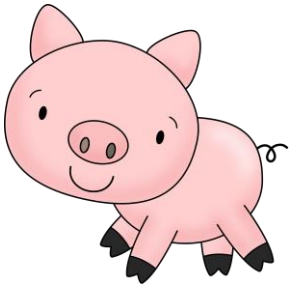


Pork or Beef?

Pork plasma has been successfully used in CMR since plasma was first investigated in milk replacers in the 1990s

During the BSE crisis of 2004 all users were converted from bovine to porcine plasma or serum, and with success.

CFIA only allows importation of pork plasma into Canada, thus Nutrapro P has been successfully used in the Canadian milk replacer industry for more than a decade

Nutrapro P and Nutrapro B have the same intense quality standards

Intuitively bovine plasma is best for the calf (22 – 23% bovine IgG), but research shows pork plasma performs well and that it delivers health benefits to calves.

Pork plasma research summary

2023: pork plasma vs. colostrum vs. antibiotic used as interventions in diarrheic calves. NSD. n=95

2021: All-milk vs. 5% pork plasma vs. 10% pork plasma, 90 lbs. CMR/calf. NSD. n=320

2020: All-milk vs. 5% pork plasma vs. 5% beef plasma. Traditional Calf Ranch strategy. ↓scours. n=90.

2019: All-milk vs. All-milk + additives vs. 5% pork plasma. ↓scours. n=158

2003: All-milk vs. 5% pork plasma vs. 5% beef plasma. ↓mortality. ↓scours. ↑starter intake. n=120

2001: Bovine vs. Porcine as day 1 – 15 additive to all-milk CMR. Pork ↓scours. n=120

1999: All-milk vs. 10 or 25 g/L beef vs. 25 g/L pork. *E coli* challenge. Beef ↓ scours, fever, *E coli* shedding, and mortality, pork did not. n=24.

1995: All-milk vs. 7% pork plasma vs. 7% beef plasma. Both pork and beef ↑body weight gain. n=120

1992: Skim milk vs. pork plasma with or w/o NT in veal feed starter. Pork ↓scours and ↑BW gain w/NT. n=102.

1991: All-milk vs. pork vs. beef. NSD in ADG or scour scores. n=96.

NSD = No Significant Difference

10 reputable studies. 5 were published, 2 presented at ADSA.

Pork Plasma: Research Summary

10 studies examining pork plasma encompassing **1,245 calves** reared in a broad range of environments and on different nutrition strategies, including:

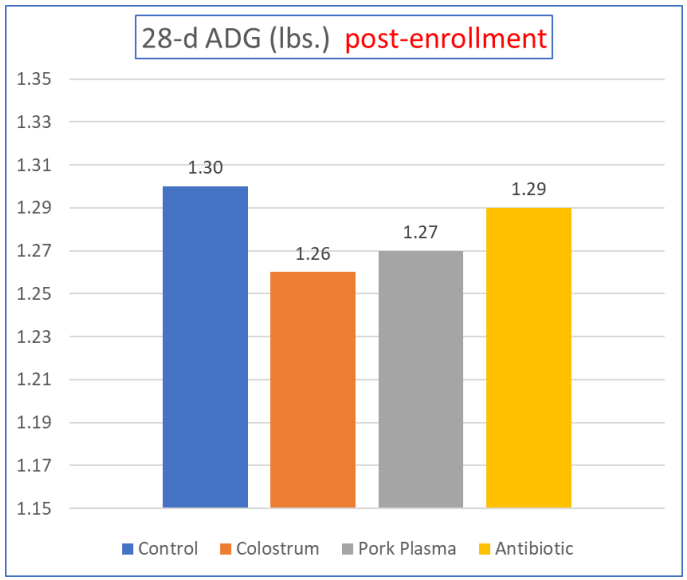
1.) Mechanically ventilated barns on a relatively hi plane of nutrition (65 to 90 lbs. CMR) and excellent starter grain: 3 studies, 573 bull calves, mostly Holsteins, some crossbreds, Mapleview Agri, Ontario, Canada
2.) California calf ranch. Calves housed in hutches fed very traditional CMR and grain strategies coordinated by Fresno State University using 90 calves
3.) APC's former calf research unit coordinated by Jim Quigley PhD and his staff of ISU students he employed when there. Hutches, traditional CMR strategies. 2 studies, long transport Holstein bull calves. 240 calves.
4.) University of Gent in Belgium, *E coli* disease challenge study. 24 Holstein calves
5.) Kansas State University, traditional feeding strategy, long transport Holstein calves reared in hutches. 120 calves.
6.) Special milk fed veal. Traditional veal feeding strategy, no grain or forage. 102 calves. Vitek (Animix predecessor).
7.) First studies conducted at MSC in 1991, Holstein heifer calves reared in ex-veal facility. Boscobel. Janusz Sowinski. Pork comparable ADG to all-milk

Bottom line: Pork vs. All-milk

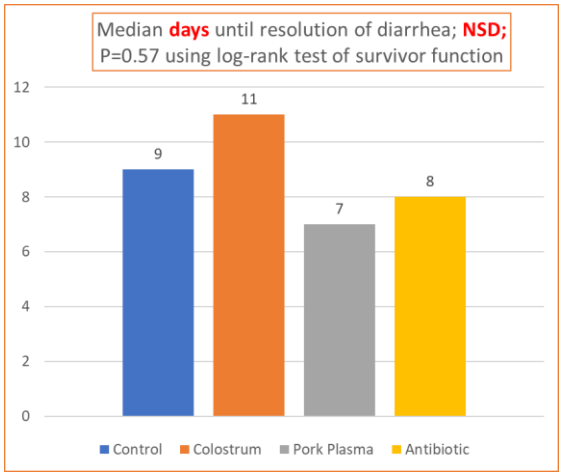
Pork plasma in CMR, 10 reputable studies:

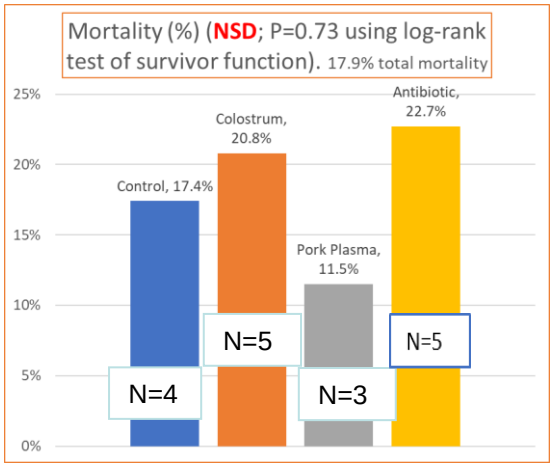
- ✓ Results in no significant difference in ADG in 7 of 10 studies and significant ↑ in ADG in 3.
- ✓ Results in a significant reduction in scours in 5 of 10 studies and no significant difference in 5.
- ✓ One study noted significant in mortality, and another in ↑ starter intake

Pork Plasma vs. Colostrum vs. Antibiotic as intervention at onset of diarrhea (2022)



