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Postnatal Total Serum Protein Concentration Influences the Health and Growth Parameters of Preweaned Female Holstein Friesian Calves

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Abstract: This study focuses on the effect of the total serum protein (TSP) concentrations at 3 days after birth on the health and growth parameters of preweaned female Holstein Friesian calves. A total of 165 female calves were enrolled and evaluated for morbidity which included diarrhea (D), respiratory disease (Rd) and omphalitis (O). Also, calves with more than one disorder in the same time were recorded as multi-morbid. Body weight (BW) was determined at birth, 30 and 60 days of age. Blood samples were taken at 3 days after birth and TSP was determined using a digital Brix refractometer. For statistical analysis all female calves based on TSP concentration were grouped into 3 categories: 1-TSP ≥ 6.2 g/dL, 2-TSP 5.8-6.1 g/dL, and 3-TSP < 5.8 g/dL. Overall, the average of TSP concentration was 6.38 g/dL. The prevalence of diarrhea, respiratory disease (Rd) and omphalitis (O) was 16.96%, 7.88% and 4.85% respectively, in calves with one disorder and 6.06% in calves with D + Rd, 3.64% in calves with Rd + O, 3.03% in calves with O + D, and 3.64% in calves with D + Rd + O. As the TSP concentration in calves decreased from ≥ 6.2 g/dL to < 5.8 g/dL the calf hood disorders increased in female calves with one disorder and with more than one disorder. The female calves with fair to poor immunity (category 3-TSP < 5.8 g/dL) were significantly more likely (OR 6.28, 95% CI 2.91-13.5, *p* value < 0.001) to be affected by diseases compared with female calves with excellent immunity (category 1-TSP ≥ 6.2 g/dL). Also BW and average daily gain (ADG) at 30 and 62 days of life decreased as TSP concentrations decreased. The female calves with TSP ≥ 6.2 g/dL at 3 days of life had the greatest BW at 30 and 62 days of age (51.8 kg and 77.1 kg respectively) compared with female calves with TSP < 5.8 g/dL at 3 days of life (46.6 and 70.6 kg respectively). Moreover, starter feed intake during the first 30 days of life, 31 to 62 days of life and 1 to 62 days of life was greater in female calves with excellent immunity (TSP ≥ 6.2 g/dL) than female calves with good immunity (TSP 5.8-6.1 g/dL) or with fair to poor immunity (< 5.8 g/dL TSP). Measuring the TSP at 3 days of calf's life, offers information directly correlated to an individual calf's immunity status, their likeliness of morbidity, mortality and body development and overall the effectiveness of the colostrum management program in the dairy farm.

Key words: Immunity categories, diarrheal disease, respiratory disease, omphalitis disease, multiple morbidity, calf starter feed.

1. Introduction

Bovine colostrum contains, nutrients, several bioactive compound including immunoglobulins, bioactive peptide, lactoferine, oligosaccharides, hormones growth factors, and immune related microRNA which play critical roles in the health and development of the calf [1-3]. Early feeding of colostrum is essential because of the progressive decline in the uptake of immunoglobulin (large molecule of IgG, IgA and IgM), during the first days of life due to gut closure [4].

There are concerns that prophylactic uses of antimicrobial drugs in food animal production increase antimicrobial resistance with potential adverse effects on human health [5-7].

Dairy animal industries are being encouraged to reduce the use of all type of antimicrobial drugs, to find new alternatives for therapeutic needs, and to optimize animal health through management practices [8].

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One area of focus in the dairy farms is calves being reared as dairy heifers replacements. Successfully rearing of these animals is to ensure adequate intake of colostrum. At birth, calves have an immature immune system, and need a passive transfer of immunity from their dams, through colostrum until their own active immune system develops [9]. Passive immunity must be acquired by calves through the ingestion and absorption of antibodies (predominantly IgG) found in colostrum. Optimum acquiring passive immunity is influenced by number of factors, which include the IgG content of colostrum, timing of feeding as well as the volume provided [10].

