Midwest Dairy Conference

6-14-23

Noah Litherland, Ph.D.
Zach Sawall, Ph.D.

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Outline

- History of AMS feeding strategies
- Cow behavior in AMS system
- Fresh cow feeding strategies
- TMR feeding strategies
- Pellet amount and formulation strategies
- Take-home messages

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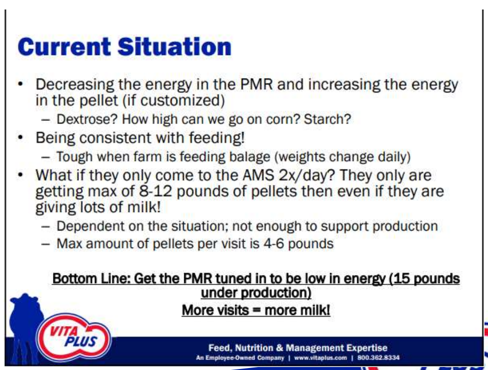
State of the union 2015



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Cow behavior

- Cows are still prey animals and reduce visits over night
- Early morning and late afternoon highest cow activity
- Cows go to robot based on udder pressure

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Fresh cow feeding strategies

- **Free choice some hay**
- **Separate grain mix**

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TMR feeding strategies

- **TMR or PMR???**
- **Where do you balance intakes at?**
- **What level of production should TMR be balanced at?**
- **How much energy is in the bunk vs robot?**

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Pellet amount and formulation strategies

- **How many lbs of pellet to feed?**
- **What kind of pellet?**
- **Nutritional value of the pellet/grain mix**
- **Settings within the robot**
  - Drop feed within the first 2 min of cow entering the robot
  - Pellet consumption is 2/3 lb per min
  - Grain mix consumption is 1/3 lb per min

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Take-home messages

- **Utilize natural cow behavior to do chores**
- **Minimize pellet/grain thru the robot**
- **Feeding the cows at the bunk drives components and profitability**
- **Formulate pellet/grain to match the TMR composition.**

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Topics for today

1. KPI's
2. Close-up dry cows and maternity
3. Inflammation in fresh cows (ISU)
4. Biogenic amines
5. Mitigate risk of enteric and respiratory pathogens
6. Moderating diet rate of passage by blending grass and alfalfa
7. Robot pellet formulation and quality control
8. On-farm corn processing
9. Water quality

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Item	KPI
Milk, lb/cow/d	100-105
Days in milk	160-170
Energy Corrected Milk	105-115 (7.5 lb F+ P)
Milkings/cow/day	2.8-3.0
Refusals/cow/day	1.6-1.8
Somatic cell count	<100,000
Cows per robot	60
Total milking cows	716
Milk speed	8.5
Milk yield/milking	36.3
Pellets/100 lb milk	11-12

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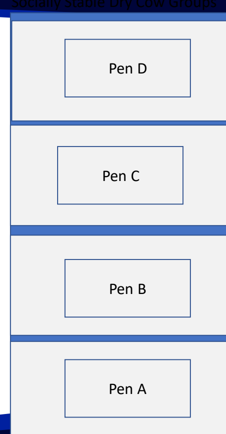
Socially Stable Dry Cow Groups



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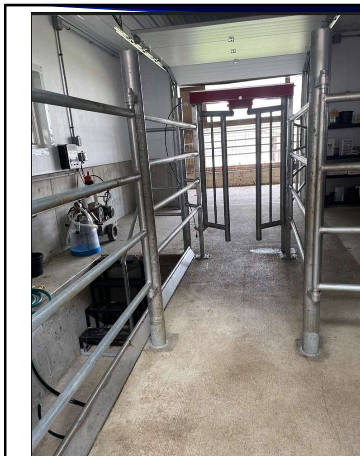

