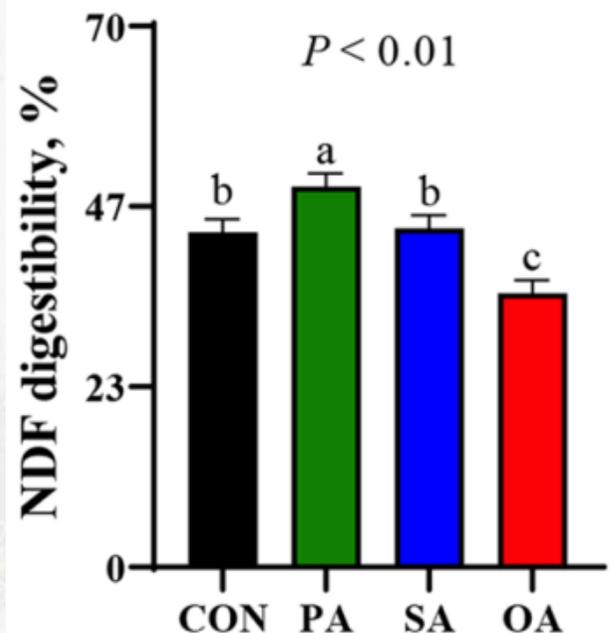
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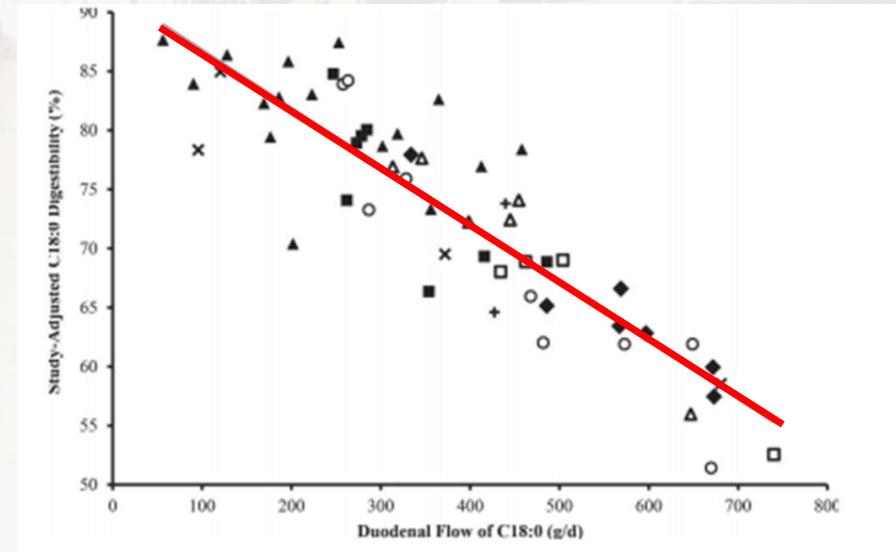
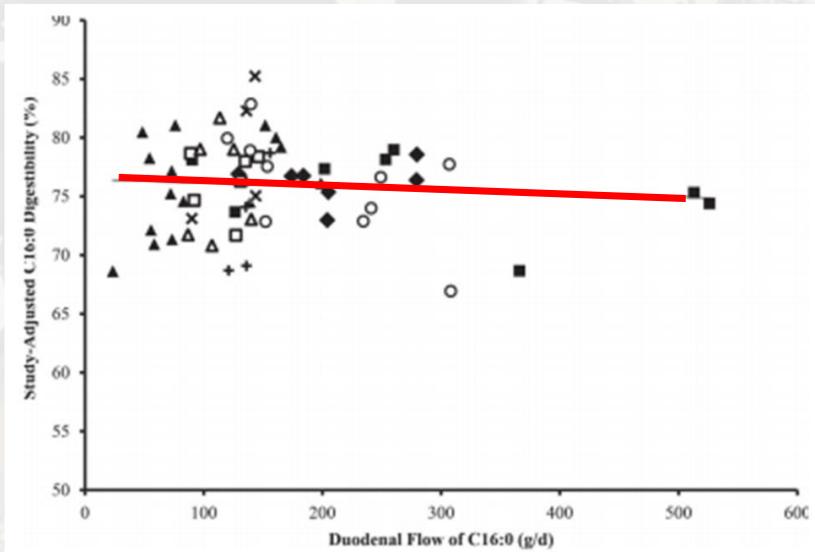
Efeito do Tipo de AG Digestibilidade dos Ácidos Graxos



J. Dairy Sci. 98:8889–8903
<http://dx.doi.org/10.3168/jds.2015-9592>
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Intestinal digestibility of long-chain fatty acids in lactating dairy cows: A meta-analysis and meta-regression

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RESULTADOS OBSERVADOS



J. Dairy Sci. 100:1072–1085
<https://doi.org/10.3168/jds.2016-11636>
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Effect of sources of calcium salts of fatty acids on production, nutrient digestibility, energy balance, and carryover effects of early lactation grazing dairy cows

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†Department of Animal Science, Michigan State University, East Lansing 48824

‡Department of Animal Science, University of Illinois at Urbana-Champaign, Urbana 81601

Avaliação da fonte de gordura em vacas a pasto

- Tratamentos (3° a 16° semana e efeito residual até 42° semana): 42 vacas Jersey x Holandesa
 - Controle (concentrado)
 - Sabão de óleo de soja (400 g dia)
 - Sabão de óleo de Palma (400 g dia)
- Avaliações:
 - Produção e composição do leite
 - Condição corporal



RESULTADOS OBSERVADOS

Efeito até 16 semanas

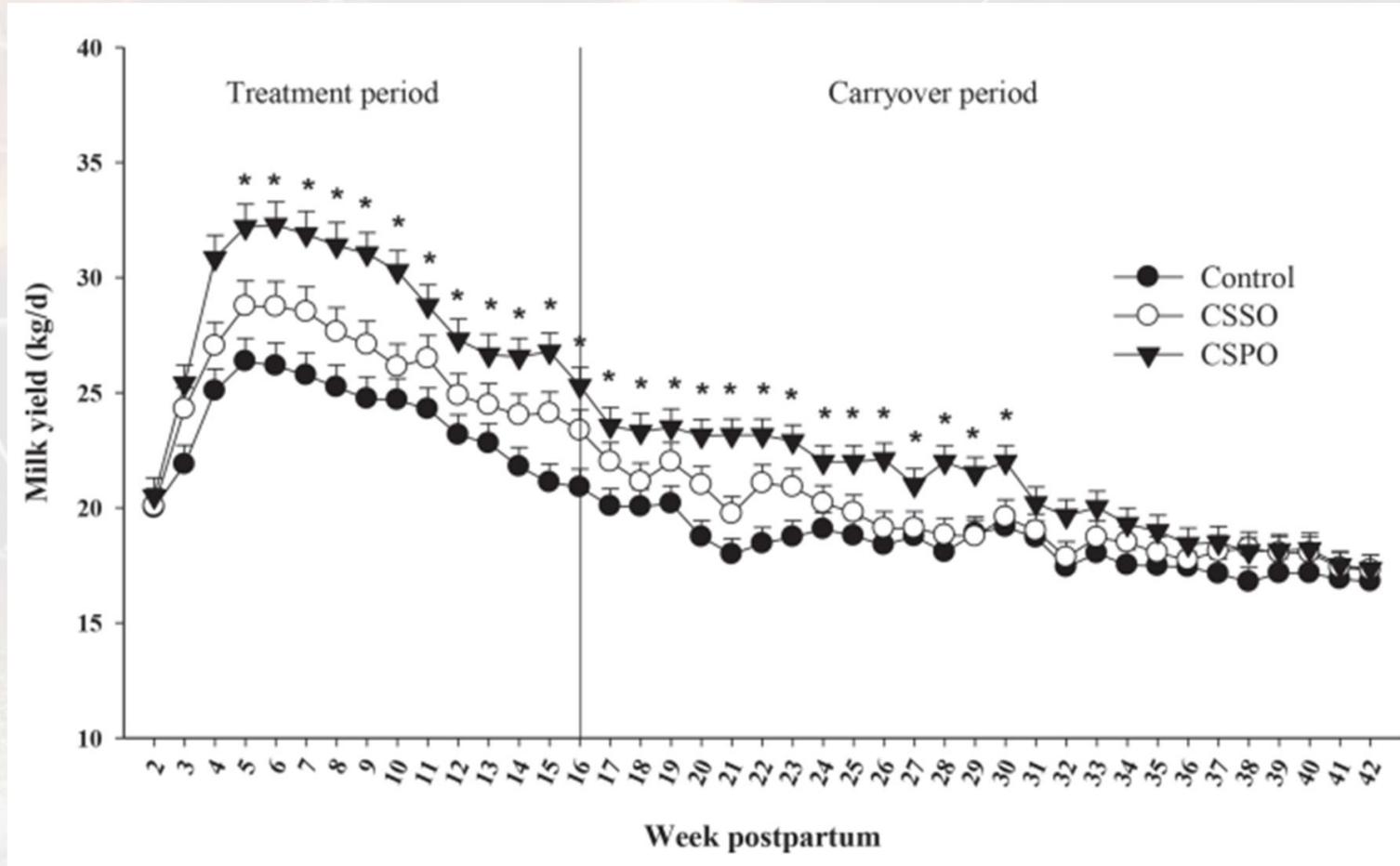
Item	Treatment (Trt)		
	Control	CSSO	CSPO
Yield (kg/d)			
Milk	24.2 ^c	26.8 ^b	29.0 ^a
Fat	0.86 ^b	0.78 ^c	0.95 ^a
Protein	0.80 ^b	0.83 ^b	0.89 ^a
Lactose	1.15 ^c	1.21 ^b	1.36 ^a
3.5% FCM ²	24.1 ^b	24.1 ^b	27.9 ^a
ECM ³	24.8 ^b	24.8 ^b	28.2 ^a
Cumulative milk yield (kg)	2,160 ^c	2,376 ^b	2,565 ^a
Feed efficiency ⁵	1.39 ^c	1.44 ^b	1.57 ^a
Milk composition (%)			
Fat	3.50 ^a	2.89 ^b	3.39 ^a
Protein	3.31 ^a	3.10 ^b	3.10 ^b
Lactose ⁶	4.60	4.52	4.60
MUN (mg/dL)	11.2	10.6	11.9
BW (kg)	475	487	476
BW change ⁷ (kg)	-2.03	-0.73	-8.54
BCS	2.84	2.88	2.70
BCS change ⁷	-0.03	-0.01	-0.12

Efeito após 16 semanas

Item	Control	CSSO	CSPO
DMI (kg/d)	19.6	19.6	19.9
Yield (kg/d)			
Milk	18.4 ^b	19.3 ^b	21.0 ^a
Fat	0.77 ^b	0.81 ^b	0.88 ^a
Protein	0.68 ^b	0.69 ^b	0.75 ^a
Lactose	0.81 ^b	0.85 ^b	0.92 ^a
3.5% FCM ²	20.5 ^c	21.6 ^b	23.4 ^a
ECM ³	20.9 ^c	21.8 ^b	23.7 ^a
Cumulative milk yield (kg)	3,349 ^c	3,513 ^b	3,822 ^a
Milk composition (%)			
Fat	4.20	4.25	4.21
Protein	3.62	3.59	3.59
Lactose	4.41	4.42	4.40
MUN (mg/dL)	10.2	10.8	10.6
BW (kg)	518	532	515
BW change ⁵ (kg)	8.66	8.41	11.5
BCS	3.27	3.30	3.18
BCS change ⁵	0.10	0.10	0.13