Extended feeding of colostrum during the first 2 weeks of the life can be beneficial to dairy calves. Chamorro et al. [11] reported that feeding milk replacer enriched with 150 g of colostrum powder during the first 2 weeks of life did not affect body weight (BW) or average daily gain (ADG), but reduced the occurrence of abnormal feces, abnormal respiration and antibiotic treatment before weaning period. Jones et al. [12] reported higher feed efficiency and a tendency to gain more BW in calves receiving IgG via natural colostrum compared with calves that received the same amount via colostrum substitute in the first week of life. Similar to colostrum, transition milk contains an abundance of bioactive compounds [13, 14]. The transition milk may be an alternative to colostrum for feeding calves when extra colostrum is unavailable.

There is evidence that antibodies remaining in the gut lumen also provide local immunity and may enhance intestinal villus development [15].

Total serum protein (TSP) in female calves within 1 to 7 days of age is a primary indicator of passive transfer of immunity. This indicator offers information directly correlated to an individual calf's immune status, their likeliness of morbidity and mortality, and the effectiveness of the colostrum management program in the dairy farm [16]. Colostrum has protective immunoglobulins (Igs) and high levels of nutrients and bioactive components that stimulate postnatal growth and development [17].

In recent studies [18] it is reported in a systematic review that calves with TSP $\geq$ 6.2 g/dL have an excellent transfer of passive immunity (TPI), and calves with TSP between 5.8 and 6.1 g/dL have a good TPI, and calves with < 5.8 g/dL have fair/poor TPI.

Using this new cut off value, we assessed the effect of calves' TSP concentration at 3 days of age on health and growth parameters in female Holstein Friesian dairy calves.

2. Materials and Methods

2.1 Farm and Management

This experiment was performed on the research dairy farm of Agricultural Research and Development Station (ARDS) Șimnic-Craiova, Romania. The research dairy farm is located in the South-West region (Oltenia, 182 m above sea level, 44°19′ N, 23°8′ E). For this experiment, all procedures were made in compliance with Directive 2010/63/EU [19], and the calves were raised according to Directive 2008/119/EC [20].

The initial dairy herd was imported from Denmark (1977-1978) as Danish Black and White (DBW) dairy cattle. Today the most genes from the original DBW cattle have been reported by Holstein Friesian genes. Nutritional and management strategies for adult young cattle stock are used to prepare the animals for lactation and to minimize the incidence of disease disorders. All forage crops consisting of corn silage, haylage, chopped alfalfa, fodder beet and grains are produced locally at ARDS Șimnic-Craiova. All feed rations are calculated to provide recommended nutrients for dairy cows (INRA, 1988, N.R.C. 2001).

The length of cow dry period usually is 50 ± 10 days and daily feed intake is 1.8%-2% (as dry matter (DW)) of the cow's BW. Cows are fed with a ration low in starch content (14%, DM basis) and high in fiber content (46% neutral detergent fiber) in the prepartum period (Table 1) and with a ration high in starch content (27%) and a lower fiber content (28% neutral detergent fiber, DM basis) in the postpartum period. Also anionic salts are used to manipulate dietary cation-anion difference

Table 1 Prepartum and postpartum dairy cows diets (DM basis).

Item	Prepartum %	Postpartum %
Ingredients		
Alfalfa hay	26	29
Grass hay	45	5.5
Corn silage	10	16
Grain mix[a]	16	47
Mineral mix[b]	3	2.5
Total	100	100
Nutrient profile		
Net energy lactation	1.28	1.60
Crude protein	12	19
Neutral detergent fiber	46	28
Acid detergent fiber	40	20
Starch	14	27
Calcium	1.40	1.30
Phosphorus	0.30	0.40
Magnesium	0.40	0.40
Kalium	1.50	1.30
Natrium	0.30	0.40
Chloride	1.10	0.40
Sulf	0.40	0.20
DCAD mEq/100 g of DM[c]	-5	26.90

1 = grain mix: barley 30.5%, corn 30.5%, wheat 13%, soybean meal 6%, sunflower meal 20% (kg basis).

2 = mineral mix: dicalcium phosphate, magnesium oxide, sodium thiosulphat, copper sulphate, cobalt sullphate.

