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# Heat-treated colostrum raises IgG absorption

**Bottom Line**

with
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PASTEURIZATION of colostrum continues to be a salient topic for the calf side of the dairy industry. A number of field measurements have found that between 40% and 90% of the colostrum fed to calves exceeded minimum plate count recommendations of 100,000 colony-forming units (CFU) per milliliter for total bacteria and of 10,000 CFU/mL for coliforms.

Pasteurization conditions for colostrum of one hour at 140°F were previously established (McMartin et al., 2006) based on laboratory conditions and then also with a larger batch pasteurizer (Godden et al., 2006; Kertz, 2006).

It has also been observed that colostral antibodies appear to be better absorbed into the calf's bloodstream when bacterial levels are lowered. Several plausible reasons for this are that fewer bacteria may be interfering with colostral antibody absorption, bacteria may bind pathogens and reduce their absorption or more intestinal absorption sites or receptors may be available with fewer bacteria present.

With all of this as background, Penn State researchers (Elizondo-Salazar and Heinrichs, 2009) developed a study "to determine effects of feeding heat-treated colostrum and unheated colostrum with two different bacterial concentrations on passive transfer of immunity in neonatal dairy calves."

First-milking colostrum was collected from Holstein cows (none of which were mothers of the calves used in this trial) using only immunoglobulin G (IgG) concentrations greater than 50 g per liter, as determined by a colostrometer.

The colostrum was frozen immediately at -4°F in new two-quart containers until 126 liters were accumulated. Then, colostrum was thawed at 39°F for 24 hours, pooled and mixed for 20 minutes in a commercial batch pasteurizer to create a unique batch of colostrum.

This batch was then subdivided into thirds: an unheated low-bacteria colostrum (ULBC) stored at -4°F, a heated colostrum (HC) heated for 30 minutes at 140°F before storing in new two-quart containers at -4°F and an unheated high-bacteria colostrum (UHBC) stored at 68°F for 24 hours to allow naturally occurring bacteria to grow freely before this colostrum was put into new two-quart containers for storage at -4°F.

All colostrum was thawed at 41°F and enumerated for standard plate count, coagulase negative staphylococci, environmental streptococci counts, coliform count, gram-negative noncoliform count, *Streptococcus agalactiae* count and *Staphylococcus aureus* count. Colostrum samples were also analyzed for ash, dry matter, crude protein, crude fat, fat-soluble vitamins, calcium, phosphorus, magnesium, sodium, potassium, zinc, iron, copper, sulfur and manganese.

Only Holstein bull calves weighing more than 66 lb. were used in this study. They were removed from their dams 20-30 minutes after birth before nursing could occur, a jugular blood sample was taken before colostrum was fed, they were placed in 3.3 sq. ft. holding pens until colostrum was fed and then they were housed in 3.3 ft. x 8.5 ft., naturally ventilated, individual calf condos bedded with straw.

A total of 30 calves were fed one of

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### 1. IgG and bacterial counts for ULBC, UHBC and HC colostrum samples

| Item | ULBC | UHBC | HC | Std. error of means |
|---|---|---|---|---|
| IgG, g/liter | 69.55 | 69.55 | 66.17 | 1.86 |
| IgG1, g/liter | 66.46 | 66.46 | 63.28 | 1.73 |
| IgG2, g/liter | 3.09 | 3.09 | 2.89 | 0.13 |
| Standard plate count, $\log_{10}$ CFU/mL | 3.97[b] | 5.61[c] | 2.81[a] | 0.81 |
| Environmental streptococci, $\log_{10}$ CFU/mL | 1.86[b] | 5.59[c] | 0.90[a] | 1.43 |
| Coagulase negative staphylococci, $\log_{10}$ CFU/mL | 0.00[a] | 0.90[b] | 0.00[a] | 0.30 |
| Coliform count, $\log_{10}$ CFU/mL | 2.02[b] | 3.16[c] | 0.00[a] | 0.92 |
| Non-coliform count, $\log_{10}$ CFU/mL | 3.37[b] | 5.39[c] | 1.82[a] | 1.03 |

[a,b,c]Means with different superscripts within a row differ ($P < 0.05$).