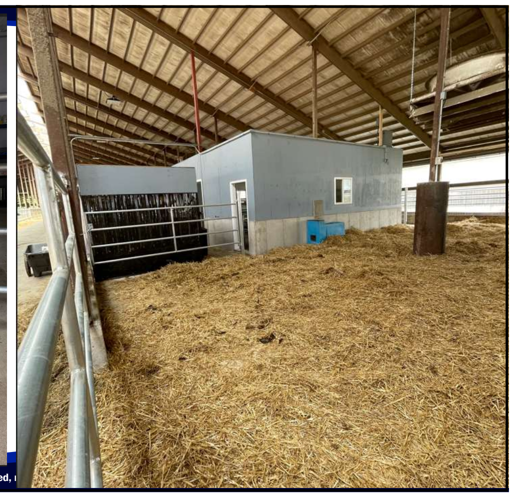

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Postpartum Rest

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Fresh Cow Robot-on the wish list

- **Dedicated fresh cow pen**
- **PMR and pellets formulated for fresh cows**
  - PMR formulation amount
  - Moderate starch
  - Grass hay
  - Choline
- **Increased attention for heifers to ensure they are milked out**
- **Graduate when ready**

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Troubleshooting.....

Fresh cow health challenges:

1. **Hypocalcemia.**
2. **Low rumination.**
3. **Hind-gut fermentation/gas.**
4. **Displaced abomasum**
5. **Subclinical ketosis**

What can your nutritionist do to mitigate these risks????

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Inflammation likely plays a significant role in fresh cow disorders

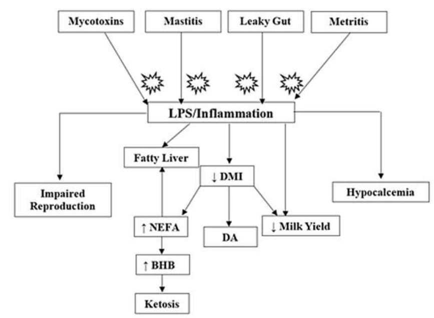

Figure 4. Potential downstream consequences of immune activation. In this model, decreased feed intake, hypocalcemia, excessive NEFA, hyperketonemia and hepatic lipidosis are not causative to poor transition cow performance and health, but rather a reflection of prior immune stimulation.

Abeyta 2022 Proceedings 4-state Dairy Nutrition and Management Conf.

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Dry-off Inflammation and its Association with Transition Cow Performance

B. M. Goetz, M. A. Abeyta, S. Rodriguez-Jimenez, J. Opgenorth, A. D. Freestone, E. J. Mayorga and L. H. Baumgard

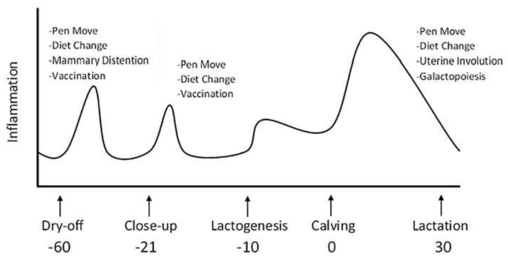

Figure 1: The inflammatory response associated with the multiple insults occurring to dairy cows from dry-off to calving

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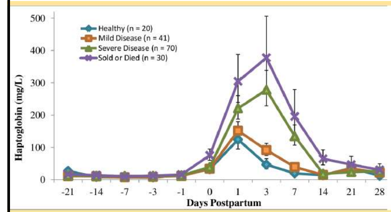
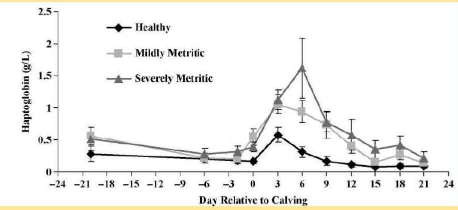
Increased haptoglobin proceeds clinical disease



Sebedra 2012



Huzzey et al., 2012

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Biogenic Amines

- **Biogenic amines histamine, tyramine, cadaverine, and putrescine**
- **Causative ages of food poisoning**
- **Absorbed amines cause abdominal cramping, headache, flushing, fever, swelling, and hypertension.**
- **For cows and calves…occurs in:**
  - Bad haylage
  - In the rumen in high starch/high protein diets.
  - During body fat mobilization