RESULTADOS OBSERVADOS





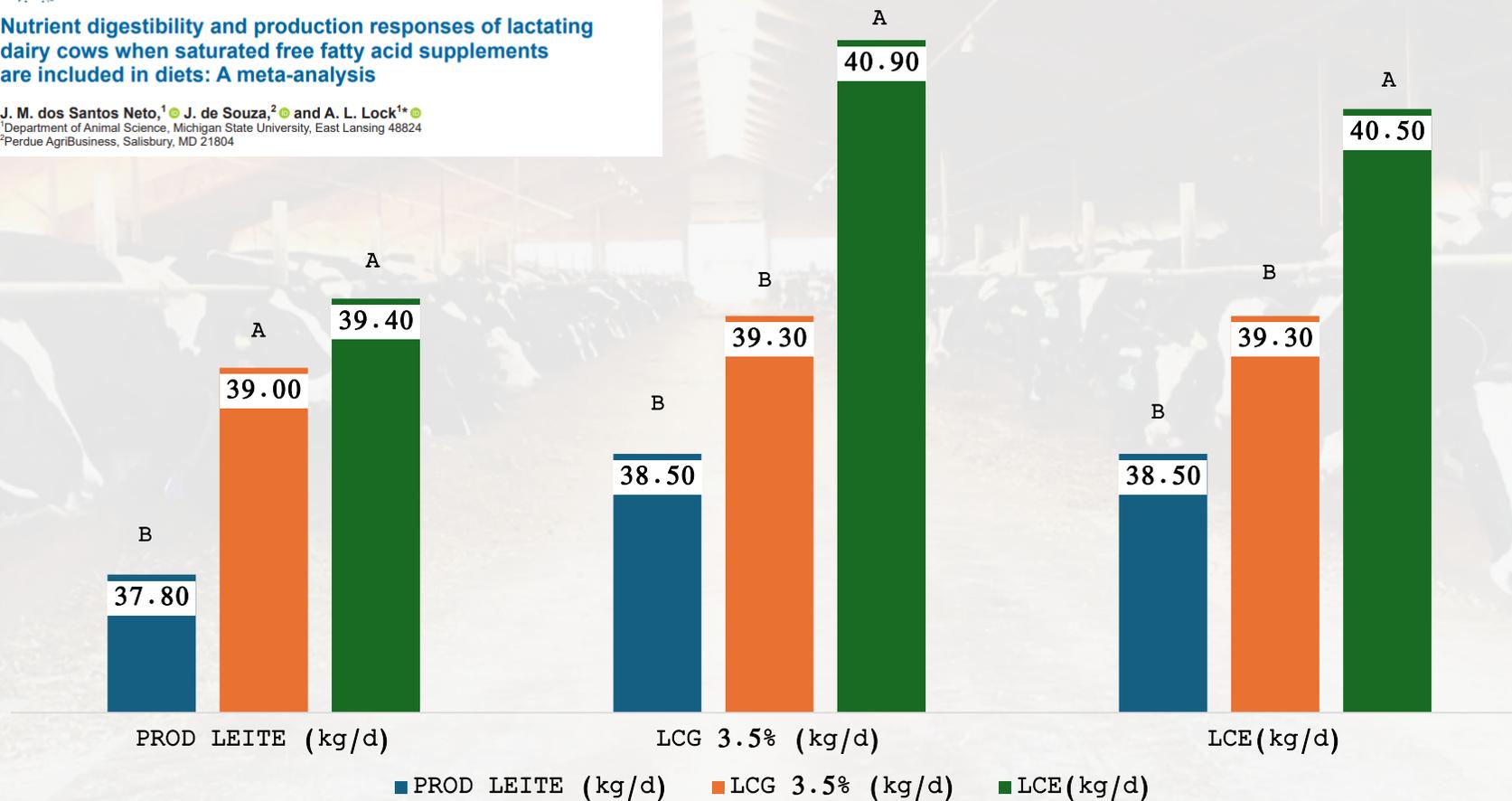
RESULTADOS OBSERVADOS



J. Dairy Sci. 104:12628–12646
<https://doi.org/10.3168/jds.2021-20699>
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Nutrient digestibility and production responses of lactating dairy cows when saturated free fatty acid supplements are included in diets: A meta-analysis

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¹Department of Animal Science, Michigan State University, East Lansing 48824
²Perdue AgriBusiness, Salisbury, MD 21804



OBS:
Suplementação = 3% IMS
CMS = NS



RESULTADOS OBSERVADOS



J. Dairy Sci. 101:3110–3117
<https://doi.org/10.3168/jds.2017-13560>
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Short communication: Comparison of a palmitic acid-enriched triglyceride supplement and calcium salts of palm fatty acids supplement on production responses of dairy cows

J. de Souza and A. L. Lock¹
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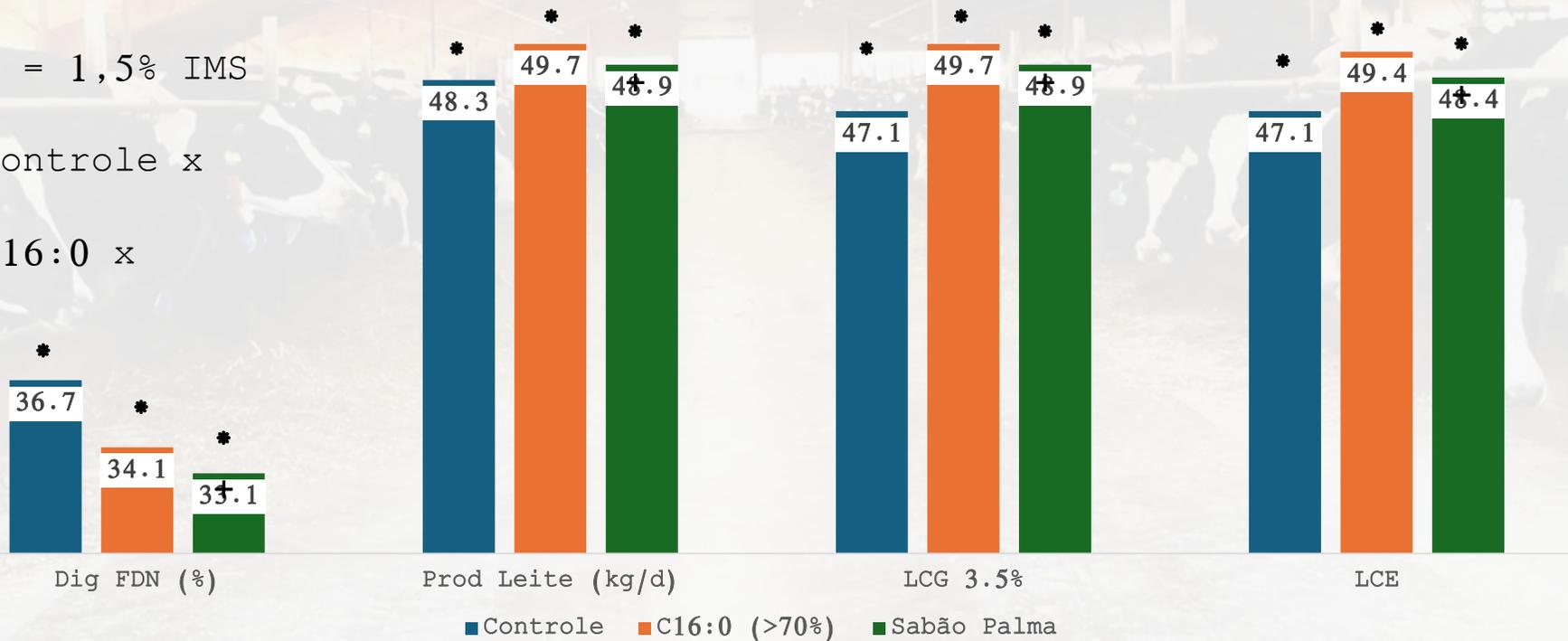
OBS:

Suplementação = 1,5% IMS

CMS = NS

* = $p < 0,05$ (Controle x Tratado)

+ = $p < 0,10$ (C16:0 x Sabão Palma)





RESULTADOS OBSERVADOS

Arq. Bras. Med. Vet. Zootec., v.62, n.1, p.116-123, 2010

Primeira onda folicular e ovulação de vacas primíparas da raça Holandesa alimentadas com diferentes fontes energéticas durante o período de transição

[First follicular wave and first postpartum ovulation of primiparous Holstein dairy cows receiving diets with different energetic sources during the transition period]

M.A.T. Artunduaga¹, S.G. Coelho², A.M. Borges², A.M.Q. Lana², R.B. Reis², B.G. Campos³,
H.M. Saturnino², R.V. Sá Fortes⁴, H.N. Costa³

- 50 Vacas Holandesas (28 dias antes do parto e 21 dias pós parto)
- 3 tratamentos:
 - ✓ Sabão de Calcio de Soja (100 g pré parto e 250 g pós parto)
 - ✓ Soja tostada (400 g pré parto e 400 g pós parto)
 - ✓ Propilenoglicol (800 g pós parto)
- Tamanho de folículo



RESULTADOS OBSERVADOS

Tabela 3. Média e desvio-padrão do diâmetro do folículo maior (DFM) e do volume do tecido lúteo (VTL), de vacas leiteiras alimentadas com diferentes fontes energéticas durante o período de transição, nos diferentes grupos experimentais

Grupo	DFM (mm)	VTL (cm ³)
Controle	13,95±2,60	1,78±0,47
Megalac-E [®]	16,10±4,90	1,78±0,95
Soja tostada	12,40±1,64	1,64±0,73
Propileno-glicol	12,70±3,05	1,16±0,41

Tabela 5. Média e desvio-padrão do intervalo parto – primeira ovulação de vacas leiteiras alimentadas com diferentes fontes energéticas durante o período de transição, nos diferentes grupos

Grupo	Intervalo (dias)
Controle	28,77±6,47b
Megalac-E [®]	23,30±6,23b
Soja tostada	30,20±11,32b
Propileno glicol	36,75±4,33a

Médias seguidas de letras distintas diferem entre si pelo teste Scott Knott (P<0,05); CV: 23,5%.