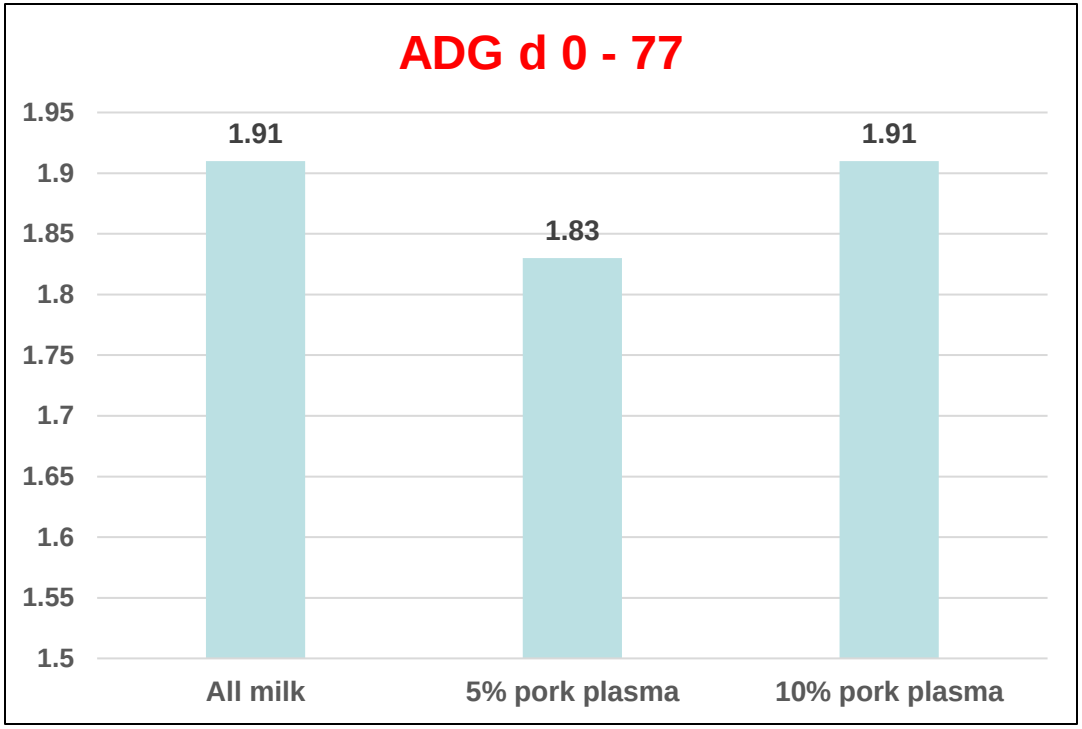
in a one-way ANOVA NSD between groups (P=0.99). Also, no significant difference (**NSD)** between groups in a linear regression model.





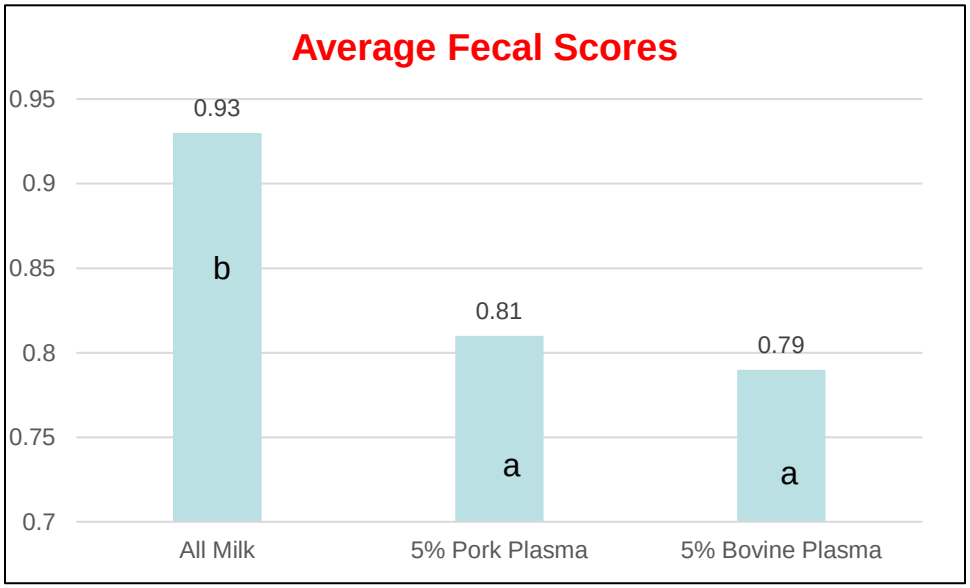
Calves fed 83.3 lbs. 26:20 all-milk CMR, 2x/d strategy, in step-up, step-down fashion over 56 d. Texturized starter ad lib. Calves were enrolled when experiencing 2 consecutive days scour score 2, or one day of scour score 3, and then followed for 7 consecutive days with resolution of diarrhea defined as 2 consecutive scoring periods w/scour score of 0 or 1. Treatments: 1.) CMR (26:20) with spray dried colostrum (SCCL, 30g/fdg), 2.) Same CMR (26:20) with pork plasma (APC, Nutrapro P, 30 g/fdg), 3.) Same CMR no functional protein + injection trimethroprim sulphadoxine (Borgal) at 3 mL/d for 5 d, or 4.) CONTROL, same CMR (26:20) but NO injectable antibiotic. N=95 calves. Wood et al, Mapleview Agri, will be presented at ADSA Ottawa, 2023.

“All Milk” vs. 5% Pork vs.10% Pork (2021)

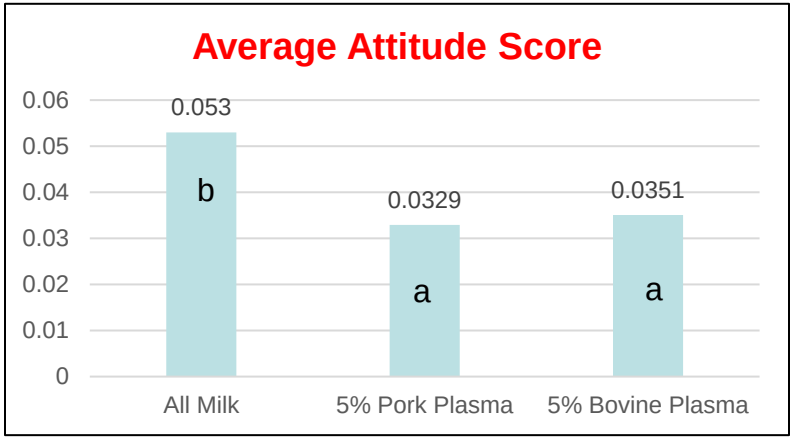


89.8 lbs of 26:20 to d 56 fed in a step-up, step-down fashion. 20% CP starter *ad lib*. NSD in ADG pre- or post-wean or in entire 77 d study (P=0.98). Prewean F:G 1.86, 1.9, 1.82 for all-milk, 5% pork, and 10% pork, respectively (P=0.86).NSD in scour score (P=0.12). Low mortality. N=320 calves. Wood et al, JDS Comm 2021;2. Mapleview Agri, Ontario, Canada

“All Milk” vs. 5% Pork vs. 5% Beef (2020) California Calf Ranch – summer heat stress