3 = calculated as DCAD = (mEq of Na + mEq of K) – (mEq of S + mEq of Cl).

(DCAD) for close-up dry-cow group, and not for heifers. Adding anionic salts (magnesium sulfate, calcium sulfate, ammonium sulfate, calcium chloride, ammonium chloride and magnesium chloride) is a way to achieve a negative DCAD (Table 1). All cows and heifers are fed in the morning and afternoon. Additionally the cow and heifers have access to pasture (alfalfa or ryegrass), and the water is always available ad libitum. The lactating cows are milked two times a day (05:00 am and 17:00 pm), in a DeLaval milking system, and are housed free in barns bedded with straws.

At weeks before due date, the cows and heifers are moved into the close-up pens, where the farm workers and research personnel monitor the cows once every hour, and move cows displaying signs of active labor to the maternity pen. Peri- and post-partum clinical events are recorded and described.

According to farm protocols the fresh maternal first-milking colostrum is collected within 1 h from calving, and tested for quality, using a Brix digital refractometer (Atago Pal-S, Japan).

A fresh maternal first-milking colostrum with Brix reading of 25% or higher is used to feed calves within one-half hour after it is harvested. All calves receive using a calf bottle with nipple, flour colostrum meals (2 L/meal) in the first two days of life. In the first day of life calves receive first meal of 2 L colostrum within 4 h of life and 2 L colostrum within 12 h of life as second meal, in order to realize a high concentration of Ig Gin blood of the calves. In the second day of life calves are fed with 4 L/day of colostrum in order to realize a protective coating by unabsorbed antibodies that prevent microorganisms from attaching to the wall of the calf's intestinal tract. To do this the surplus high quality colostrum is mixed with transitional milk (second milking of his dam).

Surplus high quality colostrum is refrigerated, for short-term storage (≤ 24 h) or frozen, for long-term storage (> 24 h). In the third day of life the calves are fed with 4 L/day of transitional milk from his dam.

After that all calves are fed with whole milk (5 L/day from day 4 to 15 of life, 6 L/day from day 16 to 24 of life, 7 L/day from day 25 to 50 of life, 5 L/day from 51 to 55 of life, 4 L/day from day 56 to 60 of life, and 2 L/day for days 61 and 62 in 2 daily meals at 07:00 and 16:00).

At day 5 of life all calves are fed with calf starter in order to provide the opportunity for rumen development and growth of the young calves. Also, water is provided to promote intake of dry feed and an aqueous environment needed by rumen bacteria.

Calves are separated after birth from their mothers, weighed and housed in individual pen (1.5 × 2.5) bedded with straw and replenished at 2 or 3 days.

Table 2 Ingredients and chemical composition of the calf starter feed.

Item	% of dry matter (DW)
Feed ingredients	
Alfalfa hay chopped	10
Ground barley grain	15
Rolled barley grain	15
Corn grain coarsely ground	15
Corn grain rolled	12
Soybean meal	30
Calcium carbonate	1
Dicalcium phosphate	0.5
Salt	0.5
Sodium bicarbonate	0.5
Mineral + vitamin mix[a]	0.5
Nutrient composition	
DW (% as fed)	90
Crude protein	21
Neutral detergent fiber	18
Acid detergent fiber	9.1
Ether extract	2.7
Ash	7.5
Ca + P	1.4
Starch	39
Metabolizable energy Mcal/kg of DW[b]	3.03

1 = 250.000 IU vitamin A, 50.000 IU vitamin D, 1,500 IU vitamin E, 120 g Ca, 2.5 g Mn, 7.7 g Zn, 20 g P, 20.5 Mg, 186 g Na, 1.5 g F, 3 g S, 15 mg Co, 1.5 g Cu, 60 mg I, 10 mg Se per kg of mineral and vitamin mix.
2 = calculated using NRC (2001) equations.

Calf starter ration is formulated to meet the recommendations of the NRC (2001), consisting of cereal grains as a primary source of starch (grinding coarsely or rolled) and soybean as protein source (Table 2).