RESULTADOS OBSERVADOS

Effects of rumen-protected polyunsaturated fatty acid supplementation on reproductive performance of *Bos indicus* beef cows¹

C. N. Lopes,* A. B. Scarpa,* B. I. Cappellozza,* R. F. Cooke,†
and J. L. M. Vasconcelos*²

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J. Anim. Sci. 2009. 87:3935–3943
doi:10.2527/jas.2009-2201

Referência	Fonte da Gordura e nível ou concentração na dieta	Nº vacas	Controle %	Adição de gordura (%)
Lopes et al., 2009 ²	100 g/dia Megalac-E®** primíparas	910	39,1	50,0*
Lopes et al., 2009 ²	100 g/dia Megalac-E®** multíparas	504	35,5 ²²	47,9*
Lopes et al., 2009 ²	100 g/dia Megalac-E®** receptoras	435	36,9	49,1*



RESULTADOS OBSERVADOS

Reprod Dom Anim 43 (Supp. 2), 23–30 (2008); doi: 10.1111/j.1439-0531.2008.01139.x
ISSN 0936-6768

Long Chain Fatty Acids of Diet as Factors Influencing Reproduction in Cattle

JEP Santos¹, TR Bilby², WW Thatcher¹, CR Staples¹ and FT Silvestre¹

¹Department of Animal Sciences, University of Florida, Gainesville, FL; ²Department of Animal Sciences, University of Arizona, Tucson, AZ, USA

Table 2. Effect of supplemental fat on plasma progesterone concentrations in dairy and beef cattle

Measurement	Progesterone, ng/ml			Reference
	Control	Fat	p <	
Dairy cows				
Peak concentration	6.0	8.1	0.08	Garcia-Bojalil et al. (1998)
Week 2 to 12 postpartum	4.2	4.8	0.05	Son et al. (1996)
Week 5 to 12 postpartum	4.5	6.0	0.05	Spicer et al. (1993)
Day 1 to 12 of oestrous cycle	4.2	5.2	0.05	Lucy et al. (1993)
Day 9 to 15 of oestrous cycle	6.6	7.7	0.05	Carroll et al. (1990)
Beef cows and heifers				
Peak concentration	15.5	14.2	NS	De Fries et al. (1998)
Days 12 to 13 of the EC	5.8	11.8	0.02	Hawkins et al. (1995)
Day 5 of the second EC	<2.6	>4.0	0.01	Lammoglia et al. (1997)
Weekly samples	7.6	10.3	0.01	Lammoglia et al. (1996)
Day 5 of FSH-induced EC	21.5	24.1	NS	Thomas and Williams (1996)



Progesterona



RESULTADOS OBSERVADOS

Reprod Dom Anim 43 (Suppl. 2), 23–30 (2008); doi: 10.1111/j.1439-0531.2008.01139.x
ISSN 0936-6768

Long Chain Fatty Acids of Diet as Factors Influencing Reproduction in Cattle

JEP Santos¹, TR Bilby², WW Thatcher¹, CR Staples¹ and FT Silvestre¹

¹Department of Animal Sciences, University of Florida, Gainesville, FL; ²Department of Animal Sciences, University of Arizona, Tucson, AZ, USA

Table 3. Effect of fat supplementation on pregnancy at first post-partum AI in lactating dairy cows

Reference	Cows	Fat source and amount	Pregnancy per AI, %	
			Control	Fat
Ferguson et al. (1990)	253	0.5 kg of saturated free FA	42.6	59.1*
McNamara et al. (2003)	201	0.32 to 0.36 kg of FA from Ca-LCFA	35.5	51.1*
Schingoethe and Casper (1991)	153	Oilseeds	46.5	42.0
Schneider et al. (1988)	181	0.5 kg of Ca-LCFA	43.1	60.5
Scott et al. (1995)	443	0.45 kg of Ca-LCFA	49.3	45.7
Sklan et al. (1991)	99	2.6% of ration as Ca-LCFA	41.5	39.2
Sklan et al. (1994)	102	2.5 of ration as Ca-LCFA		
		Primiparous	73.7*	33.3
		Multiparous	42.1	33.3



Taxa de Prenhez na IA



Conclusões Sobre o uso de Gordura em Ruminantes

- A gordura protegida no rumen é uma ferramenta eficaz para aumentar a densidade energética da dieta, preservar a fermentação ruminal e otimizar o desempenho produtivo em vacas leiteiras e bovinos de corte.
- Suplementação com ácidos graxos saturados protegidos, como **C16:0** (palmítico) e **C18:0** (esteárico), promove:
 - ↑ Produção de leite (+0,8 a 3,0 L/vaca/dia) - *Loften et al., 2014; Rabiee et al., 2012*
 - ↑ Teor de gordura do leite (+0,15 a 0,30 pontos %) - *Piantoni & Lock, 2015*
 - ↑ Eficiência alimentar e recuperação do escore corporal - *Harvatine & Bauman, 2009*
- Gorduras com alto teor de **C16:0** estimulam diretamente a lipogênese mamária.
- O uso de Fracionadas e Gorduras encapsuladas por spray cooling apresenta as melhores respostas produtivas e estabilidade ruminal, com digestibilidade intestinal superior a 85%.
- Sabões de cálcio são opções viáveis, principalmente em dietas com



Composição dos principais produtos do mercado

Tipo de gordura protegida	Dose diária recomendada (g/vaca)	Efeito esperado	Taxa de resposta (ganho/100 g)
Prilled C16:0	300-500	↑ gordura do leite, ↑ produção	~1,0 L leite / 300 g
C18:0 hidrogenado	250-400	↑ energia líquida, escore corporal	~0,6 L leite / 300 g
Sabão de cálcio	200-400	↑ energia, ↓ fermentação quando mal usado	~0,5-0,7 L leite / 300 g



ÁCIDOS
GRAXOS



ÁCIDOS
GRAXOS



VITAMINAS

Por que suplementar com Vitaminas Protegidas do rúmen?



Vitaminas do complexo B que devem ser suplementadas em forma protegida do rúmen são aquelas que:

- Possuem alta taxa de degradação ruminal, ou
- Têm uma demanda aumentada durante fases críticas do metabolismo, como o período de transição, lactação intensa ou crescimento acelerado.

Por que suplementar com Vitaminas Protegidas do rumen?



Colina (Vitamina B4)

•**Motivo:** Praticamente 100% degradada no rúmen; essencial para formação de fosfatidilcolina (exportação de gordura hepática via VLDL).

•**Funções principais:**

- Prevenção da lipidiose hepática;
- Melhora da fertilidade;
- Redução da hipocalcemia subclínica;
- Apoio ao metabolismo energético.

Zenobi et al., 2018; Lima et al., 2024; Myers et al., 2025; Arshad et al., 2023

Por que suplementar com Vitaminas Protegidas do rumen?



Niacina (Vitamina B3)

•**Motivo:** Até **90%** degradada no rúmen na forma livre (não protegida); demanda aumentada em vacas em estresse térmico, risco de cetose ou acidose.

•**Funções principais:**

- Redução da lipólise excessiva e mobilização de ácidos graxos;
- Redução de β -hidroxibutirato (BHB) e risco de cetose;
- Estabilização do metabolismo energético;
- Potencial ação anti-inflamatória.

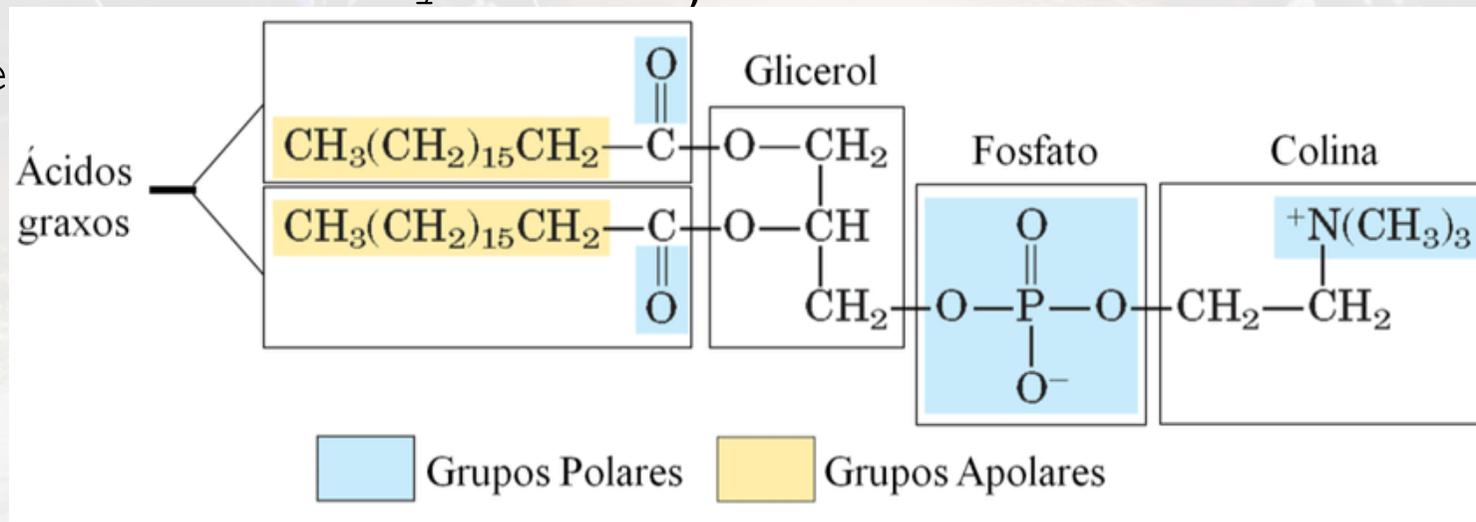


Colina (funções):

1. Precursor de Fosfatidilcolina para formação de lipoproteínas (VLDL)

- Em ruminantes, a capacidade hepática de exportar gordura via VLDL é limitada. Por isso, a colina é crítica para evitar **acúmulo de triglicerídeos hepáticos** (lipidiose ou "fatty liver").

Myers e
2023



al.,

Colina (funções):



2. Efeito lipotrópico: Redução da lipidiose hepática

- Promove a exportação de gordura do fígado ao facilitar a formação de VLDL.
- Suplementação com colina protegida do rúmen pode reduzir em até **28,5%** os níveis de triacilglicerol hepático em vacas submetidas a restrição alimentar e balanço energético negativo (Arshad et al, 2024 ; Lima et al, 2024).

3. Fonte de grupos metil (via betaína)

- Após sua oxidação a betaína, a colina doa grupos metil para a formação de S-adenosilmetionina (SAME) – um dos principais doadores de metil do organismo.
- A metilação de DNA, proteínas, fosfolipídios e

Colina (funções):



4. Participação no metabolismo energético

- A colina influencia indiretamente a gliconeogênese e oxidação hepática de ácidos graxos, ao reduzir o acúmulo de lipídios no fígado e melhorar a eficiência hepática.
- Isso reduz a incidência de cetose e melhora a utilização dos nutrientes energéticos.