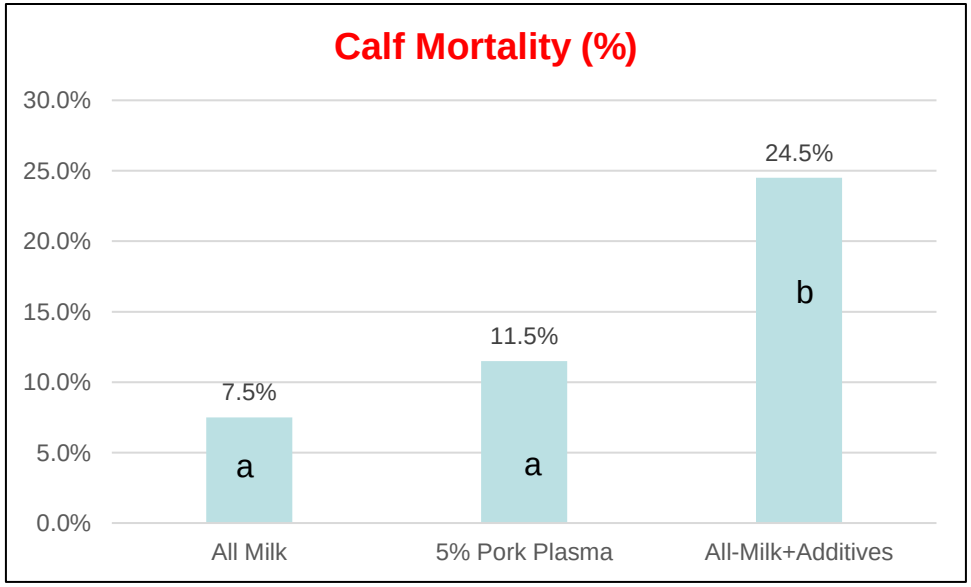
Subscripts different, P<0.05



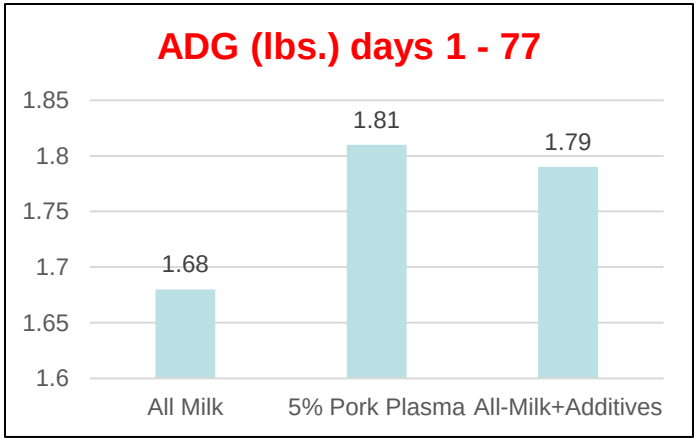
Subscripts different, P<0.05

63 lbs of 22:20 to d 56 fed in traditional calf-ranch 4 quart/d with 1x/d feeding week 8 wean. Starter *ad lib*. NSD (P>0.05) in 56-d body weight (BW). BW (lbs.) d 56 was 164.7, 165.9, and 167.3 lbs. for all-milk control, 5% pork plasma, and 5% bovine plasma, respectively. Calves fed either plasma-containing milk replacer were also started on one dose of Lifeline Protect (APC, bovine serum) at placement. Both pork and beef plasma reduced (P<0<0.05) average fecal scores and average attitude scores. Treatment costs were numerically reduced in both plasma groups vs. the all-milk. N=90 calves. Fringer et al, Fresno State U, 2020 ADSA Poster M66.

“All Milk” vs. “All Milk” + additives vs. 5% Pork Plasma (2019)



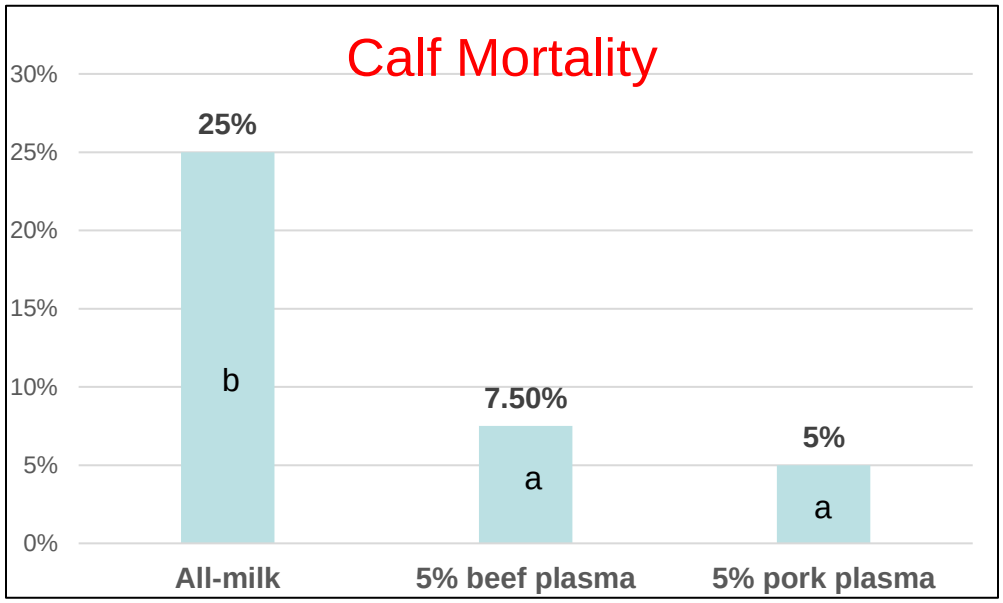
Subscripts different, P<0.05



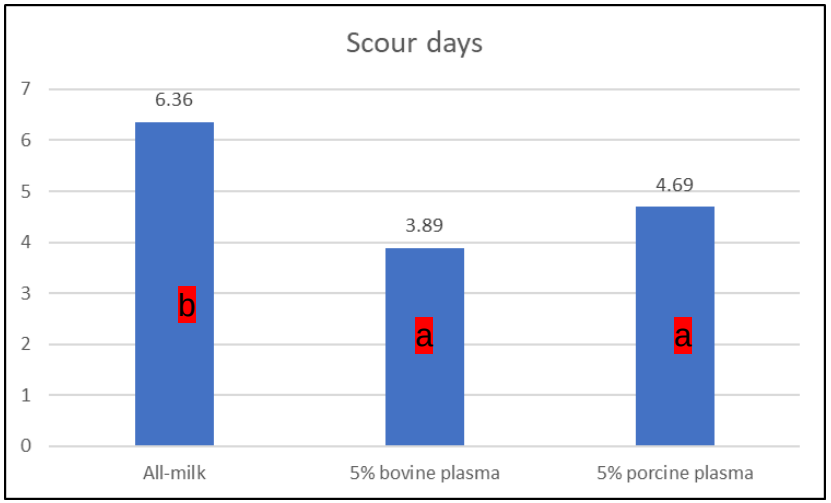
No significant difference (NSD)

65.3 lbs of 26:17 to d 49 fed in a step-up, step-down fashion. “Additives” were Bioplus 2B 1.28 million cfu bacillus/lb. CMR(Chris Hansen) & Na Butyrate (Profmormix, Probiotech, 70% concentration, 2 kg/metric ton).18% CP starter *ad lib*. NSD (P>0.05) in ADG pre- or post-wean or in entire 77 d study. ADG d 0 to 77 was 1.68, 1.81, and 1.78 lbs. for the all-milk, 5% pork plasma, and all-milk+additives groups, respectively. Proportion of time with fecal score 3 (watery stool) was reduced (P<0.05) when pork plasma was fed vs. either the all-milk or all-milk+additives. Mortality was 7.5%, 11.5%, and 24.5% for all-milk, 5% pork plasma, and all-milk+additives, respectively. N=158 calves. Wood et al, JDS, 2019, 102:7183. Mapleview

“All Milk” vs. 5% bovine vs. 5% Porcine (2003)



