Corn Silage in TMRs for Preweaned Calves

Al Kertz, PhD, PAS, DIPL ACAN
ANDHIL LLC
St. Louis, MO 63122
andhil@swbell.net
www.andhil.com

Inclusion of forage or roughage sources in calf starter diets is often discussed, done, and debated. The greatest factor is whether or how this impacts gut fill. But this is often not measured or even discussed. And too often whether the calf starter is pelleted or well-texturized is not considered in evaluating the study and its field application.

In this light, a study will be reviewed in which whole plant flint corn silage (WPFCS) was fed in a total mixed ration (TMR) to calves prior to weaning (Toledo et al., 2023). This study was conducted in Piracicaba at Sao Paulo University in Brazil between July and November 2021 during which the average temperature was 72º F with a range of 93 to 46 ºF. Calves were Holsteins (36 males and 9 females) averaging 81.2 ± 2.7 lb birth weight. All calves were fed 10% at body weight high quality colostrum (> 50 mg/ml IgG) within 2 hours after birth.

Calves were individually housed, initially in suspended pens until 14 days of age, and then in wood hutches tethered by chain to allow an area for walking but no physical contact with other calves. Calves were fed 6 L/day of whole milk by teat buckets until the beginning of the weaning process. Calves had free access to a pelleted commercial calf starter (88.0% DM, 22.0% CP, 16.1% ADF, 28.2% NDF, 3.9% ether extract, 10.2% ash, 35.7% NFC (non-fiber carbohydrates), 22.4% starch), and after 28 days of life, experimental diets were fed once a day after morning milk feeding and was available until the next day. Calves were managed equally until 28 days and then divided into randomized blocks according to sex, birth date, and weight (107 ± 2.7 lb). Each of 3 treatments had 15 calves as follows: (1) TMR with 0% of WPFCS (**0CS);** (2) TMR with 10% of WPFCS (1**0CS**); and (3) TMR with 20% of WPFCS (**20CS**). Treatment diets were formulated to be isonitrogenous, and TMR started to be fed on day 28. The chemical composition and ingredients of the treatment diets are shown in **Table 1**.

All calves received 6 L daily of whole milk divided into 2 meals (0700 and 1700 hours) while the TMR were fed once a day during the morning period. Calves were gradually weaned (reducing 1 L daily), regardless of the solid diet intake, starting at 52 days until the end of 56 days. After weaning, calves were evaluated for a further 14 days. Blood samples were collected 2 hours after morning feeding, beginning at the fourth week of life, while ruminal fluid samples were collected 2 hours after feeding at weeks 6, 8, and 10.

Note that these are high starch TMR with about 40% versus the pelleted starter with 22% (**Table 1**). So, some forage was needed in these TMR in to ameliorate marginal ruminal acidosis as ruminal pH was 5.69, 5.85, and 5.92, respectively, on these 3 TMR. The 0CS TMR had no corn silage (forage), so it is not surprising that calves fed it would have the lowest rumen pH. Especially since it contained 43% starch. Thus, it also had the greatest in vitro DM and NDF digestibilities, which declined as CS was added.

Table 1. Composition of total mixed rations (TMR) containing 0, 10, and 20% corn silage (CS).

Item	0CS	10CS	20CS

Ingredient, % of DM			
Ground corn	54.7	50.9	47.9
Corn silage	0.0	10.2	20.2
Soybean meal	23.7	26.7	28.7
Wheat meal	18.2	8.9	0.0
Vitamin/mineral	3.4	3.3	3.2
Chemical composition, % of DM			
DM	87.1	78.3	72.5
CP	19.1	19.1	19.3
ADF	7.1	9.3	11.7
NDF	20.6	22.1	25.4
Ash	7.6	6.9	6.9
Ether extract	3.3	3.0	5.7
Starch	43.2	41.0	39.4
NFC	49.3	48.8	42.7
In vitro digestibility, %			
DM	76.6	72.0	67.7
NDF	55.9	53.8	51.9