5. Melhoria da imunidade e redução da inflamação

- A colina modula a resposta imune ao reduzir **citocinas pró-inflamatórias** (como $\text{TNF-}\alpha$ e IL-6) e proteínas de fase aguda (como haptoglobina).
- Vacas suplementadas apresentaram menor resposta inflamatória à exposição ao LPS, com **melhora na função**

Colina (funções):



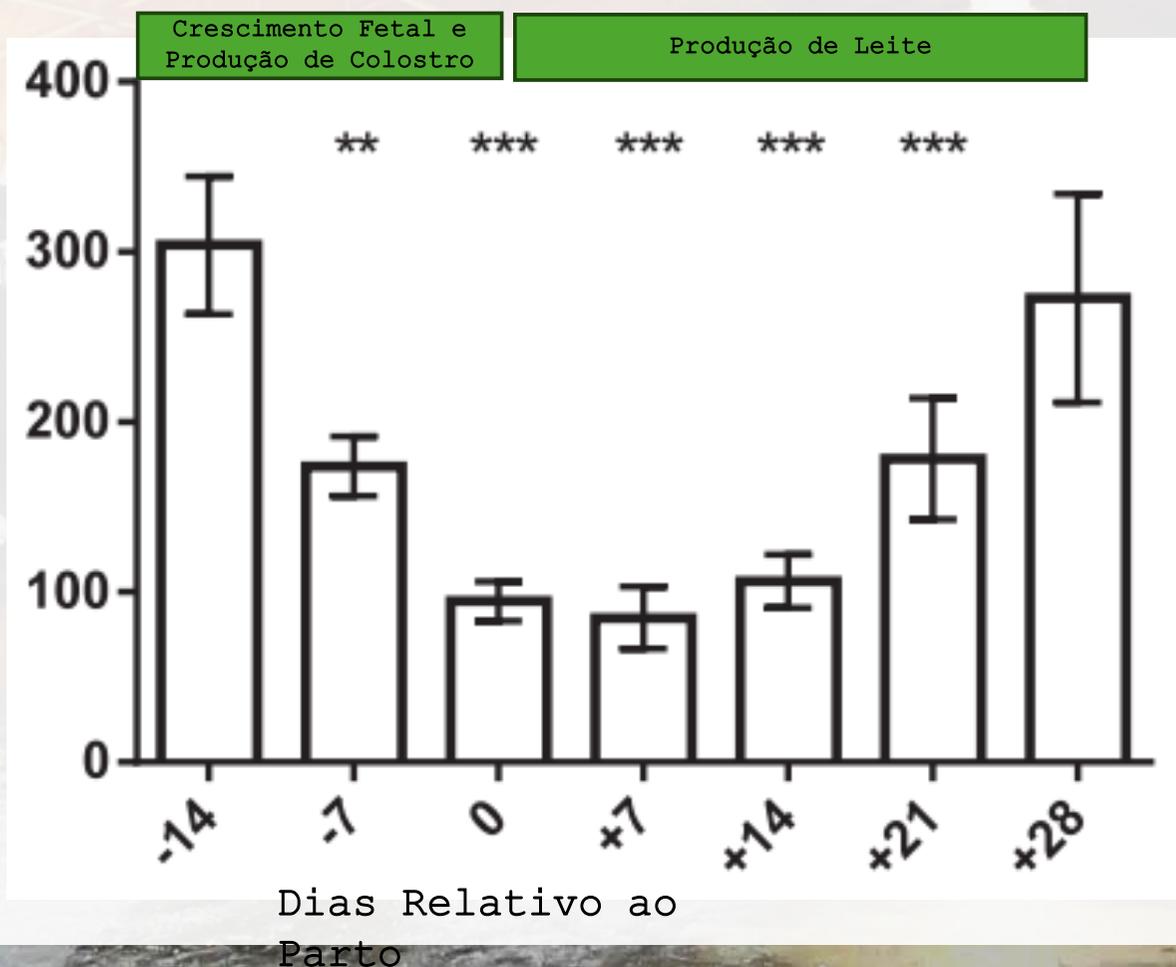
6. Papel na reprodução e fertilidade

- Colina participa da síntese de fosfolipídios nas membranas celulares do oócito e do embrião, além de contribuir com a metilação de DNA em tecidos embrionários.
- A suplementação tem sido associada a maior taxa de prenhez à IATF e maior crescimento fetal.

7. Efeito sobre o colostro e a progênie

- Vacas suplementadas com colina protegida apresentaram colostro com maior concentração de IgG, e suas bezerras mostraram melhor eficiência de absorção de imunoglobulinas, além de maior ganho de peso e menor resposta inflamatória nos primeiros dias de vida.

Níveis de Fosfatidilcolina durante Período de Transição:



Valores médios \pm SEM; *P < 0,05, **P < 0,01 e ***P < 0,001 em comparação com os valores no início do estudo (dia -14)

Resultados de Pesquisa:



J. Dairy Sci. 103

<https://doi.org/10.3168/jds.2019-16842>

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Meta-analysis of the effects of supplemental rumen-protected choline during the transition period on performance and health of parous dairy cows

U. Arshad, M. G. Zenobi, C. R. Staples,  and J. E. P. Santos* 

Department of Animal Sciences, DH Barron Reproductive and Perinatal Biology Research Program, University of Florida, Gainesville 32611

Objetivos: Utilizar métodos meta-analíticos para determinar os efeitos da quantidade de íon colina suplementar como colina protegida no rúmen a partir do pré-parto sobre a produção e saúde de vacas leiteiras.

O estudo analisou 21 experimentos com 66 tratamentos com 1313 vacas

Resultados de Pesquisa:



J. Dairy Sci. 103

<https://doi.org/10.3168/jds.2019-16842>

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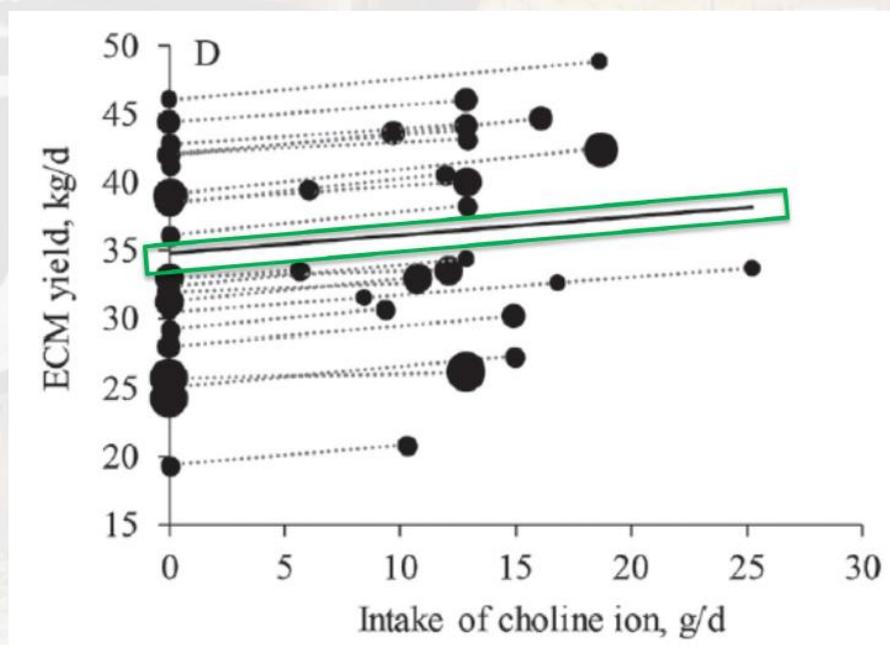
Meta-analysis of the effects of supplemental rumen-protected choline during the transition period on performance and health of parous dairy cows

U. Arshad, M. G. Zenobi, C. R. Staples, and J. E. P. Santos*

Department of Animal Sciences, DH Barron Reproductive and Perinatal Biology Research Program, University of Florida, Gainesville 32611



VITAMINAS



A resposta média da ECM em todas as 36 comparações de tratamento foi de 2,2 kg

- Efeito Dose Resposta Dependente
- Resposta Consistente e Positiva
- Dose ótima de 12,9 g/ion

Modificado de Arshad et al, 2020. Journal of Dairy Science

Holdorf e outros, 2023; Swartz e outros, 2023

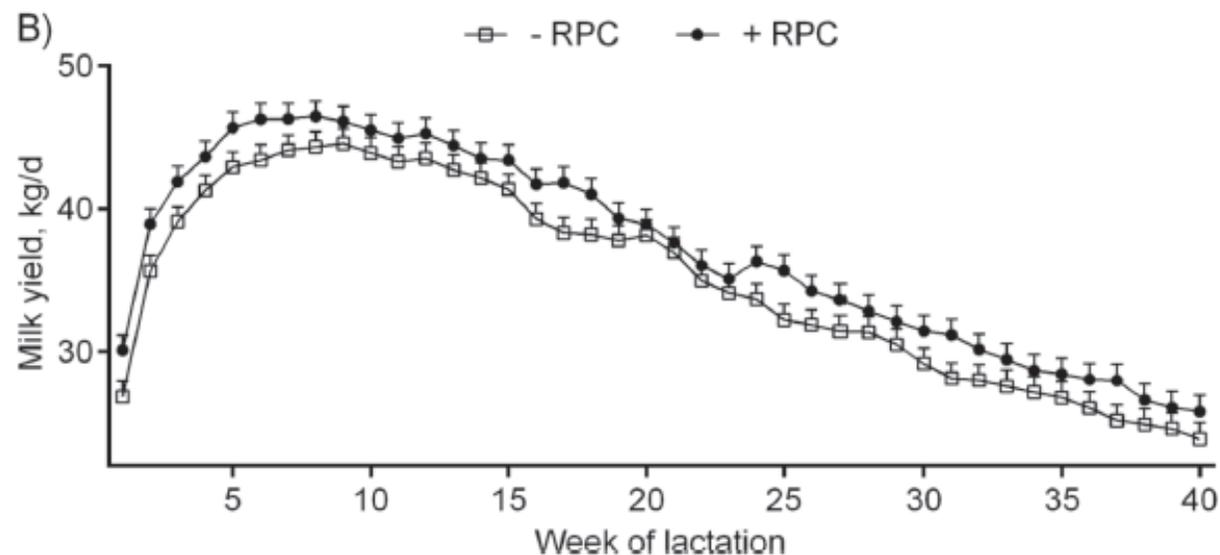
Resultados de Pesquisa:



J. Dairy Sci. 103
<https://doi.org/10.3168/jds.2019-17293>
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Timing of initiation and duration of feeding rumen-protected choline affects performance of lactating Holstein cows

J. M. Bollatti,¹ M. G. Zenobi,¹ N. A. Artusso,¹ G. F. Alfaro,¹ A. M. Lopez,¹ B. A. Barton,² C. D. Nelson,¹ C. R. Staples,¹ and J. E. P. Santos^{1*}
¹Department of Animal Sciences, University of Florida, Gainesville 32611
²Balchem Corp., New Hampton, NY 10958