2.2 Experiment: Measurements and Sampling

For this experiment a sample size for a significant difference among the experimental groups of calves estimated for multiple comparisons at a power of 95% and alfa of 0.5, and a minimal detectable difference, resulted in a sample size of 50 calves per group, adding an additional 10% to account for attrition (a reduction in the number of calves in experimental groups and not replacing those who leave). The total sample size of 55 female calves per group was estimated. In the period from 2020 Jan. 1 to 2023 Apr. 30, a total of 165 female calves at 3 days of life were enrolled. All female calves were without birth defects, delivered without assistance at calving, and with normal respiratory rates, and were studied from the third day of birth until 62nd day of life. Each female calve was evaluated for morbidity which included: fecal consistency, attitude, hydration, respiratory and umbilicus scores using a method described by Berge et al. [8], and Love et al. [21] until 30 days of age by research veterinary personnel. Each fecal consistency score is described as follows: 0 = normal (firm but not hard); 1 = soft (does not hold form, piles but spreads slightly); 2 = ranny (spreads readily); 3 = watery (liquid consistency, splatters). A score of ≥ 2 indicated the presence of diarrhea. A simplified scoring system assesses siz clinical signs for respiratory disease (cough = points, eye discharge = 2 points, fever ≥ 39.2 °C = 2 points, abnormal respiration = 2 points, nasal discharger = 4 points, ear drop or head tilt = 5 points). A total score of 5 or higher classifies a calf as a respiratory disease case. Calves suspected to have omphalitis were calves with clinical signs of swelling, local heat, and discharge (pus). Also calves with more than 1 disease were recorded as multimorbid. BW of each female calf was determined at birth, at 30 days and 62 days of using a digital scale. Weighing was always performed before their morning meal. The calves were fed with whole milk and starter diet in accordance with farm protocols at 08:00 a.m. and 18:00 p.m. in individual hutches where calves are able to have direct visual and tactile contact and direct access to fresh starter diet and water offered in 2 buckets. Individual feed intake was recorded daily throughout the experiment period and feed refusal was adjusted daily at 5%. To enhance palatability and improve rumen digestion calf starter quantity of 1 kg was mixed by hand with 50 g of dried molasses [22]. BW of all female calves was determined at 3, 30 and 62 days of life. Weight gain feed intake, feed conversion ratio (FCR) and ADG were calculated at 30 and 62 days of life and across the entire study.

Blood samples were taken at 3 days after birth from regular vein in vacuum blood collection tubes and TSP was determined using a Brix % refractometer (Atago Pol-S, Japan).

The TSP was measured twice and the average was recorded for each sample [23-26].

2.3 Chemical Analysis

Feed ingredients were analyzed in ARDS Șimnic-Craiova's in laboratory crude protein (using Kjeldahl nitrogen analyzer Gerhardh Vapodest, Germany), including ADF and NDF (using Fibretherm Gerhardt), ether extract (by Soxtherm Gerhardt), ashes (by combustion at 550 °C), DW (sample dried in a forced air oven at 65 °C), Ca and P (by AOAC Official Method 935.13 and 964.06 respectively) and starch (AOAC method 996.11).

2.4 Statistical Analysis

Descriptive data were analyzed using Microsoft Excel computer program. All female calves based on TSP concentrations at 3 days of life were grouped into 3 categories: 1-TSP ≥ 6.2 g/dL, 2-TSP 5.8-6.1 g/dL and 3-TSP < 5.8 g/dL [18]. To evaluate the effect of TSP on calf performance (growth and calf starter intake) linear mixed (PROC MIXED) was used. Also, a linear regression was used to evaluate the linear relationship between TSP concentrations at 3 days of life with performance traits (BW and ADG). The trait with repetitions during the study was analyzed as repeated measurements. To estimate the strength of the association between two categorical variables, odds ratio calculator was used (MedCalc).