Intake of liquid (milk) from 28 to 56 days of age was the same across treatments **(Table 2)** while TMR intake and total intake were quadratic. This is most likely because marginal acidosis kept 0CS intake lower, and as 10% CS was added ration intake of that TMR increased since it ameliorated lower rumen pH (5.85 vs 5.69). Rumen pH did increase to 5,92 when 20% CS was added to that TMR, but evidently the higher CS level decreased intake most likely due to gut fill. Authors did attempt to estimate gut fill by the estimates of Jahn and Chandler (1976); but that study used 8 to 20 week old calves and orchard grass hay to vary forage/fiber levels. So, those equations from Jahn and Chandler (1976) are inappropriate for this study by Toledo et al., (2023). Thus, daily gains did not parallel very well the EBWG predictions across treatments nor with TMR intakes either.

A similar quadratic pattern for intake and daily gains was evident across treatments for the postweaned (57 to70 days of age) period as for the preweaned period. And, similarly, EBWG predictions did not fare well either. Overall daily gains favored the 10% CS TMR followed by the 0 % CS TMR and lastly by the 20% CS TMR.

Table 2. Performance data for calves on 0, 10, or 20% corn silage (CS) TMR.

Item	**0CS**	**10CS**	**20CS**
Preweaning 28-56 days			
DMI, lb/day			
Liquid	1.61	1.62	1.63
TMR	1.39	1.87	1.47
Total	3.00	3.49	3.10
NDF	0.29	0.41	0.38
peNDF[a] >4 mm	0.001	0.052	0.068
Starch	0.64	0.77	0.60
Daily gain	1.56	1.70	1.53
EBWG[b]	1.52	1.59	1.41

Postweaned 57-70 days			
DMI, lb/day	6.30	7.57	6.18
NDF	1.31	2.03	1.98
peNDF[a] >4 mm	0.022	0.206	0.307
Starch	2.80	3.02	2.46
Daily gain	2.27	2.46	2.28
EBWG[b]	2.15	2.29	2.10
Initial BW (day 28), lb	106.8	107.2	103.5
Weaning (day 56)	153.0	156.1	147.5
Final (day 70)	182.8	189.3	177.4
Overall daily gain (day 28-70)	1.81	1.95	1.76

[a] Physically effective NDF

[b] Empty body weight gain calculated according to Jahn and Chandler (1976).

There are some key caveats and some context needed in evaluating this study.

- **Gut fill.** The authors did attempt to estimate this, but the equation used was inappropriate as previously noted. Unfortunately, too many studies are conducted and reported that do not even consider this factor. Of three studies cited in this regard (Coverdale et al., 2004; Khan et al., 2011; Castells et al., 2012), only the middle one measured gut fill. But then, it missed noting the significance of this measurement. The study used a poorly texturized calf starter which when hay was also made available resulted in the erroneous title and conclusion. While provision of hay did improve rumen pH **(Table 3)**, it created gut fill which confounded and actually resulted in less true body weight gain. *Yet, I have not seen anyone who cites this study reference with this key result!*

Table 3. Effect of hay intake along with starter on gut fill.

	Starter	**Starter/hay**	***P* <**
Rumen-reticulum + digesta, lb	17.6	28.0	0.02
Rumen-reticulum – digesta, lb	3.5	4.2	0.03
Rumen pH	5.06	5.49	0.002