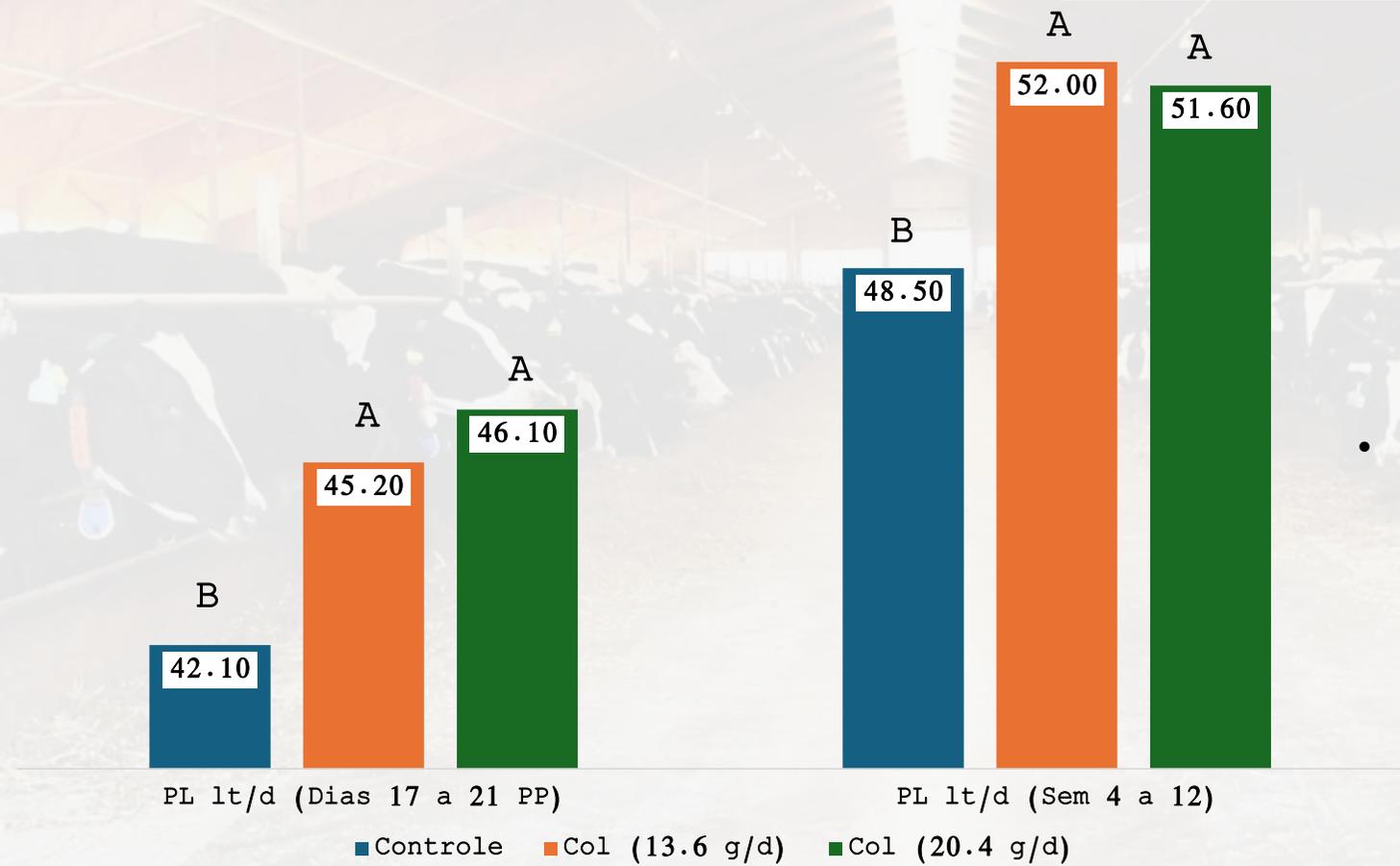


Suplementação:

- 21 dias pré parto e 21 dias pós parto
- Avaliação Produção e Composição
- Aumento médio de 2,1 lts/d

Resultados de Pesquisa:

J. Dairy Sci. 106:8561-8582
<https://doi.org/10.3168/jds.2023-23259>
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This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).
Effects of dietary rumen-protected choline supplementation to periparturient dairy cattle on inflammation, metabolism, and performance during an intramammary lipopolysaccharide challenge
T. H. Swartz,^{1,2*} B. J. Bradford,^{1,2} L. K. Mamedova,¹ and K. A. Estes³
¹Department of Animal Science, Michigan State University, East Lansing, MI 48824
²Department of Dairy and Food Science, South Dakota State University, Brookings, SD 57007
³Balchem Corporation, Montvale, NJ 07645



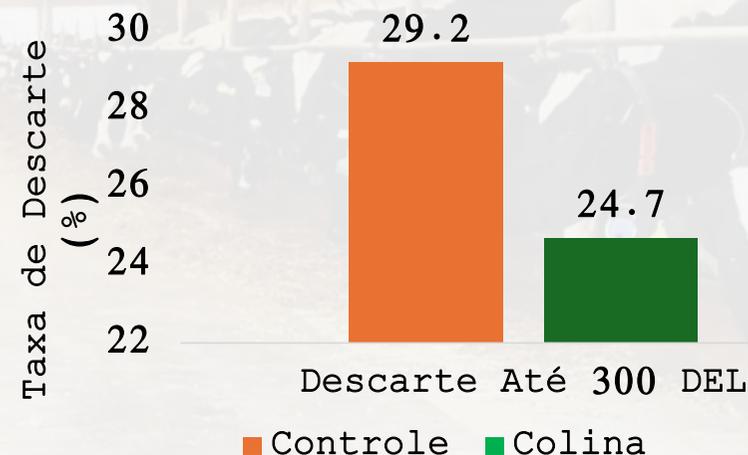
• Aumento médio de 3,1 lts

Resultados de Pesquisa: Effects of feeding rumen-protected choline on incidence of diseases and reproduction of dairy cows

F.S. Lima, M.F. Sá Filho, L.F. Greco, J.E.P. Santos

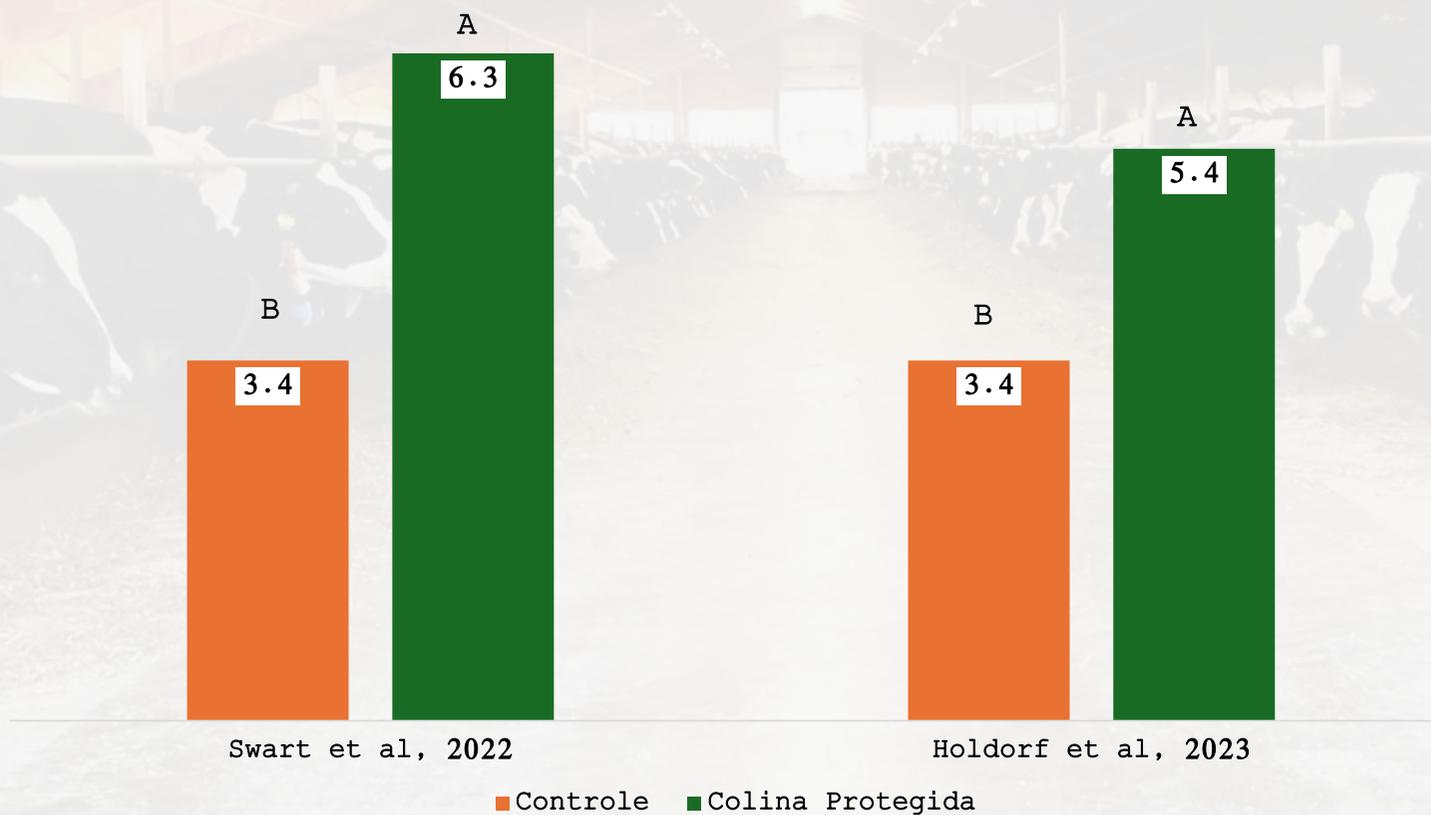


	Controle Média (%)	Colina Protegida Média (%)	Redução (%)	P-Value
Retenção de Placenta	11,2	10,1	9,8	0,72
Metrite	11,3	31,6	-1,6	0,77
Cetose Clínica	11,3	4,0	64,6	0,01
Mastite	22,5	14,80	34,2	0,06
Morbidade	57,1	38,4	32,7	0,01
Doenças Subclínicas				
hipocalcemia	51,4	54,3	-5,6	0,49
Hiperetonemia	18,8	18,9	-0,5	0,96
Descarte até 300 DEL	29,2	24,7	15,4	0,05



Resultados de Pesquisa:

Produção de Colostro (lts/d) de vacas alimentadas com Colina Protegida



Resultados de Pesquisa:



J. Dairy Sci. 105:9896–9916
<https://doi.org/10.3168/jds.2021-21689>

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Effects of maternal choline supplementation on performance and immunity of progeny from birth to weaning

M. G. Zenobi,^{1*} J. M. Bollatti,¹ A. M. Lopez,¹ B. A. Barton,² C. L. Hixson,¹ F. P. Maunsell,³ W. W. Thatcher,¹ K. Miller-Cushon,¹ J. E. P. Santos,¹ C. R. Staples,¹ and C. D. Nelson[†]