Feed intake and live weight curves were elaborated according to the method used by Buonaiuto et al. [27] and Cavallini et al. [28], using the following polynomial regression model:

$$y_{jklm} = day_j + \sum_{i=1}^{n} \beta_n P_n + \sum_{i=1}^{n} \alpha_n P_n + e_{jklm}$$

where y_{jklm} is feed intake, or live weight measured during experimental period for the k animal, day j is the fixed effect of the j-th time at measuring. β_n is the n-th fixed regression coefficient of the polynominal modelling records of the intake or live weight throughout the experiment, α_n is the n-th random regression coefficient of the polynominal modelling records of feed intake or live weight through experiment for calf k-th, and e_{jklm} is the residual term.

The significance level was set at $p < 0.05$.

3. Results

The average of TSP (± standard deviation) in each TSP group is presented in Table 3.

Overall the average (±SD) of TSP concentration was 6.38 (±0.38) g/dL (Table 1) and 7.07 (±0.58) g/dL, 5.98 (±0.11) g/dL and 5.43 (±0.29) g/dL in category 1-TSP ≥ 6.2, category 2-TSP 5.8 to 6.1 and category 3-TSP < 5.8 g/dL respectively.

The TPI to new-born calves is categorized excellent (TSP ≥ 6.2 g/dL), good (TSP 5.8 to 6.1 g/dL) and fair to poor (TSP < 5.8 g/dL). The herd goal must be 40% calves (excellent), 30% (good) and 30% (fair to poor) [18].

Table 3 Descriptive statistic of total serum protein (TSP) concentrations in each category of female calves (n = 165).

TSP category	n (%)	Average	±SD*	Interquartile 1	Median	Interquartile 3
		g/dL	g/dL	g/dL	g/dL	g/dL
1-TSP ≥ 6.2 g/dL	80 (48.5)	7.07	0.58	6.6	7	7.6
2-TSP 5.8-6.1 g/dL	32 (19.4)	5.98	0.11	6	6	6.1
3-TSP < 5.8 g/dL	53 (32.1)	5.43	0.29	5.4	5.5	5.6
Overall	165 (100)	6.38	0.38	5.9	6.3	6.6

* Standard deviation.

Table 4 Incidence of disorders in preweaned female calves, overall and in each TSP category.

Disorder	Overall		TSP category					
			1-TSP ≥ 6.2 g/dL		2-TSP 5.8-6.1 g/dL		3-TSP < 5.8 g/dL	
	n	%	*n*	%	*n*	%	*n*	%
Diarrhea	28	16.96	10	11.5	5	20	13	24.5
Respiratory disease	13	7.98	4	4.6	3	12	6	11.3
Omphalitis	8	4.85	2	2.3	2	8	4	7.5
Diarrhea (D) multi morbidity*	10	6.06	2	2.3	2	8	6	11.3
Respiratory disease (RD) multi morbidity**	6	3.64	2	2.3	2	8	2	3.8
Omphalitis (O) multi morbidity***	5	3.03	2	2.3	1	4	2	3.8
Multi morbidity****	6	3.64	1	1.1	-	-	5	9.4
Total	76	46.06	23	26.4	15	60	38	71.6

* D+RD; ** RD+O; *** O+D; **** D+RD+O.

Table 5 Odds ratio (OR) for female calves to be affected by calf hood disease in each TSP category.

TSP category	Odds ratio	95% CI	*p* value
1-TSP ≥ 6.2 g/dL	Reference		
2-TSP 5.8-6.1 g/dL	2.87	1.15-7.17	0.012
3-TSP < 5.8 g/dL	6.28	2.91-13.5	< 0.001

Prevalence of disorders in preweaned female calves and in each TSP category is presented in Table 4.

Diarrhea (16.96%) was the most prevalent disorder in female calves followed by respiratory disease (7.88%) and omphalitis (4.85%). In total 29.69% of all experimental calves were affected by at least 1 disorder and 16.37% were affected by multiple disorders, most often diarrhea in combination with respiratory disease (Table 5). Regarding the incidence of health disorders in TSP categories the TSP concentration at 3 days after birth influenced health status of female calves. The female calves with fair and poor immunity (category 3-TSP < 5.8 g/dL) were significantly more likely (OR 6.28, 95% CI 2.91-13.5, p value < 0.001) to be affected by diseases compared with calves in category 1-TSP ≥ 6.2 g/dL (Table 5).