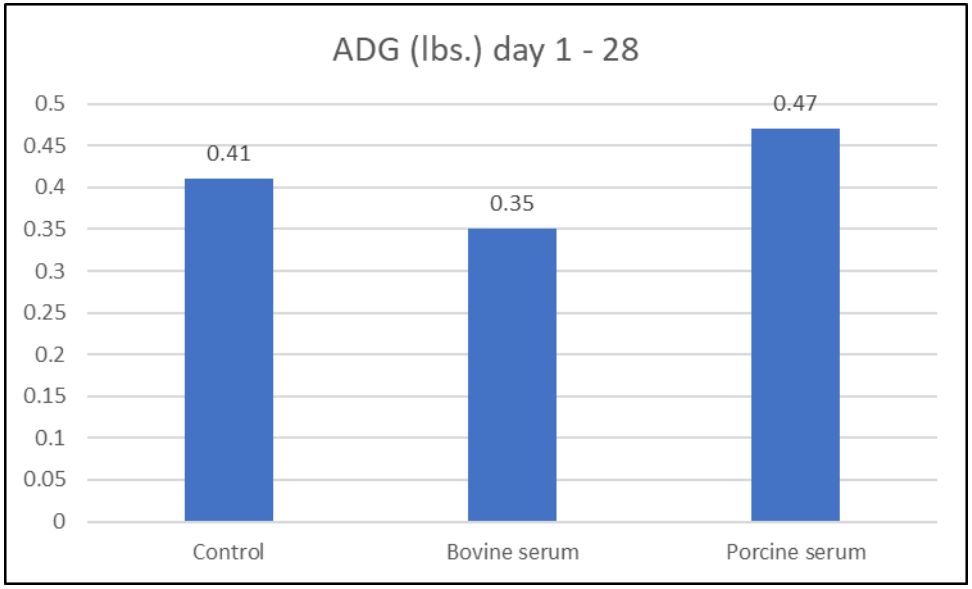
Subscripts different, P=0.003



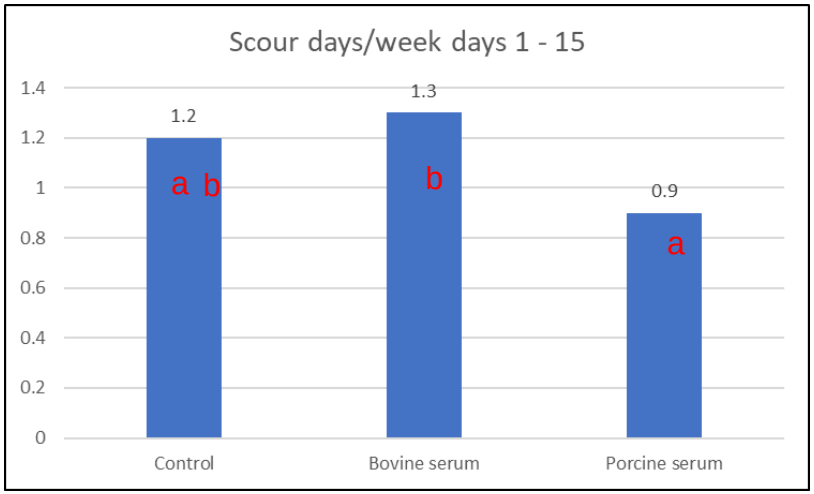
Subscripts different, P=0.009

APC research. Quigley et al, 2003 JDS 86:586; 20% CP, 20% fat, 49.3 lbs CMR/calf, free choice starter. ADG d 0 – 28 tended (P=0.08) less for pork vs. beef, but NSD with all-milk.Avg daily starter intake d 0 – 42 ↑ (P=0.05) for both bovine and porcine plasma compared to the all-milk (0.35, 0.43, and 0.42 lbs./d for all-milk, beef, and pork, respectively). n=120 calves. Both beef and pork plasma lowered mortality vs. “all-milk” control, P<0.05.

APC unpublished work, 2001, Quigley
CMR +/- NT 200/400 & added pork or beef serum



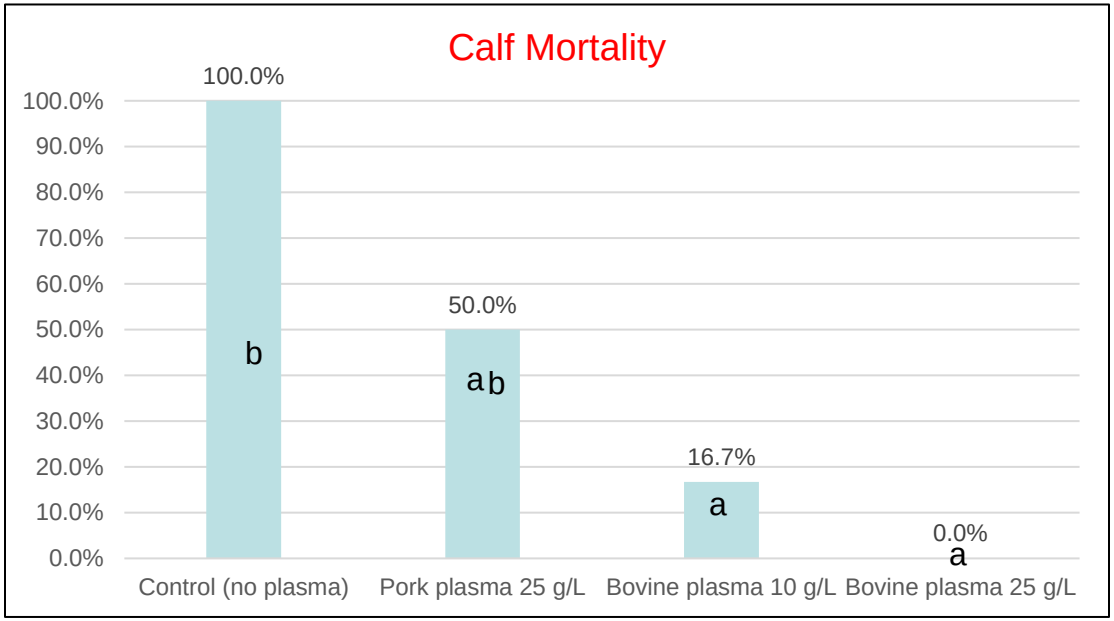
No significant difference



Subscripts different, P=0.08

Calves were assigned at placement to either a.) Gammulin using bovine serum, b.) Gammulin using pork serum, or c.) no Gammulin. Calves were fed 22:20 all-milk CMR either with or w/o NeoTerra 200/400. Gammulin was 80% serum when I worked at APC, and it contained FOS and modest VTM supplementation. ADG d 0 – 56 was 1.03 (ab), 0.96 (b), and 1.12 (a) lbs./d for control, bovine, and porcine, respectively (subscripts different P=0.06). Gammulin was fed at 1.5 lbs. per calf over the first 15 days (60, 45, 30 g/d during d 1-5, 6-10, 11-15, respectively. Calf mortality was 2, 1, and 1 for control, bovine, and porcine, respectively. N=120 calves. Quigley, APC unpublished research JDQ0104, 2001.

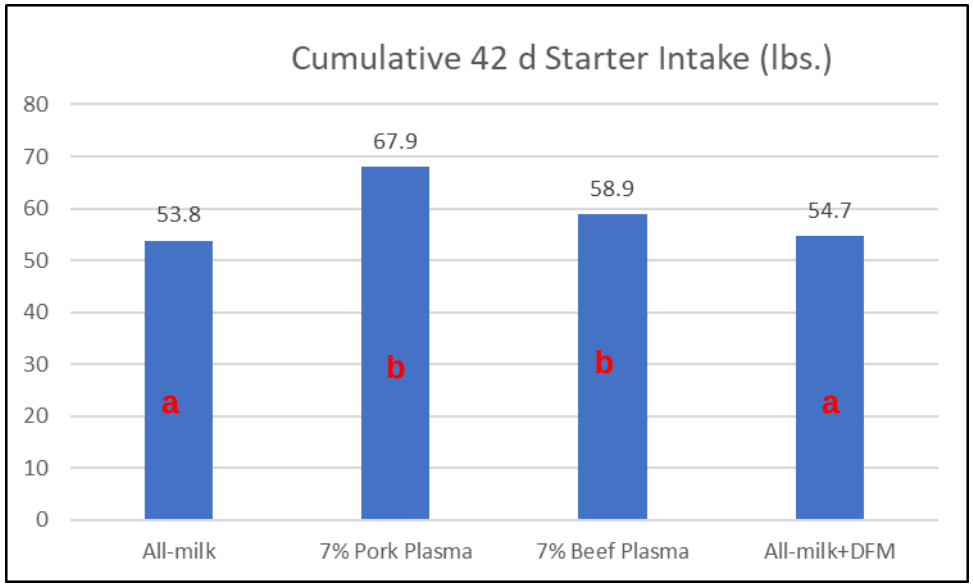
E coli (F5+ & F17+ strains) disease challenge study University of Gent, Belgium (1999)