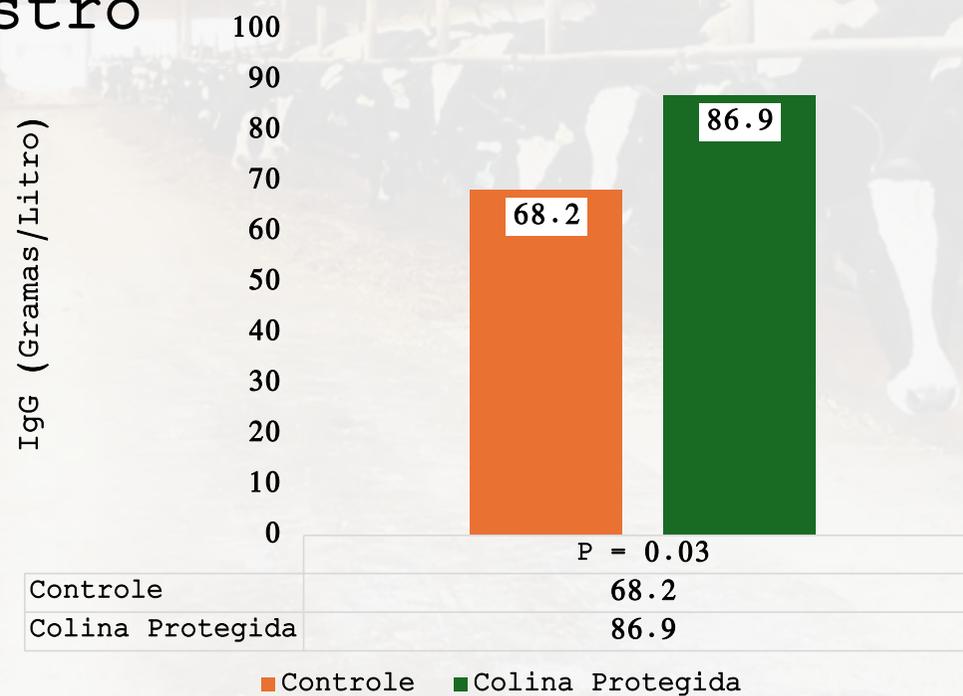
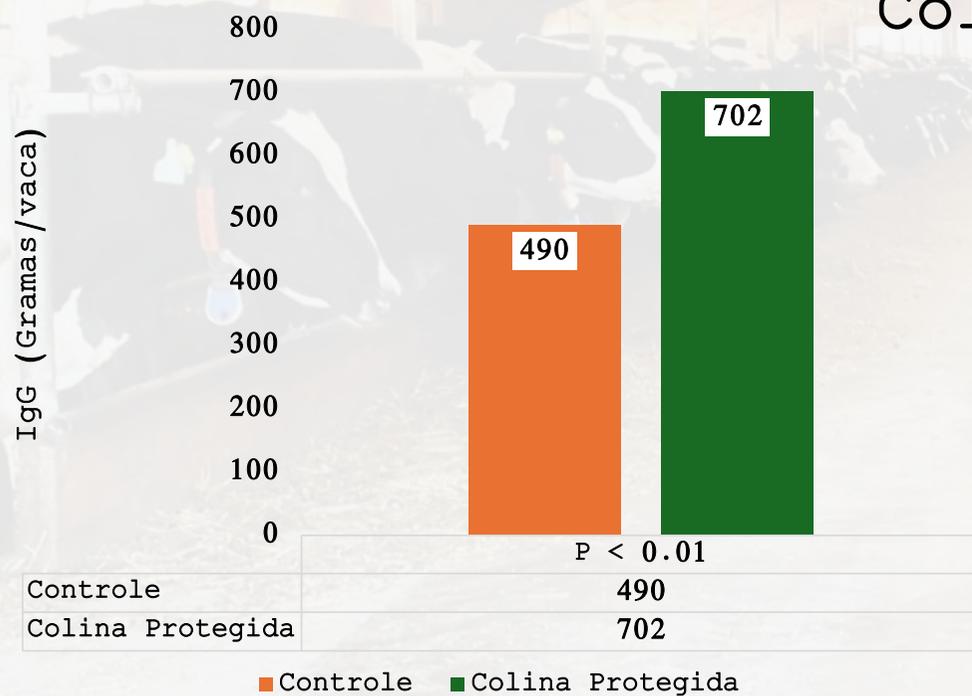
¹Department of Animal Sciences, University of Florida, Gainesville 32611

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Efeito sobre a qualidade do Colostro



Resultados de Pesquisa:



J. Dairy Sci. 105:9896–9916
<https://doi.org/10.3168/jds.2021-21689>

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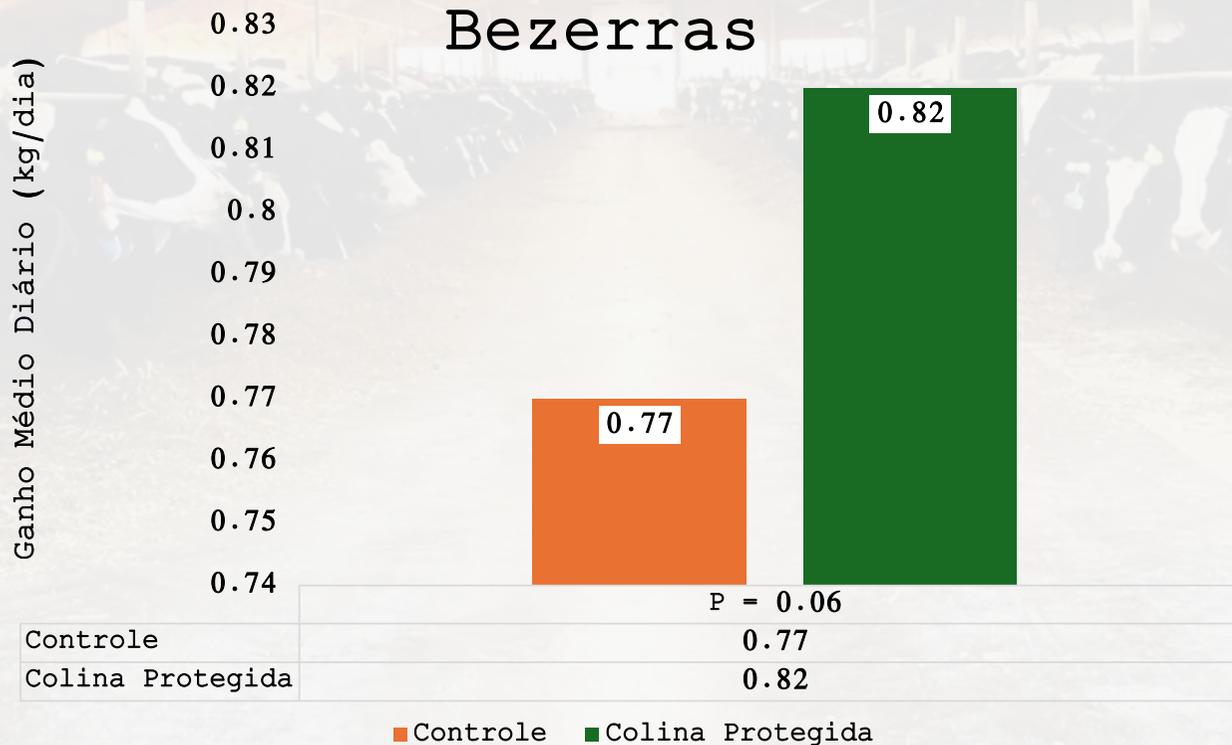
¹Department of Animal Sciences, University of Florida, Gainesville 32611

²Balchem Corp., New Hampton, NY 10959

³Food Animal Reproduction and Medicine Service, University of Florida, Gainesville 32611



Efeito sobre O Desempenho de Bezerros



Niacina (funções):



1. Cofator essencial em mais de 200 reações metabólicas

- A niacina atua como precursor dos nucleotídeos de piridina NAD^+ e NADP^+ , que são cofatores centrais em:
 - Metabolismo de carboidratos (glicólise, TCA, gliconeogênese);
 - Oxidação de ácidos graxos;
 - Síntese de aminoácidos e proteínas;
 - Produção de energia mitocondrial (ATP).

2. Redução da lipólise e mobilização de gordura corporal

- A niacina, especialmente na forma ácido nicotínico (NA), atua sobre o receptor HCAR2 (GPR109A), reduzindo a atividade da lipase hormônio-sensível (HSL).
- Isso leva à menor liberação de ácidos graxos não esterificados (NEFA) do tecido adiposo, reduzindo risco de cetose e lipidiose hepática.

Niacina (funções):



3. Aumento do consumo de matéria seca (CMS ou DMI)

- A suplementação de niacina protegida do rúmen (RPN) aumentou o DMI em **0,60 kg/dia**, possivelmente via:
 - Modulação do rumen microbiota (aumento de protozoários);
 - Estímulo de hormônios orexigênicos como orexina A e neuropeptídeo Y, que controlam o apetite.

4. Melhoria da produção de leite e seus componentes

- Segundo a meta-análise:
 - RPN (niacina protegida): aumento de **1,10 kg/d** de leite com dose média de **4,7 g/d**;
 - Aumento de produção de ECM, gordura e lactose;
 - Efeito mais consistente e superior ao RUPN (não protegida).

Niacina (funções):



5. Efeito vasodilatador e possível melhora na absorção de nutrientes

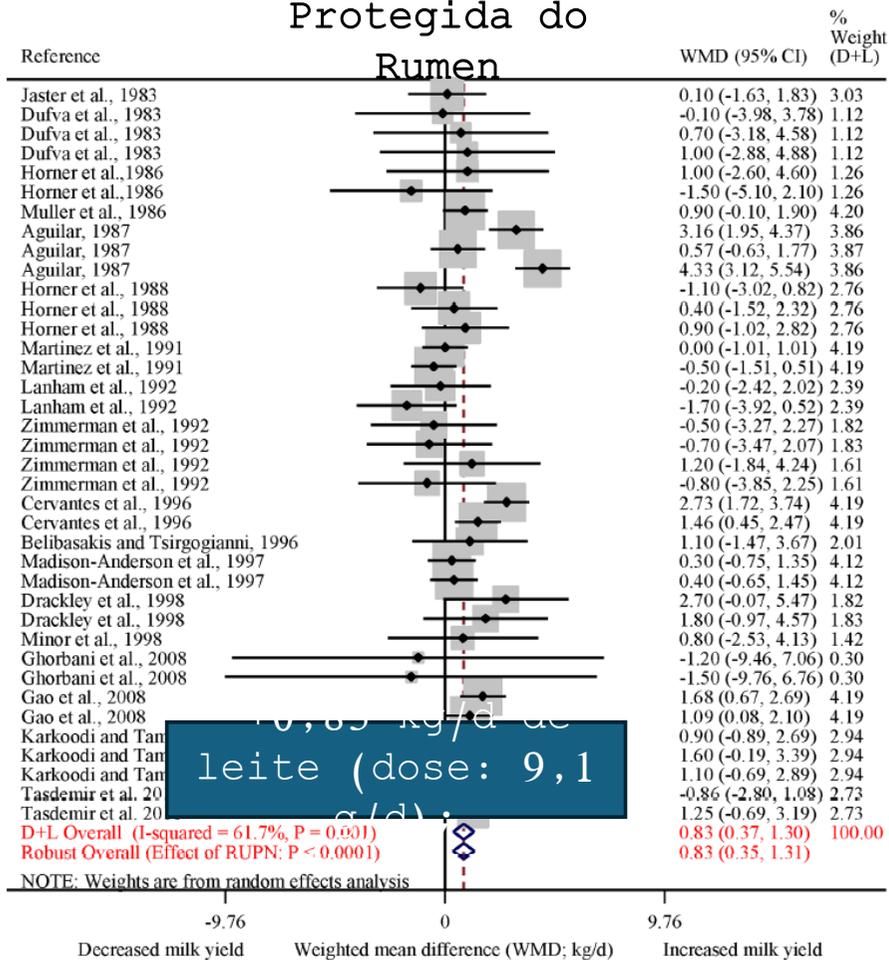
- A niacina possui efeitos vasodilatadores, o que pode melhorar a perfusão sanguínea no trato digestivo e, conseqüentemente, a absorção de nutrientes e o suporte à síntese de leite.