The female calves with excellent immunity (category 1-TSP ≥ 6.2 g/dL) had lower chance (OR 0.16, 95% CI 0.07-0.34, $p < 0.001$) to be affected by calf hood diseases in preweaning period.

The proportion of the female calves with at least 1 the calfhood disorder increased as TSP concentrations decreased. Also the proportion of the female calves with more than 1 calf hood disorder increased as TSP concentrations decreased.

Birth weight ranged from 36.9 to 44.8 kg with mean and standard error of mean of female calves of 40.7 ± 0.35 kg, 40.2 ± 0.56 kg, and 40.5 ± 0.43 kg in category 1-TSP ≥ 6.2 g/dL, category 2-TSP 5.8-6.1 g/dL, and category 3-TSP < 5.8 g/dL respectively (Table 6).

The female calves with TSP ≥ 6.2 g/dL at 3 days had the greatest BW at 30 days and 62 days of age (51.8 kg and 77.1 kg respectively) compared with female caves with TSP < 5.8 g/dL at 3 days of age (46.6 kg and 70.6 kg; Table 6) or with female calves TSP 5.8-6.1 g/dL at 3 days of age (50.1 kg and 73.5 kg). ADG during 1-30 and 1-62 days of age decreased as TSP concentrations decreased (Table 6). There were significant differences in ADG between female calves categorized with excellent, good and fair to poor immunity. Moreover, starter feed intake during the first 30 days of life, 31 to 62 days of life and 1 to 62 days of life was greater in female calves with TSP ≥ 6.2 g/dL than female calves with TSP 5.8-6.1 g/dL.

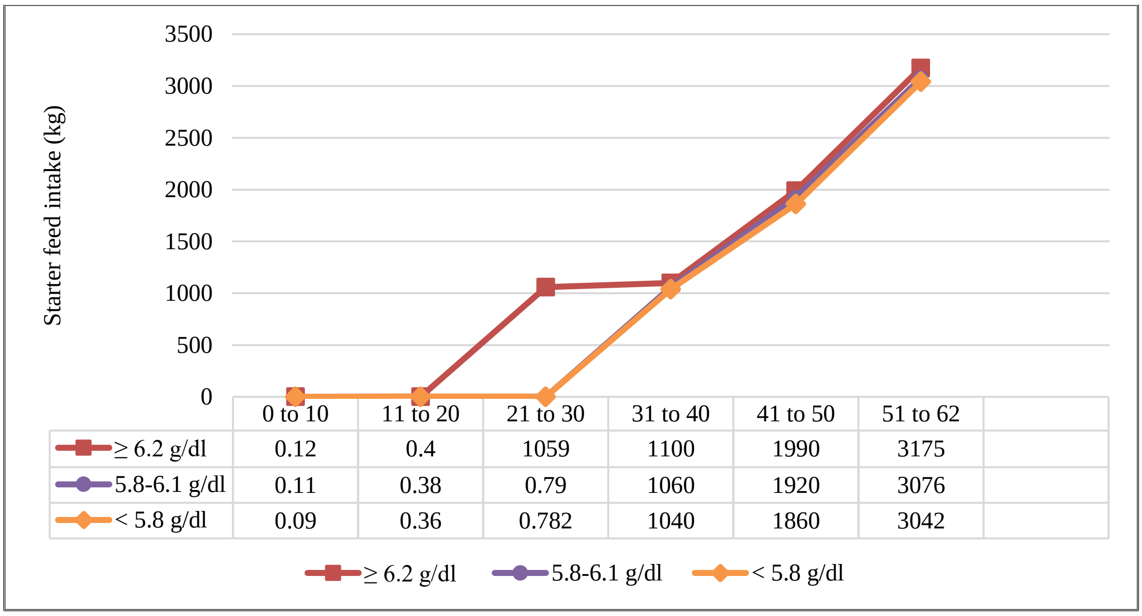

Fig. 1 Starter feed intake during experimental period by calves with different total serum protein (TSP) levels at 3 days of life.