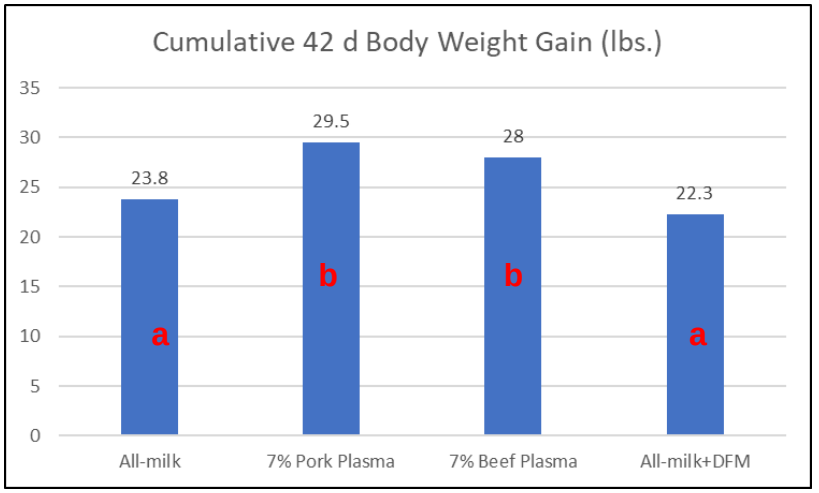
Subscripts different, P<0.0399. Pork plasma fed calves tended ↓mortality (P=0.0665) for F+5 but NSD (P=0.4913) for F+17 vs. control.

24 newborn colostrum-deprived calves fed 2 L sterilized whole milk 3x/d for 2 weeks post infection. Grain and hay ad lib thereafter accompanied with CMR. 4 groups of 3 calves were infected orally at 12 – 24 h age and again immediately prior 1st milk feeding with F5+ *E coli* & fed via milk either a.) no plasma powder, b.) bovine plasma 25 g/L, c.) bovine plasma 10 g/L, or d.) porcine plasma 25 g/L, each fed daily to d 14. Same regiment on 4 more groups of 3 calves infected with F17+ *E coli*. All plasma was pasteurized at a max. 122 F for 15 m prior to spray drying at max product temp of 104 F. No antibodies for F17+ or F5+ *E coli* were detected in any plasma. Bovine plasma at either dosage (but not porcine) ↓ diarrhea, ↓fever, and ↓ *E coli* shedding in feces vs. control group. N=24 calves. Nollet et al, 1999, J. Vet. Med. A46, 185. .

“All-Milk” vs. “All-Milk + DFM” vs. 7% Pork Plasma vs. 7% Bovine Plasma (1995)



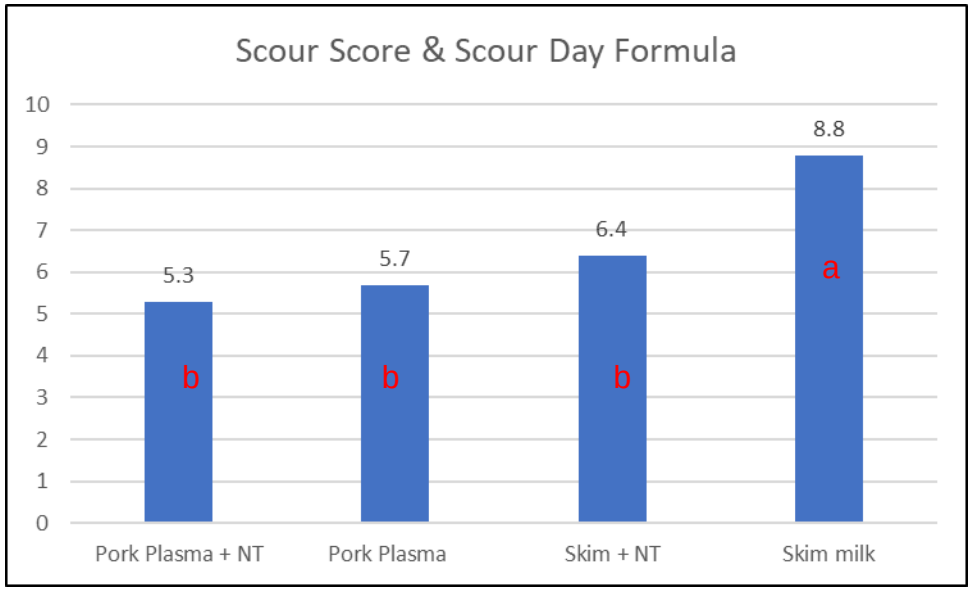
Subscripts different, P<0.05



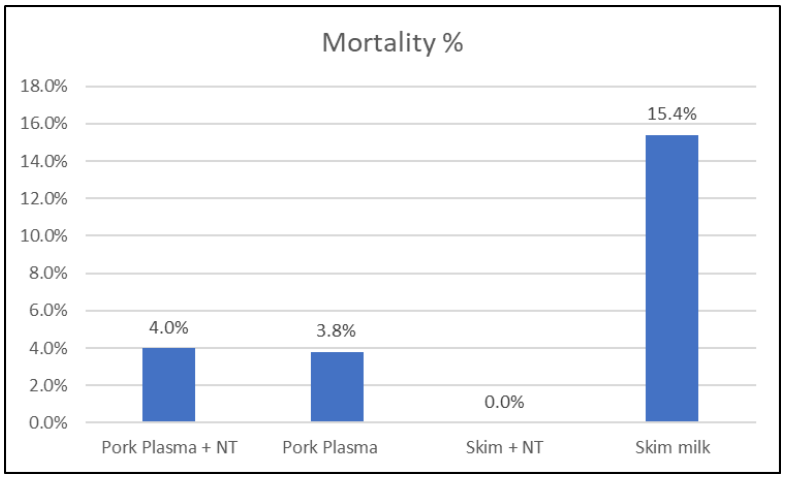
Subscripts different, P<0.05

20:20 CMR one-pound/d traditional strategy, calves weaned when consuming 1.5 lbs./d of starter. Long distance transport (WI to KS) calves were started on just 0.75 lbs/d of CMR and slowly increased to 1.0 lbs/d. Cumulative BW gain at 42 d was 23.8 (a), 29.5 (b), 28 (b), and 22.3 (a) lbs. for all-milk, pork plasma, beef plasma, and all-milk+DFM, respectively (subscripts different P<0.05). DFM fed was Chris Hansen Biomate 2B. Purina Startena was fed daily ad lib and weighed back weekly. 42 d cumulative starter intake was 53.8 (a), 67.9 (b), 58.9 (b), and 54.7 (a) lbs., for all-milk, pork plasma, beef plasma, and all-milk+DFM, respectively. NSD in mortality (5% average). N=120 calves. Morrill et al, JDS, **1995**, 78:902

Vitek (Animix predecessor) 1992.
Veal: Skim vs. Pork Plasma & NT, 2 x 2 factorial