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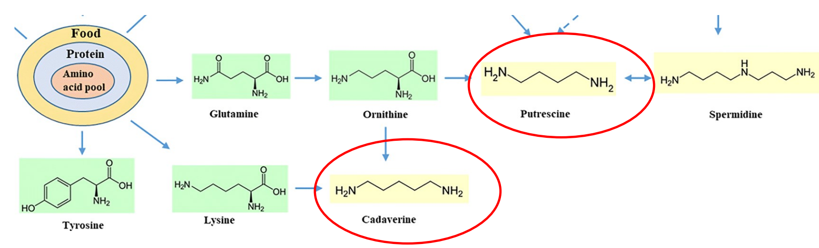
Biogenic amines



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Biogenic amines-Focus on fresh cows

- **Appear to cause a shift in intake and fermentation**
- **Effects on intake are dependent upon amount of biogenic amines escaping the rumen**
  - Variation in rate of degradation (biogenic amine type and diet factors)
- **More than forage effects……**
- **Diet composition**
  - Starch, RDP, rate of passage
- **Body condition score?**
- **Variation in intestinal absorption into blood.**

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Certificate of Analysis

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Madison WI

TRILOGY

Trilogy Analytical Laboratory
office: 636.239.1521
toll free: 855.256.8244
fax: 636.239.1531

870 Vossbrink Drive,
Washington, MO 63090 USA

Biogenic Amine	Haylage ppm	BA Intake mg/hd/d	%
Cadaverine	58.0	368.3	10.2
Histamine	25.9	164.5	4.6
Phenethylamine	92.8	589.3	16.4
Putrescine	45.8	290.8	8.1
Spermidine	12.5	79.4	2.2
Spermine	6.1	38.7	1.1
Tryptamine	0.0	0.0	0.0
Tyramine	326.2	2071.4	57.5
Total	567.3	3602.4	100.0

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J. Dairy Sci. 95:6606–6623
http://dx.doi.org/10.3168/jds.2012-5403

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A metabolomics approach to uncover the effects of grain diets on rumen health in dairy cows

- **Rumen fluid samples from 8 dairy cows fed barley 0, 15, 30, and 45% diet DM.**
- **21 day period w/ 11 day adaptation**

Table 2. Concentration (μ*M*, unless otherwise stated) of rumen metabolites in dairy cows fed graded amounts of barley grain as determined by GC-MC (LSM ± SEM; n = 8)

Metabolite[1]	Metabolic pathway[2]	Barley grain proportion (% of diet DM) 0	15	30	45	SEM	*P*-value[3] Linear	Square
AA metabolism								
4-Aminobutyrate	AAM, BM	66.1	75.7	86.3	103.1	4.84	<0.01	0.46
Hydrocinnamic acid	BM	633	523.8	487.7	406.9	27.4	<0.01	0.6
Methionine	GM, PM, SMB	20.6	24.6	34.6	47.1	3.21	<0.01	0.17
Phenylalanine	SM, TM, SMB	28.9	35.7	64.5	77.7	3.8	<0.01	0.46
Putrescine	APM, SMB, GM	26.4	52.2	122.2	314.7	12	<0.01	<0.01

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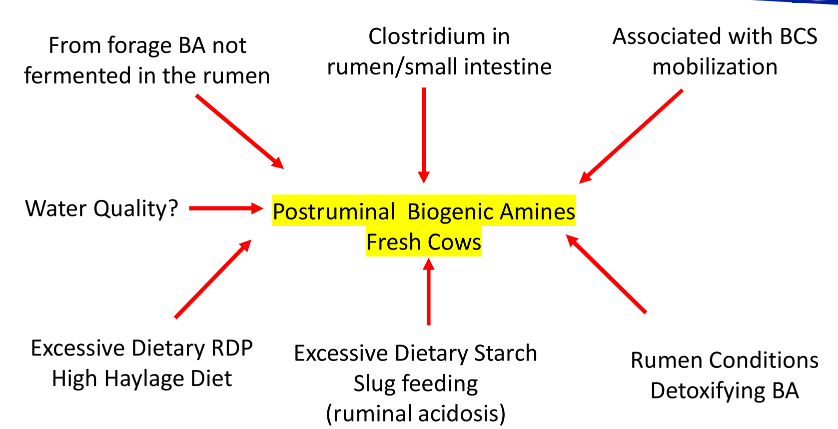