6. Efeitos termorregulatórios (em condições de estresse térmico)

- Estudos anteriores (Zimbelman et al., 2010 e 2013) mostraram que a niacina reduz a temperatura corporal e cutânea, favorecendo a performance em vacas sob estresse térmico.

Niacina (Resultados de Pesca

Niacina Não Protegida do Rumen



J. Dairy Sci. TBC
<https://doi.org/10.3168/jds.2024-25902>
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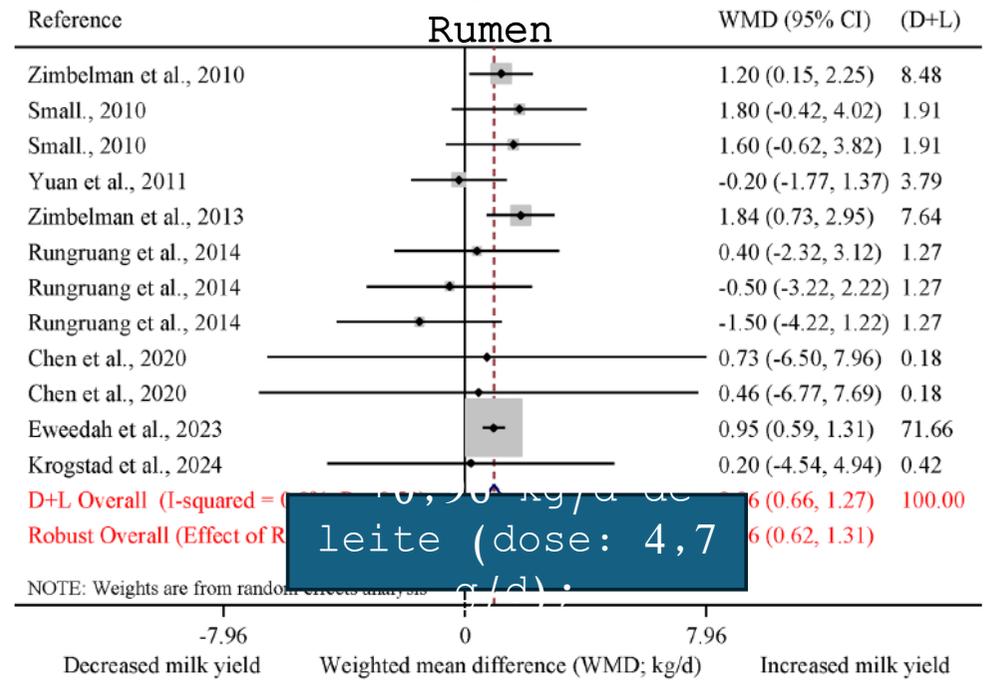
Meta-analysis to determine the effects of supplementation of niacin during the transition or lactating period on performance in dairy cows

U. Arshad,¹ S. Bagaria,¹ C. M. Ncho,¹ M. Sagheer,² K. Krogstad,² and M. Niu^{1*}

¹ETH Zurich, Animal Nutrition, Institute of Agricultural Sciences, Department of Environmental Systems Science, Zurich 8092, Switzerland
²Department of Animal Sciences, University of Florida, Gainesville, 32611, USA
³Department of Animal Sciences, The Ohio State University, 1680 Madison Ave, Wooster, OH, USA 44691



Niacina Protegida do Rumen



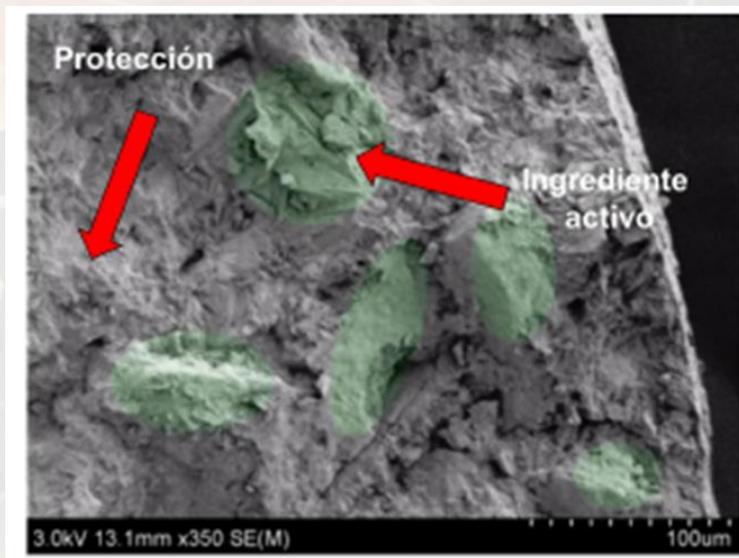
leite (dose: 9,1

leite (dose: 4,7

Tipos de Proteção



Matriz de Encapsulação



- Aditivo exposto na superfície externa
- Proteção e estabilidade reduzida

Encapsulação Verdadeira



- Não tem exposição do aditivo na superfície
- Alta Proteção e estabilidade

Tipos de Proteção

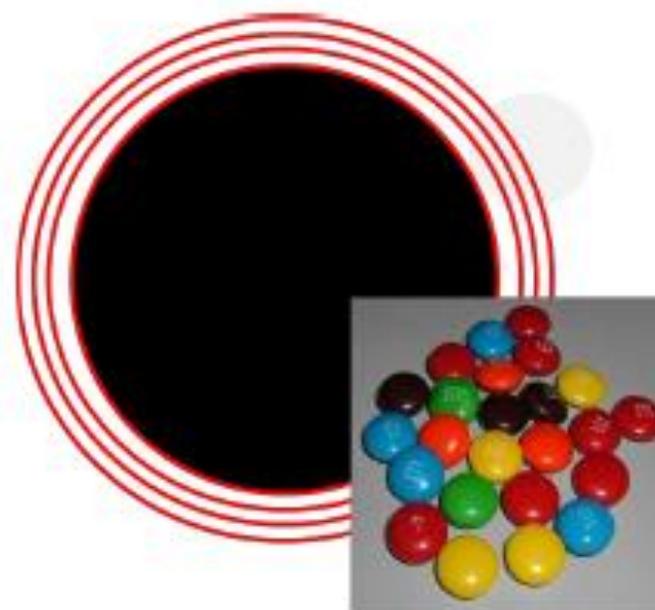


Matriz de Encapsulação

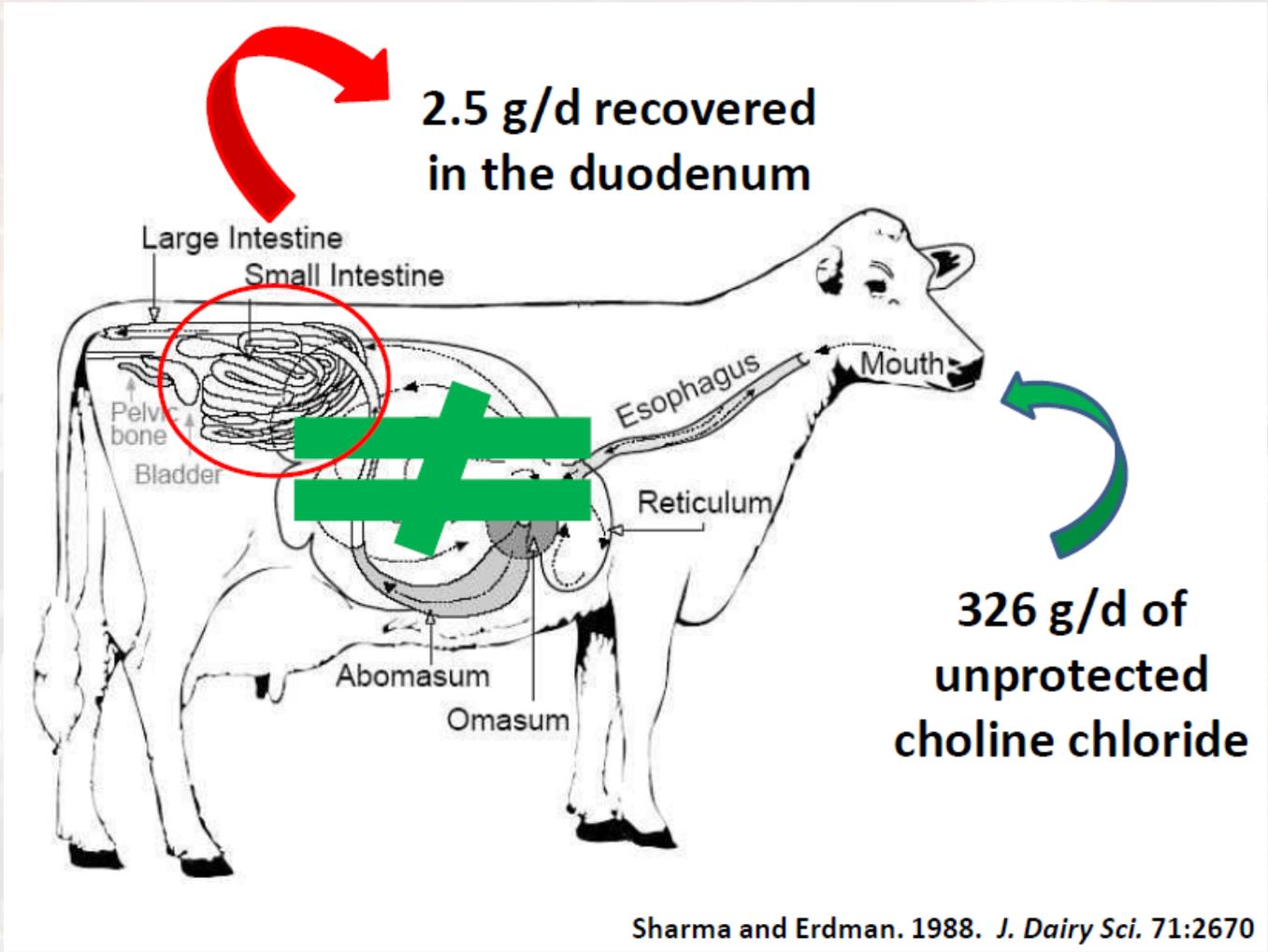


- Aditivo exposto na superfície externa
- Proteção e estabilidade reduzida

Encapsulação



- Não tem exposição do aditivo na superfície
- Alta Proteção e estabilidade



Cortesia de Marcos Zenobi (2025)

Journal of General Microbiology (1976), 92, 391-397
Printed in Great Britain 391

Role of Choline in the Nutrition of the Rumen Protozoon *Entodinium caudatum*

By T. E. BROAD AND R. M. C. DAWSON
Biochemistry Department, Agricultural Research Council Institute of Animal Physiology, Babraham, Cambridge CB2 4AT

(Received 1 September 1975)

SUMMARY

A requirement of choline for the growth of *Entodinium caudatum* in a simplified culture medium has been demonstrated. Ethanalamine, *N*-methylethanalamine, or *N*-dimethylethanalamine were ineffective as substitutes. In the rumen, the normal environment of this organism, levels of free choline were virtually zero even after ingestion of pasture containing phosphatidylcholine which was rapidly catabolized. Free [^{14}C]choline is very rapidly cleared from rumen fluid, a little being incorporated into the phosphatidylcholine of pasture, but the clearance also occurs in animals. *Entodinium caudatum* obtains choline from the pasture it has ingested, rather than from the rumen fluid.