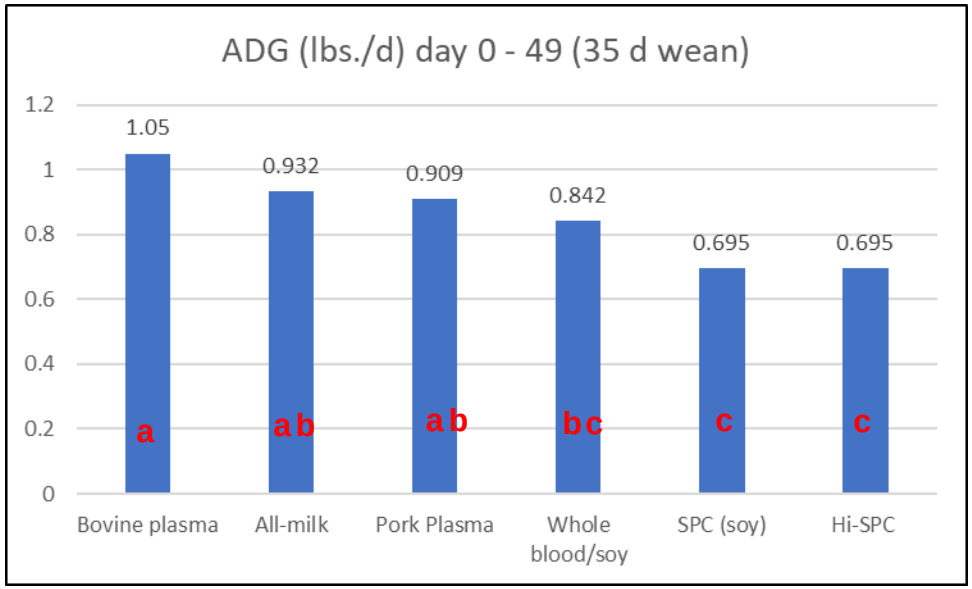
Subscripts different, P<0.05



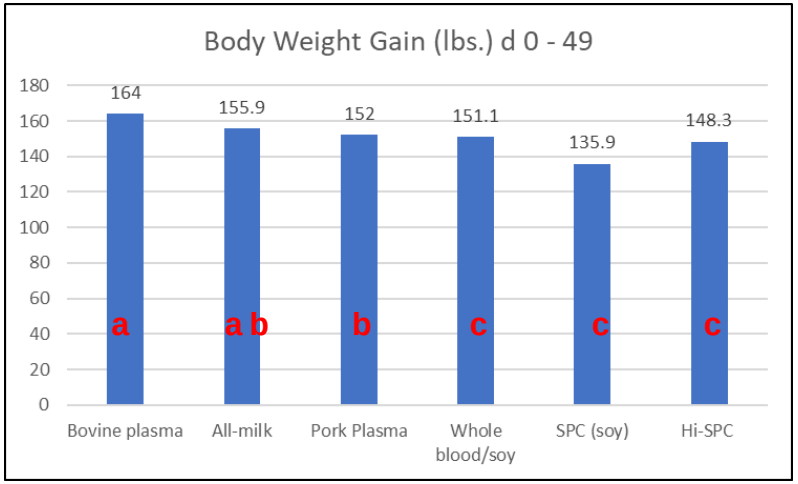
Mortality was 1/25, 1/26, 0/25, and 4/26, for pork + NT, pork alone, skim + NT, and skim alone, respectively

Traditional special milk fed veal milk replacer strategy with no grain or forage provided. **2 x 2 factorial design** comparing either a 100% skim milk protein formula or one with 20% of skim replaced with APC pork plasma and +/- Neomycin and OTC at 1 gram and 500 mg per head per day, respectively, for 2 weeks. ADG d 0 – 43 was 1.44, 1.42, 1.55, and 1.22 for pork + NT, pork alone, skim + NT, and skim non-med, respectively. Avg body weight gain d 0 – 14 was 6.24 (b), 4.19 (ab), 4.68 (ab), and 3.0 (a) lbs. for pork + NT, pork alone, skim + NT, and skim non-med, respectively (subscripts different P<0.05). N=102 calves. Doppenburg, J. Vitek Supply, Animix predecessor company. 1992.

All-milk vs. bovine plasma vs. pork plasma vs. various soy sources



Subscripts different, P<0.05



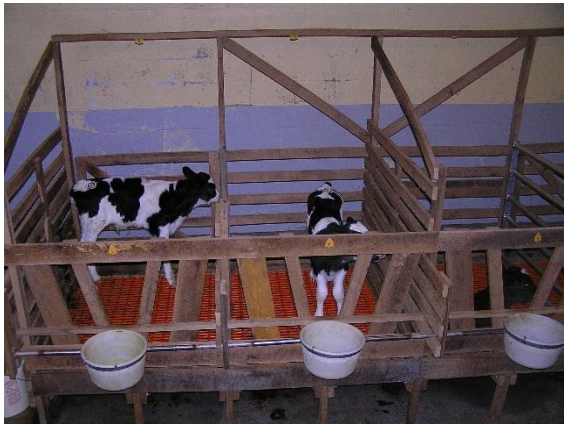
Subscripts different, P<0.05

21:15 CMR's were fed to Holstein bull calves (app. 100 lbs.) housed in individual stalls and fed 50 lbs of CMR over 35 d with starter introduced ad lib d 22. Treatment groups were a.) bovine plasma replacing one-third of CP, b.) all-milk, c.) pork plasma replacing one-third, d.) whole spray dried blood + soy replacing 60% of milk, e.) "standard" soy protein concentrate replacing 48% of CP, and "hi" soy protein concentrate replacing 60%. Calves reported as healthy with similar (1.01 to 1.08) fecal scores the first two weeks. N=96 calves. Milk Specialties, 1991. Sowinski project HR-91-1

Spray Dried Plasma Protein

Dave Wood, Animix

Improving calf health and growth



Plasma's Physical properties

Will make the change in CMRs nearly undetectable

+Will not change CMR color
+Will not change aroma of CMR
+Will not change solubility of CMR

- It is important to note that CMRs containing **plasma** should not be mixed with water that is 150+°F (65°C). Higher temperatures will denature globulin proteins and reduce solubility.

Typical analysis as reported on APC Nutrapro spec.:

- 78% C.P., 0.3% fat, 0.5% fiber, 7% moisture, 8.5% ash

Plasma's Physical properties . . . continued

Dense in globulin proteins (IgG)

- Nutrapro B (bovine) average of 39 samples, 22.4% IgG
- Nutrapro P (porcine) average of 10 samples, 17% IgG
- As reported by APC, July 7, 2011
- Avg 568 lots of Nutrapro B, **22.2% IgG**, st. dev. ±**2.75**. Animix RID testing Fall, 2021.