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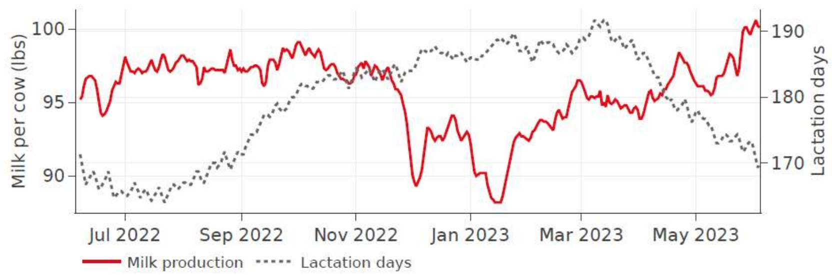
Gut and respiratory challenges impacting milk production



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Exploring forage options

Winter Rye (2023)

Description (%DM unless specified)	Dry Matter Basis	Small grains 60 dy Avg
Dry Matter	47.89	15.4
Moisture	52.11	84.9
Crude Protein	11.54	19.3
Avail. Crude Protein	11.31	19.0
ADICP	0.23	0.316
NDICP	1.42	1.64
Soluble Protein, %CP	21.77	35.4
ADF	33.57	29.0
aNDFom	50.50	42.5
Lignin	4.61	3.72
NDFD 48, %NDF	67.92	77.5
uNDF240	8.41	4.61
Fat (EE)	3.13	4.33
Total Fatty Acid (1.2x)	1.65	2.03
Sugar (WSC)	16.45	13.7
Ash	8.58	10.6
Calcium	0.18	0.235
Phosphorus	0.30	0.398
Magnesium	0.13	0.167
Potassium	2.22	3.11
Sulfur	0.11	0.201
Calculations* **		
RFV	108	135
RFQ	131	184
NDF Kd, %/hr	6.02	7.27

3rd crop Alfalfa Silage (2022)

Description (%DM unless specified)	Dry Matter Basis	Legumes (60 dy Avg
Dry Matter	49.60	42.4
Moisture	50.40	57.6
pH	4.72	4.79
Crude Protein	23.37	22.0
Avail. Crude Protein	22.37	21.1
ADICP	1.00	0.889
NDICP	2.53	1.82
Soluble Protein, %CP	50.12	52.0
Ammonia-N, %CP	5.84	8.38
ADF	31.34	33.9
aNDFom	29.69	35.1
Lignin	7.04	7.64
NDFD 48, %NDF	51.77	50.1
uNDF240	13.77	17.0
Fat (EE)	3.11	3.00
Total Fatty Acid (1.2x)	2.13	1.85
Sugar (WSC)	8.31	6.21
Ash	10.67	11.8
Lactic Acid	3.61	4.80
Acetic Acid	0.90	1.44
Butyric Acid	0.09	0.178
Fermentation DM Loss**	2.14	2.59
Calculations* **		
RFV	177	148
RFQ	191	151
NDF Kd, %/hr	7.15	7.90

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50.5-8.41 = 42.1%

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2.6 times

more potentially digestible NDF

(aNDFom- uNDF240) = potentially digestible NDF

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Robot pellet formulation

Code	Ingredients	Batch Wt
900610B	WHEAT MIDDLINGS	618.70
900417B	SOYBEAN MEAL HI PRO (V+)	458.13
900113	CORN GROUND SHELL	323.62
900997B	EXCELLER MEAL	175.05
900079B	CANOLA MEAL	152.04
901070B	SOY HULLS, GROUND	122.41
900433	STARCH	70.02
900255	MOLASSES, LIQUID	60.02
900070B	CALCIUM CARBONATE	20.01
Total		2,000.00

Nutrient	Unit	As fed	Dry Matter
DM	%	86.98	86.98
NEl	Mcal/lb	0.72	0.83
TDN	%	68.51	78.76
CP	%	23.83	27.40
Fat (EE)	%	2.93	3.37
CF	%	7.59	8.73
ADF	%	10.16	11.68
aNDFom	%	21.39	24.59
Starch	%	19.79	22.76