### 2. Serum concentrations of total protein, IgG and AEA from ULBC, UHBC and HC colostrums

| Item | ULBC | UHBC | HC | Std. error of means |
|---|---|---|---|---|
| Serum total protein, g/liter | | | | |
| 0 hours | 43.1 | 41.8 | 43.7 | 0.23 |
| 24 hours | 57.0[b] | 56.2[b] | 62.5[a] | 0.23 |
| 48 hours | 56.8[b] | 54.5[b] | 61.4[a] | 0.23 |
| Total IgG, g/liter | | | | |
| 0 hours | 0.0 | 0.0 | 0.0 | 0.00 |
| 24 hours | 20.2[b] | 20.1[b] | 26.7[a] | 1.47 |
| 48 hours | 19.1[b] | 18.4[b] | 24.9[a] | 1.47 |
| AEA of total IgG, % | | | | |
| 24 hours | 35.4[b] | 32.4[b] | 43.9[a] | 2.90 |
| 48 hours | 33.2[b] | 29.5[b] | 41.0[a] | 2.90 |

[a,b,c]Means with different superscripts within a row differ ($P < 0.05$).

the three 100°F colostrum treatments via esophageal feeder at the rate of four quarts for the first feeding between 1.5 and 2.0 hours of life. The subsequent second and third feedings were pasteurized whole milk at 5% of bodyweight, and remaining feedings were a milk replacer that was 20% all-milk protein and 20% fat fed in the amount of 5% of bodyweight at both morning and afternoon feedings until two weeks of age.

Blood samples were taken from every calf at 24 hours and 48 hours of age.

Mean birth weights were 108, 99 and 93 lb. for the ULBC, UHBC and HC treatments, respectively. Time after birth for the first colostrum feeding ranged from 90 minutes to 120 minutes across treatments. The median parity averaged 2.5, and the calving score never exceeded three on a scale from one to five (most difficult) across treatments.

Chemical and physical measurements of colostrum varied little among treatments, except for lower vitamin E (1.55 µg/g versus 2.13-2.24 µg/g) in ULBC and lower pH (4.83 versus 6.11) and lactose (8.5% versus 9.5%) in UHBC. The latter reflects greater bacteria counts and metabolism for UHBC.

None of the IgG categories differed among treatments (Table 1), and these values were within the range found in other studies. As might be expected, all bacterial categories were lowest ($P < 0.05$) for HC, with the exception of ULBC, which also had no detectable coagulase-negative staphylococci.

The process of allowing ULBC to grow over a 24-hour period was successful, as indicated by the greatest ($P < 0.05$) bacterial counts in every category compared to the other two colostrum treatments. Although 30 minutes of heat treatment at 140°F were adequate to achieve the noted bacterial reductions, 60 minutes were required to virtually eliminate *Mycobacterium avium* subspecies *paratuberculosis* (Godden et al., 2006).

Serum total proteins were similar among treatments at birth (Table 2) but were less than the 50-55 g per liter minimum objective. By 24 hours and at 48 hours after birth, those values increased to a minimum of 55 g per liter across all treatments, except for 48-hour UHBC, which was at 54.5 g. However, heat treating increased ($P < 0.05$) serum total protein over the other two treatments at both 24 hours and 48 hours.

A similar pattern was found for total IgG and apparent efficiency of IgG absorption (AEA), where a minimum of 10 g per liter is the objective. It is critical to note that all calves received the same mass of protein and IgG from colostrum, so it was the lower absorption efficiencies from non-heat-treated colostrum that reduced both serum total protein and IgG levels.

The authors further noted that serum total protein underestimated total IgG absorbed, which "may mean that refractometry is not an accurate means to estimate serum total IgG concentrations with standard reference values when calves are fed high volumes of colostrum or heat-treated colostrum."

It has been hypothesized (Johnson et al., 2007) that bacteria in colostrum may bind free IgG in the gut lumen or block the uptake and transport of IgG, thereby interfering with passive absorption of IgG. However, in this study, there were no differences in IgG levels or AEA between low- and high-bacteria colostrum, neither of which were heated.

The authors speculated that "heat treatment denatures some colostral proteins that otherwise would interfere or compete for receptors on neonatal enterocytes, thus reducing the number of receptors available for IgG uptake; however, this hypothesis has to be further investigated."

## The Bottom Line

Proper heat treatment of colostrum has been shown to increase IgG absorption and serum levels in calves. Higher bacteria levels in unheated colostrum did not decrease serum IgG levels, indicating that lower bacteria levels *per se* are not likely the mechanism leading to greater serum IgG when colostrum is heat treated.

## References

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