Data from certificates of analysis on all 49 Nutrapro production lots purchased by Animix between 09/01/16 – 01/09/17; all UV-treated:

- Crude Protein 82.9%, standard deviation ±1.03
- Plate count 19,649 cfu/gram st. deviation 16,130
- All guaranteed salmonella negative

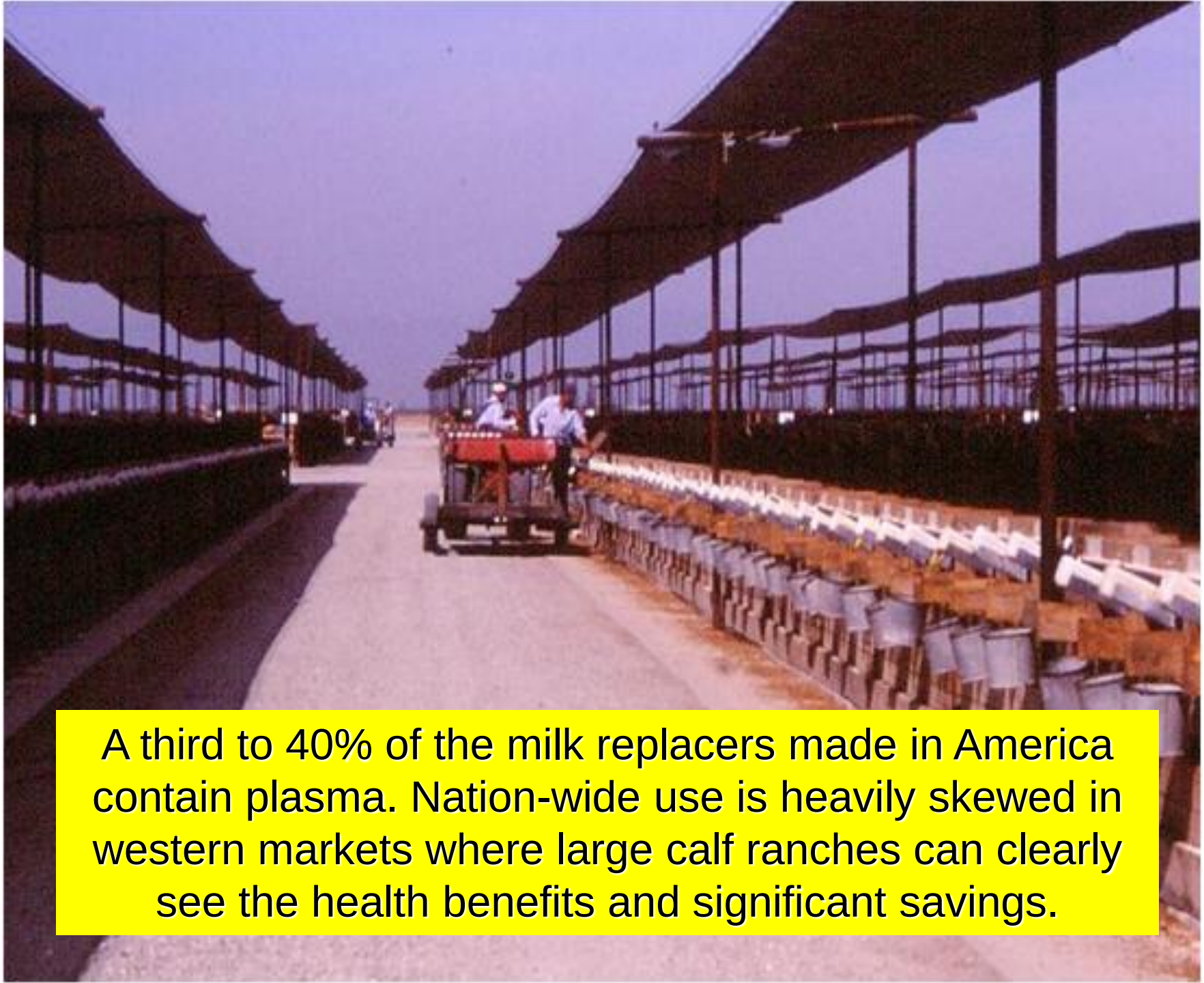
Data 618 production lots 01/2020 to 09/2021, avg 82.3% CP, st. dev. ±0.91


Nutrapro B (APC) spray dried plasma
78% - 82% C.P. Similar a.a. profile to milk protein

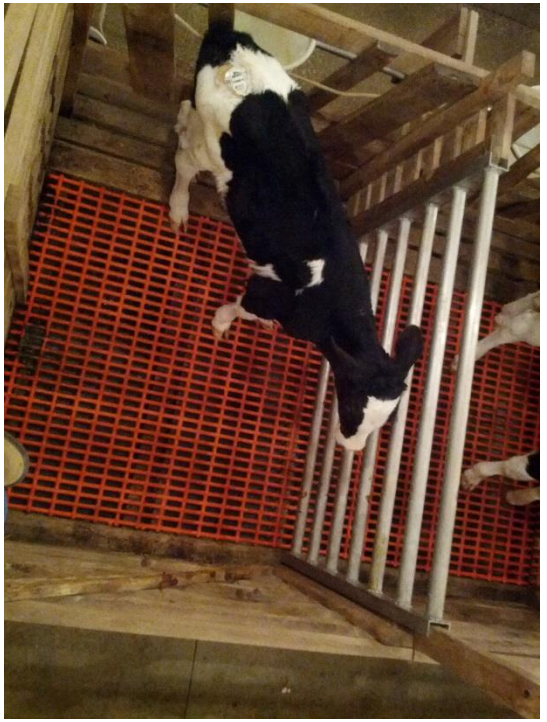
Judging Spray Dried Plasma

48

- Research shows
  - Reduced scours
  - Improved livability
- Proof
  - 22 published calf trials
  - 26 non-published calf trials
  - Well proven in the field
- Often lowers CMR costs
- Currently similar vs. WPC:
  - B raises costs some; P lowers



A third to 40% of the milk replacers made in America contain plasma. Nation-wide use is heavily skewed in western markets where large calf ranches can clearly see the health benefits and significant savings.



Broad scale use of plasma protein in early-life veal formulas
(first 6 – 8 weeks)

Very high adaptation of plasma in baby pig feeds

Published Calf Trials

- Morrill, J. Dairy Sci. (JDS), K-State,1995
- Quigley, JDS, Univ. of Tenn, 1996
- Nollet, J Vet Med, 1999, Gent U, Bel. E Coli challenge
- Quigley/Drew, Fd & Ag Immunology, 2000. E coli
- Arthington, JDS, Iowa State, 2002. Coronavirus challenge
- Hunt, Pediatric Res., NC State, 2002. Crypto challenge
- Quigley/Kost, JDS, APC, 2002
- Quigley/Wolf, JDS, APC, 2003
- Jones/Quigley, JDS, VA Tech/APC, 2004
- Quigley/Wolfe, JDS, APC, 2006
- Kehoe/Carlson, JDS, UW River Falls, 2015
- Raeth, The Pro. Animal Sci., U of MN Waseca, 2016
- Pineda/Ballou/Drackley, JDS, TX Tech/U of Ill, 2016
- Vasquez, JDS, U of Illinois, 2017
- Morrison/Drackley, JDS, U of Illinois 2017
- Wood, JDS, Animix/Mapleview Agri/U of Guelph, 2019
- Grice/Drackley, JDS, U of Illinois, 2020
- Henrichs/Drackley, JDS, U of Illinois, 2021
- Wood, JDS Comm, Mapleview Agri/U of Guelph, 2021
- Chebel, JDS, UC Davis, 2021

22 calf trials in 20 published papers (two had two trials)

26 Non-published calf trials

- Sowinski, MSC, JDS Abst, 1990
- Doppenburg, Vitek, veal, 1992
- Doppenburg, Vitek, veal, 1993
- Doppenburg, Vitek, veal, 1993
- Doppenburg, Vitek, veal
- Johnson, CSU, CMR, 1997
- Quigley 1999
- Catherman, Strauss, JDS Abst. 2001
- Quigley, APC, Gammulin, 2001
- Wawrzyniak (Kehoe), ISU, coronavirus, 2004
- Wood, Animix, JDS Abst., 2009
- Carlson, Waseca, JDS Abst. 2009
- Hayes, Waseca, JDS Abst. 2009
- Hill, Provimi, JDS Abst. 2013
- Wood, Animix, veal, JDS Abst. 2013
- Wood, Animix, veal, JDS Abst. 2014
- Zeigler, Waseca, JDS Abst. 2014
- Thornsberry, Waseca, JDS Abst 2015
- Froehlich, SDSU, JDS Abst. 2015
- Chester-J., Waseca, JDS Abst. 2016
- Ziegler, Waseca, JDS Abst. 2017
- Ziegler, Waseca, JDS Abst. 2018
- Fringer, CSU-Fresno, JDS Abst. 2020
- Fringer, CSU-Fresno, JDS Abst. 2020
- Wood, Mapleview Agri, JDS Abst. 2023
- Wood, Mapleview Agri, JDS Abst. 2023