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PDI-Pellet durability index

Batch #	OPERATOR	TONS	START TIME	STOP TIME	FEEDER SPEED	PELLET MILL %	STEAM PRESS.	TEMP TO DIE	AMBIENT TEMP.	AMBIENT HUMIDITY	PDI
87057	CHRIS	23	9:25	2:25	50	120		145	82	49	95%
87173	CHRIS	23	4:45	8:50	52	120		140	83	42	91%
87314	CHRIS	23	1:45	5:55	56	110		145	83	44	88%
87374	CHRIS	8	6:10	7:40	54	120		135	85	42	88%
87443	CHRIS	23	3:15	6:55	58	120		150	80	39	91%
87556	CHRIS	23	4:10	8:10	58	120		150	81	45	89%
87689	CHRIS	23	7:40	12:25	48	120		140	79	48	94%
87808	CHRIS	23	6:10	10:25	60	110		150	84	58	85%
87894	CHRIS	8	10:00	11:20	60	110		140	65	44	92%
87916	CHRIS	23	7:40	11:30	58	120		150	65	41	90%
88083	CHRIS	23	6:20	10:30	54	120		145	76	33	89%
88169	JEFF	5.75	11:35	12:35	62	110		160	70	51	90%
88169	CHRIS	17.25	1:30	4:40	60	110		160	75	49	90%

- **Some factors influencing PDI-**
  - Formula, ingredient particle size, pellet mill speed, batch size, environmental temperature and humidity.

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Corn Processing

- **First 3 sieves yielded 14.5% of sample**
- **1.6 lb/hd/d**
- **Mean particle size of 491 microns**
- **Standard deviation of 2.75**

US Sieve #	Sieve Opening (microns)	Weight (gm)	Percent on Sieve
8	2380	1.4	1.41
10	2000	2.9	1.47
16	1190	22.6	11.64
30	600	28.4	16.56
Pan	45	43.9	30.68
	TOTAL =	99.2	

Average (mean) particle size (microns)	491.05
Uniformity (standard deviation) of particle size	2.75

Ranking*	Particle Size Uniformity	
Excellent	1.0 - 2.0	
Good	2.0 - 2.3	
Fair	2.3 -2.6	
Poor	> 2.6	*As determined by KSU

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Iron concentration in water

- Potential for decreased palatability.
- Increased oxidative stress contributing to immune dysfunction.
- Iron is a free radical and can cause cellular damage leading to oxidative stress.
- Decreased absorption of copper, manganese, and zinc.
  - This is thought to be due to competition for binding sites for trace mineral absorption and binding of trace minerals to iron resulting in decreased absorption.
- Iron is a nutrient required by salmonella (and essentially all other organisms).
- Dr Sockett has a short paper focusing on Salmonella control in calf facilities where he references water iron concentration greater than 0.3 ppm increase persistency of gram-negative bacteria in the intestine

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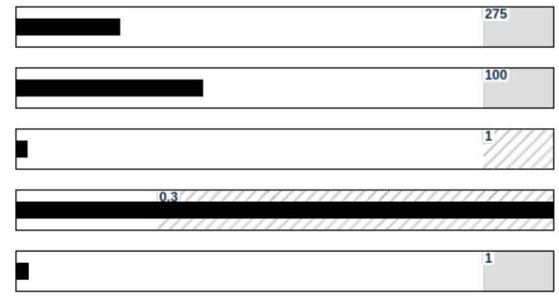
Water mineral analysis

	Units	Value
Calcium	ppm	60.83
Magnesium	ppm	39.89
Copper	ppm	0.02
Iron	ppm	1.14
Zinc	ppm	0.03



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Environment impacts cow behavior

- **Temperature influences air speed/air turn-over in cross-vent barns.**
  - Air quality, cow lying behavior, feeding behavior (meal size and frequency)
- **Seasonal rhythms impact cow behavior**
- **Diet composition and timing of delivery impacts microbial ecology of the rumen (Penn State)**
- **Heat stress has multi-generational effects on performance (U. Florida/U Wisconsin)**