Table 6 Effects of TSP at 3 days of calves' life on body weight (BW), average daily gain (ADG) and average starter intakes.

Item	1-TSP ≥ 6.2 g/dL		2-TSP 5.8-6.1 g/dL		3-TSP < 5.8 g/dL	
	Mean	±SD*	Mean	±SD	Mean	±SD
Initial BW (kg)	40.7	0.35	40.2	0.561	40.5	0.432
BW at 30 days (kg)	51.8	0.36[a]	50.1	0.722[a]	46.6	0.550[b]
BW at 62 days (kg)	77.1	0.70[a]	73.5	0.796[a]	70.6	0.920[b]
ADG (g/day)						
1-30 days	370.2	20.2[a]	332.6	22.7[b]	221.2	18.8[c]
31-62 days	790.8	22.7[a]	730.2	24.2[b]	750.8	26.2[c]
1-62 days	587.1	18.4[a]	537.1	20.6[b]	485.5	17.8[c]
Average starter feed intake (g/day)						
1-30 days	526.3	15.6[a]	426.6	16.4[b]	410.4	14.4[c]
31-62 days	2,088.3	26.8[a]	2,018.8	18.2[b]	1,980.6	16.2[c]
1-62 days	1,307.3	20.2[a]	1,222.6	18.8[b]	1,195.6	14.2[c]

* Standard deviation; a-c = means within a row with different superscripts are significantly different ($p < 0.05$).

g/dL or with female calves with < 5.8 g/dL (Table 6; Fig. 1).

4. Discussion

The aim of this study was to evaluate the influence of TSP concentrations at 3 days of age on health and growth parameters of preweaned female Holstein Friesian calves. The results showed that TSP concentrations at 3 days of age of female calves of ≥ 6.2 g/dL positively influenced the calfhood morbidity, BW and ADG during the preweaning period (1 to 62 days after birth).

We used a digital refractometer to measure TSP and % Brix. Using a refractometer is still a suitable test if low cost and speed are important [29, 30]. Also a digital refractometer can be used as an on-farm test to evaluate the predicted serum IgG levels [31] or colostrum IgG concentrations [32, 33].

The postnatal period in calves is the most critical period and is known as adaptive period [34, 35]. Colostrum and subsequently milk provide a complete diet for the new birth calve during initial period of its life. Intake of quantity of colostrum with good quality to provide proper blood concentrations of TSP, ensures healthy calves.

Passive transfer of immunity in dairy calves is evaluated by measuring the TSP within the first 1 to 7 days of life.

This procedure offers information directly correlated to an individual calf's immune status, their likeliness of morbidity and mortality, and the effectiveness of the colostrum management program in the dairy farm.

In the same in-depth study, instead of categorizing passive immunity as dichotomized "pass/fail" system, the authors recommended an excellent/good/fair/poor classification system. In our study, "excellent" calves had a significantly reduced disease risk and fair/poor calves had significantly increased risk of contracting disease.

We found significant differences in the prevalence of clinical disorders between the three TSP categories of female calves. These differences were found for diarrhea, respiratory diseases and omphalitis. The etiology of these disorders is multifactorial and the risk factors are complex and interconnected.

Usually diarrhea is a factor disease, but strictly speaking it is a symptom. The higher fluid volume in the intestine, its increased peristalsis, pathogens and toxins are excreted.

Multiple enteric pathogens (viral, parasitic and bacterial) are infectious causative agents of neonatal calf diarrhea [36]. Hypersecretory diarrhea evolves when an abnormal quantity of fluid is secreted into the intestinal gut surpassing the resorptive capacity of the mucosa. Malasbsorptive diarrhea evolves when the capacity of the mucosa to absorb fluid and nutrients is damaged and cannot keep up with the normal influx of ingested and secreted fluids. The villans atrophy evolves and its extension and distribution varies with different pathogens, and this gives a reason for severity of clinical disease [37]. Along diarrhea, bovine respiratory disease (BRD) is the most common disorder in calves, and can occur in both clinical and subclinical forms [38].