48 Total Plasma Studies

40 plasma, 8 serum, 3 combination

Criteria to Judge – compared to an "all Milk"

- **Gain** – 6 superior *(p<0.05)*, *2* trend superior *(p<0.10)*, 31 equal, 2 trend poorer *(p<0.10),* 2 poorer *(p<0.05).*
- **Scours** – 33 measured fecal score or scour days. 14 reported less *(p<0.05)*, *3* trended less *(p<0.10)*, 19 reported the same. 1 reported less week 2 and more week 3 *(p<0.05)*.
- **Starter intake** – 24 reported. 4 increased *(p<0.05)*, 21 same. 1 poorer *(p<0.05)*.
- **Antibiotics** – 9 superior (fewer treatments) *(p<0.05)*, 2 show + interaction w/NT, 12 the same

Bottom line: performs *at least as well* as "all milk" and often ***better***!

% Mortality "All-milk" or Plasma group

Author, Pub./Company, Use rate	Plasma	"All-Milk"	No. Calves
Nollet, J. Vet. Med. 1999. E coli. plasma 35 or 75 g/d	**22%**	**100%**	24
Quigley, APC 1999 (NeoTerra group 25% mortality)	50%	50%	80
Doppenburg, Vitek 1993. Veal d 3 - 48. 8.3% plasma.	24%	27%	92
Quigley, JDS* 2003. 5% plasma.	**6.3%**	**25%**	120
Wood, 2019, JDS 2019. 5% plasma All-milk + additves **24.5**% mortality	11.5%	7.5%/**24.5%**	158
Quigley, JDS 2006 (Gammulin in Acc. Nut)	12.6%	22%	79
Quigley, JDS 2002. 4% plasma, +/- Gamm.	**4.0%**	**20%**	120
Wood, Mapleview Agri, ADSA abstract 2023, 60 g/d pork plasma	12%	17%	49
Drew, J Immunology, 2000. E Coli Chall. 3.5% plasma.	0%	16.7%	36
Pineda, U of Ill, JDS 2016. Gammulin 14 day	**2.2%**	**16.3%**	93
Wood, Animix 2013. Abstract. plasma	4.8%	13.2%	86
Wood, Mapleview Agri, ADSA abstract 2023, 60 g/d bovine plasma	7%	12%	52
Doppenburg, Vitek 1993. Veal d 3 - 45. 8.3% plasma.	7.3%	8.8%	102
Vasquez, U of Ill, JDS, 2017. 6.6%, 13.3% & 19.9% plasma	8.3%	11.1%	124
Wood. Animix 2009 Abstract. 5% plasma, 6% wheat.	8%	5%	120
Doppenburg, Vitek 1992. Veal, d 0-43, est. 5% plasma	3.9%	7.8%	102
Jones/Quigley JDS 2004. VA Tech, 5.6% plasma	7.8%	2.5%	78
Quigley. JDS 1996. 7.5% plasma	6%	0%	68
Lopes, U-C, Davis 2009. Gammulin d 1 - 23	5.2%	5.2%	518
Morrill, JDS, 1995. 7% plasma.	6.7%	6.6%	120
Quigley, APC 2001, Gammulin d 1 - 15	3%	5%	120
AVERAGE	**10.1%**	**18.3%**	**2,341**

* denotes Journal of Dairy Science. Red denotes statistical significance (P<0.05)

All plasma studies where one or more treatment groups experienced 5% mortality or greater

Disease Challenge Studies - Plasma

Published Calf trials on plasma

Crypto – 57 g / day serum

33% ⇩ in scours, 30% ⇧ gut repair

E Coli – 75 g / day plasma.

⇩ mortality

Not Published: Kehoe (ISU/APC) coronavirus, No effect

E Coli – 3.5% inclusion rate, plasma

Improved ADG

Coronavirus – 160 g / day serum

Improved feed intake & hydration

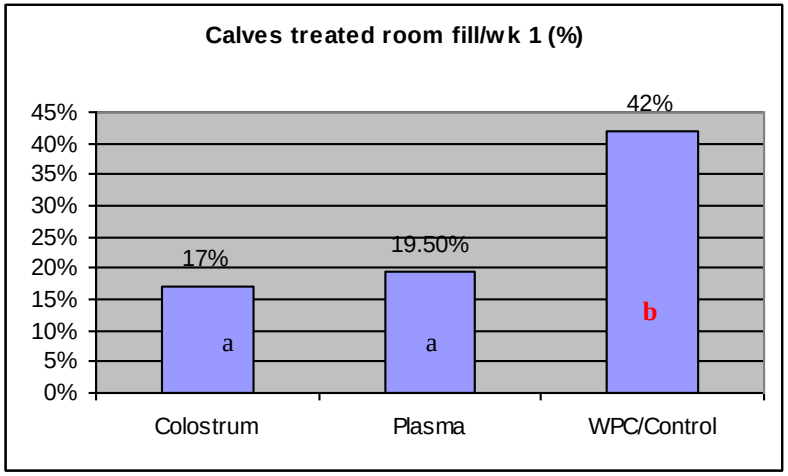
Functional proteins are in colostrum, fresh suckled milk *and* serum and plasma

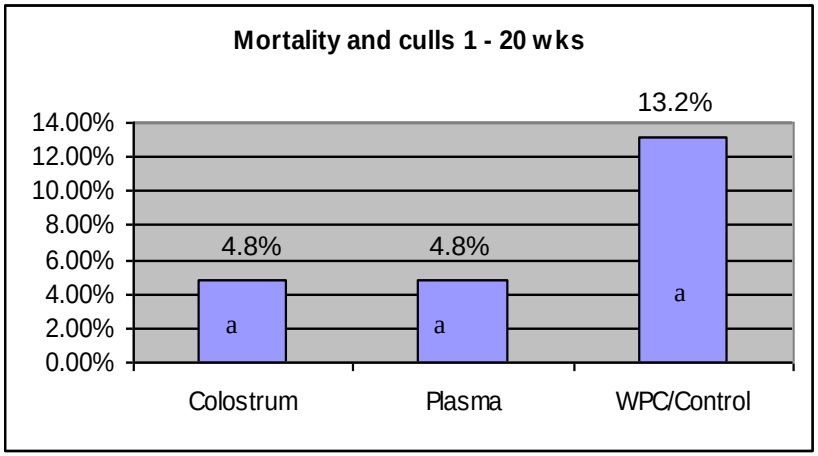
Which functional proteins?

- Globulin proteins (22%)
- Growth Factors
- Hormones
- Immune Cells

Serum and plasma are more like colostrum than milk

Plasma helps you mimic the real deal . . . Mama's milk!





Subscripts different, P<0.05

Individually bucket-fed, every-third pair in stall-barn, fed either whole colostrum (~20% IgG, 44% CP: 18% CF), or plasma/dry fat blend (~11% IgG, 44:18) or WPC/dry fat (44:18), 12.5 lbs/calf step-down fashion, first 13 weeks. 120 calves. Veal. 84% FPT

Individually bucket-fed, every third pair in stall-barn, fed either whole colostrum (13% IgG, 44%CP:18% Fat, or plasma/fat blend (~13% IgG, 52:18), WPC/fat (44:18). Step down fashion, 2 lbs in starter phase (wk 1 – 7), 1 lb finisher (wk 8 – 20). 77% FPT