- **Why not measure gut fill?** In the study by Toledo et al., (2023), there were 9 male calves per treatment. A subset of 3 or 4 calves per treatment could have been sacrificed for such measurements as was done by Porter et al., (2007).
- **Fiber requirement?** Several times, the authors (and in other papers too) refer to whether calves have a fiber or forage requirement. There really is none *per se*. Cornell researchers in the 1950s led by R. G. Warner found that it was the volatile fatty acids (VFA) produced in the rumen that led to rumen papillae development and the function of a calf's rumen (Flatt et al., 1958; Harrison et al., 1960: Sander et al., 1959; Warner et al., 1956). And not the provision of dietary forage *per se* since VFAs in the order of butyric, propionic, and then acetic lead to rumen papillae development—nearly the opposite order of that produced by ruminal forage/fiber fermentation. But there then needed to be some way to avoid marginal ruminal acidosis in young calves if fed high grain starters with no dietary forage. That can be done ether by using a well-texturized calf starter or by feeding around 3% of some forage source with the pelleted or meal calf starter.

- The **physical form of the calf starter** can predetermine results. As a reviewer of journal manuscripts, I have often found this to be the case even though the authors did not recognize this. Furthermore, the authors often wanted to extrapolate the results of their calf study across the board. In reality, results of a calf study may only apply to the unique conditions of that study. And too many calf studies do not recognize this or provide adequate information to address this (Ghaffari and Kertz 2022)

The Bottom Line

Results of this study only apply to using a meal calf starter and feeding no, 10, or 20% whole plant corn silage in a TMR to calves from 29 to 70 days of age. It was beneficial to use 10% corn silage to overcome marginal ruminal acidosis compared to without corn silage, but 20% corn silage appeared to create more gut fill (not measured) and decreased intake and daily gain.

References

Castells, L., A. Bach, G. Araujo, C. Montoro, and M. Terre. 2012. Effect of different forage sources on performance and feeding behavior of Holstein calves. J. Dairy Sci. 95:286–293.

Coverdale, J. A., H. D. Tyler, J. D. Quigley III, and J. A. Brumm. 2004. Effect of various levels of forage and form of diet on rumen development and growth in calves. J. Dairy Sci. 87:2554–2562.

Flatt, W. P., R. G. Warner, and J. K. Loosli. 1958. Influence of purified materials on the development of the ruminant stomach. J. Dairy Sci. 41:1593-1600.

Ghaffari, M, and A, F, Kertz. 2021. Review: Effects of different forms of calf starters on Feed intake and growth rate: A systematic review and Bayesian meta-analysis of studies from 1938 to 2021. Appl. Anim. Sci. 37:273–293.

Harrison, H. N., R. G. Warner, E. G. Sander, and J. K. Loosli. 1960. Changes in the tissue and volume of the stomachs of calves following the removal of dry feed or consumption of inert bulk. J. Dairy Sci. 43:1301-1312.

Jahn, E., and P. T. Chandler. 1976. Performance and nutrient requirements of calves fed varying percentages of protein and fiber. J. Anim. Sci. 42:724–735.

Khan, M. A., D. M. Weary, and M. A. G. von Keyserlingk. 2011. Hay intake improves performance and rumen development of calves fed higher quantities of milk. J. Dairy Sci. 94:3547–3553.

Porter, J. C., R. G. Warner, and A. F. Kertz. 2007. Effect of fiber level and physical form of starter on growth and development of dairy calves fed no forage. *The Prof. Anim. Scientist* 23:395-400.

Sander, E. G., R. G. Warner, H. N. Harrison, and J. K. Loosli. 1959. The stimulatory effect of sodium butyrate and sodium propionate on the development of rumen mucosa in the young calf. J. Dairy Sci. 42:1600-1605.

Toledo, A.F., S.C. Dondé, A.P. Silva, A. M. Cezar, M.G. Coelho, C. R. Tomaluski, G. F. Virgínio Jr., J.H.C. Costa, and C.M.M. Bittar. 2023. Whole-plant flint corn silage inclusion in total mixed rations for pre- and postweaning dairy calves. J. Dairy Sci. 106:6185-6197.

Warner, R. G., W. P. Flatt, and J. K. Loosli. 1956. Dietary factors influencing the development of the ruminant stomach. Agric. and Food Chem. 4:788-792.