Fig. 2. Digestion of grass leaf phosphatidylcholine by ovine rumen contents *in vivo* and *in vitro*. In the *in vivo* experiment a sheep was given 450 g grass labelled with ^{14}C , serial samples of rumen fluid were withdrawn through a fistula and the ratio of radioactivity in phosphatidylcholine and β -carotene was determined (○). In the *in vitro* experiment rumen contents were withdrawn and homogenized (Ultraturax) with 10% (w/v) grass. The percentage disappearance of phosphatidylcholine from the homogenate during anaerobic incubation at 38 °C was determined (●).

T180 In situ rumen degradability and in vitro intestinal digestibility of rumen-protected methyl donors and lysine. A. B. P. Fontoura^{*1}, W. A. Myers¹, A. F. Ortega¹, E. Grilli^{2,3}, and J. W. McFadden¹
¹Cornell University, Ithaca, NY; ²[redacted]
³University of Bologna, Bologna, Italy.

Rumen degradation and intestinal digestibility of rumen-protected (RP) methyl donor and lysine products vary. Our objectives were to evaluate the in situ rumen degradability and in vitro intestinal digestibility of 4

RP products containing choline chloride, DL-methionine, betaine, and/or L-lysine in a triglyceride matrix. Four rumen-cannulated multiparous Holstein cows (175 ± 4 DIM; 34 ± 6 kg of milk/d) were used to test commercially microencapsulate products [redacted] which contain 25% choline chloride [redacted] 55% DL-methionine [redacted] 33% L-lysine [redacted] and 22% methionine, 10% [redacted], 3% betaine, < 1% riboflavin and vitamin B12 [redacted]. The difference in composition was composed of hydrogenated palm fat. In paired duplicates, 5 g of RP product were placed in separate nylon bags and rumen-incubated for 0, 4, 8, 16, and 20 h. Bags were inserted in reverse order, removed collectively after incubation and washed in cold tap water. Intestinal digestibility was in vitro estimated using 16 h samples and an enzyme cocktail containing lipase (28 U/mL). All in situ and in vitro samples were dried and composited for N analysis using block digestion and steam distillation with automatic titration. The statistical model included the random effect of cow and replicates, and the fixed effects of product, time and their interaction. The percentage of N that passed the rumen varied across product ($P < 0.001$) and time ($P < 0.001$), and interactions were detected ($P < 0.05$). Percentage of rumen-undegraded N following in situ incubation is shown in Table 1. In vitro intestinal digestibility was 54.8 ± 3.48%, 78.1 ± 3.26%, 64.6% ± 2.89, and 74.9 ± 3.41% for RPC, RPM, RPL and RMD, respectively. Rumen protection for RPM, RPL, and RPMD was high, relative to RPC. Intestinal digestibility was high for all products tested.

Table 1 (Abstr. T180). Least squares means of rumen-undegraded nitrogen following in situ incubation

Product	Undegraded N, %				SEM
	4 h	8 h	16 h	20 h	
RPC	68.8	54.3	40.2	31.5	2.33
RPM	91.2	81.1	74.3	70.4	3.17
RPL	89.4	85.6	75.6	68.9	2.33
RPMD	76.2	64.8	51.7	49.1	3.13

Key Words: lysine, methyl donor, rumen protection

ciência da Proteção (In Situ)



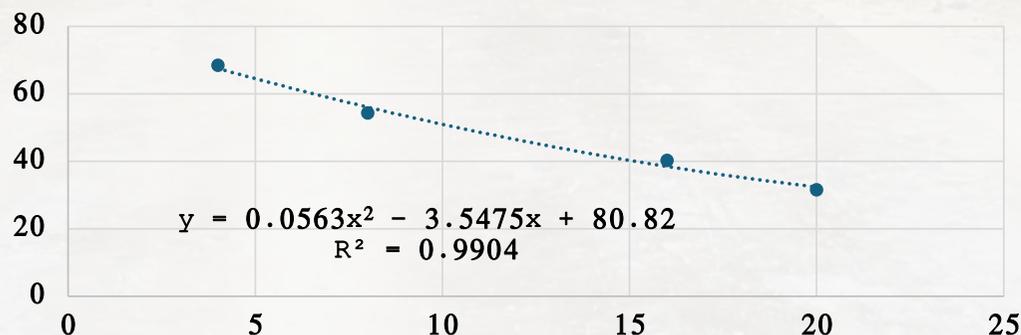
J. Dairy Sci. Vol. 102, Suppl. 1

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Key Words: lysine, methyl donor, rumen protection

Degradabilidade Ruminal de acordo com o tempo de Incubação



Eficiência da Proteção (TMR)



2268 Evaluating the total mixed ration stability of rumen-protected choline products. K. A. Estes^{1,2}, M. G. Zenobi*¹, C. A. Zimmerman¹, and M. D. Hanigan², ¹Balchem Corporation, Montvale, NJ, ²Virginia Tech, Blacksburg, VA.

A technique has been established to determine the TMR stability of rumen-protected (RP)-lysine products, but the TMR stability of RP-choline (RPC) products has not yet been explored. The objective of this experiment was to evaluate the TMR stability of 5 RPC products using a modified technique. Triplicate Ziploc bags containing RPC (equivalent of 1 g of choline chloride [CC]), no RPC (negative control), or unprotected CC (positive control; 1 g of CC) mixed with 200 g of TMR (38% DM) were incubated at room temperature (22°C) and unsealed for 0, 6, 12, and 24 h. At the end of each time point, bag contents were transferred

Table 1 (Abstr. 2268). Rumen-protected choline (RPC) release (%) at different TMR exposure times

TMR exposure time (h)	RPC					SEM
	A	B	C	D	E	
0	14.5 ^a	10.9 ^a	2.9 ^b	0.8 ^b	1.2 ^b	0.9
6	70.1 ^a	74.8 ^a	10.7 ^c	1.7 ^d	24.0 ^b	1.6
12	81.7 ^a	88.1 ^a	16.0 ^c	2.5 ^d	43.8 ^b	1.7
24	98.8 ^a	103.8 ^a	25.5 ^c	4.9 ^d	62.5 ^b	1.4

^{a-d}Within a time point, values with different superscripts differ, $P < 0.05$.

to strainer bags and soaked in 1 L of distilled water for 1 min to solubilize any free CC released from the products. A sample of solution was filtered (0.45 μ m) and stored at -20°C until analysis for CC content using a YSI biochemical analyzer. The CC content for samples containing RPC or unprotected CC were corrected for background CC measured in the negative control samples. Recovery of unprotected CC was influenced by TMR incubation time and was not complete (78%, 61%, 59%, and 51% at 0, 6, 12, and 24 h of TMR exposure, respectively). Thus, a correction factor was applied to samples containing RPC to account for unrecovered CC released from the products. Total CC release was calculated for RPC. Data were analyzed using the MIXED procedure of SAS. Means within an incubation time were separated using the Tukey adjustment. At time 0, products C, D, and E experienced minimal CC release (Table 1). Products A and B had a similar release pattern to one another across the 4 time points and were the 2 products with the highest CC release at all exposure times. Product D was the most stable from 6 to 24 h. The modified technique detected vast differences in TMR stability across RPC products over a 24-h period.

Key Words: rumen protected choline, TMR, choline

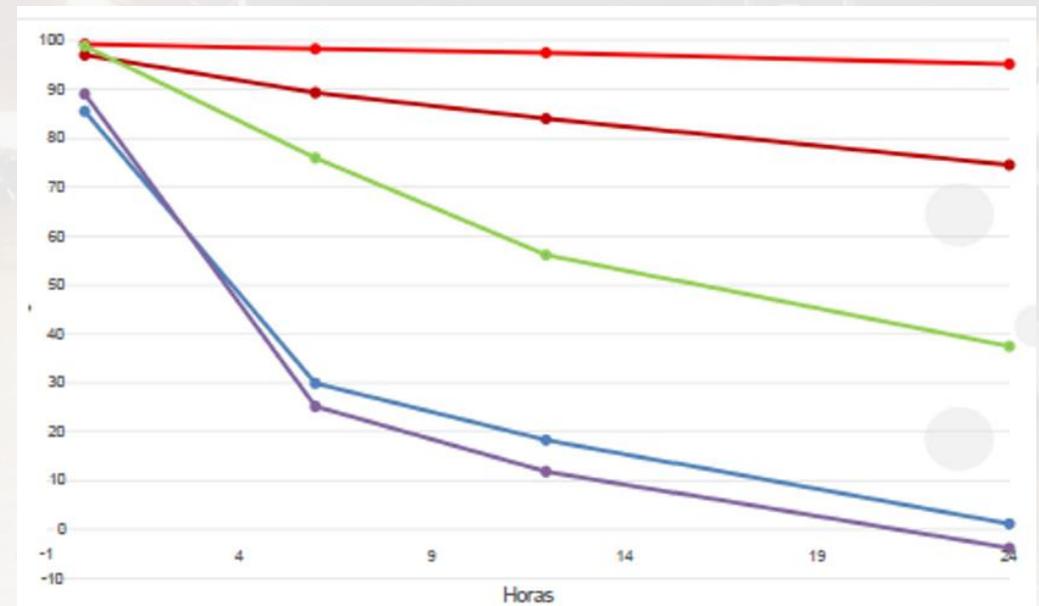
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^{a-d}Within a time point, values with different superscripts differ, $P < 0.05$.



Conclusões Sobre o uso de Vitaminas Protegidas em Ruminantes



- Ambas as vitaminas são altamente degradáveis no rúmen, exigindo proteção ruminal para eficácia.
- Buscar informações sobre o tipo e eficácia da proteção é fundamental.
- Conhecer as taxas de degradação ruminal e no ambiente auxiliam na tomada de decisão.
- A suplementação estratégica de colina e niacina deve ser considerada:
 - No pré e pós-parto imediato, quando a pressão metabólica é mais intensa.
 - Como ferramenta de manejo nutricional preventivo para distúrbios metabólicos.
- Doses de referência (dependem do produto e objetivo):
 - Colina protegida: 12 a 25 g/d de Ion Colina Metabolizável
 - .
 - Niacina protegida: 4 a 8 g/d (eficaz a partir de 4,7 g/d).



Considerações Finais Suplementação Estratégica em Ruminantes

O Uso de aditivos Protegido do Rumen é uma importante estratégia disponível atualmente para nós nutricionistas aumentarmos nosso leque de escolhas e sermos mais assertivos em dietas.

No entanto, não devem ser usados como pontes de salvação ou produtos milagrosos que irão resolver grandes problemas onde o básico não esta sendo feito de forma correta.

Analisar cada caso de forma

A black and white cow is standing in a metal stall in a barn. The cow is looking towards the camera. The barn has a high ceiling with skylights. The cow is wearing a red collar with a black tag.

OBRIGADO!

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