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Other factors impacting ECM yield

- **Sand amount in free-stalls (yo-yo effect)**
- **Feed pusher failures (effect for days after failure)**
- **Running PMR amounts too tight**
- **Additive effects of disruptions-impacting cow behavior**
  - Sand bedding, hoof trim, robot maintenance, herd health, etc.
- **Hoof health**
- **Physiological maturity of heifers**

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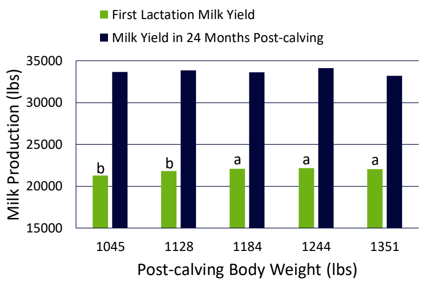
Freshening – weight



Han et al., 2020

- Mature body weight 1530 lbs
- 85% MBW = 1300 lbs
- Heaviest 60% produced 557 lbs more milk in 1st lactation.

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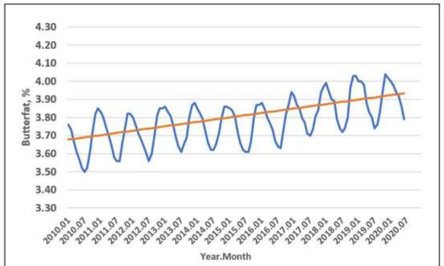
Milk fat has continued to increase with improvements in genetics, forages, nutrition, and cow care

Figure 1. Monthly milk fat concentration for all Federal Milk Marketing Orders from January 2010 to July 2020.



Source: https://www.ams.usda.gov/resources/marketing-order-statistics/total-receipts-producer-milk-order

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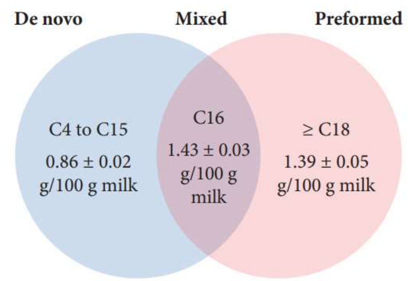
How is milk fat made?

Figure 2. Categorization of milk fatty acids by origin and values for 305 milk samples taken over a 13-month period from a Holstein herd averaging 3.84% milk fat.



http://www.whminer.org/pdfs/04-17.pdf, page 8. Accessed November 2020.

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Table 1. FA composition (g/100 g total FA) of fats and oils.

Fatty acid: Common name:	C16:0 Palmitic[1]	C16:1 Palmitoleic[2]	C18:0 Stearic[1]	C18:1 Oleic[2]	C18:2 Linoleic[2]	C18:3 Linolenic[2]
Corn	10.9	-	1.8	24.2	58.0	0.7
Cottonseed	22.7	0.8	2.3	17.0	51.5	0.2
Soybean	10.3	0.2	3.8	22.8	51.0	6.8
Canola	4.8	0.5	1.6	53.8	22.1	11.1
Linseed (flax)	5.3	-	4.1	20.2	12.7	53.3
Choice white grease	23.4	4.3	13.3	43.4	10.9	1.3
Palm	43.5	0.3	4.3	36.6	9.1	0.2
Tallow	24.5	3.7	19.3	40.9	3.2	0.7

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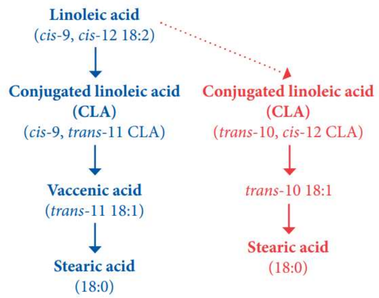
Figure 3. Pathways of the rumen biohydrogenation of linoleic acid under normal conditions (left side) and during diet-induced milk fat depression (dotted line).



Source: Bauman DE, Mather IH, Wall RJ, Lock AL. Major advances associated with the biosynthesis of milk. Journal of Dairy Science. 2006 Apr 1;89(4):1235-43.

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