Maier et al. [39] suggest that management relative to housing and calf feeding practices may be the most important factors associated with incidence of BRD in calves. Respiratory diseases have a multifactorial etiology and evolve as a result of complex interactions between environmental factors, host factors and pathogens.

This disease is usually triggered by a viral infection + subsequent opportunistic bacterial invasion. The prevalence of BRD has been investigated in several studies, and it varies from 4% to more than 80% [40, 41]. Moreover Buczinski et al. [42] in their report concluded that heifers odds of dying are 2.30 times higher than odds of herd removal before the first calving, compared with heifer not diagnosed with this condition. Also heifers with calfhood BRD had an ADG reduced by 0.067 kg/day.

In our study at herd level omphalitis was a detected disorder. Navel ill or omphalitis is a disease characterized by infection of umbilicus and its associated structures. The umbilical infection can be urachal infection, omphalophlebitis, ompholoarteritis or a combination of any of those [43]. In our report the prevalence of omphalitis was 4.85% according to clinical score in overall calves. The distribution among the STP categories was 2.3% in calves with ≥ 6.2 g/dL, 8% in calves with < 5.8 g/dL. In a report by Perrot et al. [44] it is showing that FP1 transfer is not a risk factor for omphalitis.

Growth rate and BW are important parameters to monitor during a calf's preweaning period and they reflect the results of farm management practices [45, 46].

Several factors may justify the variation in calves' BW and ADG. Diseases can affect ADG by suppressing appetite and feed intake. Early life nutrition of calves is an interesting research issue because growth and development may affect the future performance of dairy cows [47, 48]. In this study the lower incidence of disorders due to higher TSP concentrations (≥ 6.2 g/dL) is the result of the greater impact of colostrum—derived immune cells on calves' health. Also many of non-immunoglobulin factors in colostrum acted to influence the calf's health such as lysozyme lactoferrin and lacto peroxidase which are very significant in terms of the colostrum's bacteriostatic and germicidal properties [49].

Given the scope of the TPI assessment recommendation and its common use in research trials and commercial settings, understanding of serum IgG and STP dynamics is needed to optimize its applicability and interpretation. Correa et al. [50] showed that relative to day 1 of life (6.08 ± 0.17 g/dL). TSP concentrations were lover at day 4 (5.75 ± 0.13 g/dL), day 8 (5.58 ± 0.11 g/dL), day 12 (5.24 ± 0.11 g/dL) and day 16 of life (4.82 ± 0.07 g/dL). Also relative to that at day 1 of life serum protein concentration declined by 1.87 ± 0.15 g/dL for TSP excellent (31.6%), 1.18 g ± 0.32 g/dL for TSP good (21%) and 0.74 ± 0.19 g/dL for TSP faire to poor calves respectively; the degree of this decrease is associated with the initially acquired immunity classification of calves [50]. Also, other studies reported a decline in serum IgG concentration at day 7 to 8 of life [51, 52]. One study reported a 20% increase in serum IgG from day 2 to 8 of life [53].

Regarding TSP changes over time Wilm et al. [51] and Roadknight et al. [53] observed that TSP concentrations remained constant from day 1 to 10 and from 2 to 14 of life, respectively.

The IgG content is just one component of TSP (serum IgG represented 64%, 38% and 29% of the TSP at day 1 of life for IgG).

Excellent, IgG—good and IgG—fair to poor calves [50]. The changes in TSP over time are unnoticeable if other protein fractions remain relatively constant, nutrition and dehydration may influence serum concentration or proteins in female calves.

Use and catabolism of IgG and TSP in each TPI category of calves as a respond to expose to antigens represent some of the adaptive capabilities of new-born calves. Calves with greater TSP have a greater capacity to inactivate pathogenic invasion and support an earlier response than calves with lower TSP. Also, greater TSP must support an acquired humoral immune response for defense [46].

We hope that this study can help towards the improvement of farm management in dairy calf raising. For this reason, disseminating this study to a wider audience utilizing social media is a good educational tool in higher education. Muca et al. [54] in their paper present an overview of the usage of Instagram as a social media platform for teaching and engagement in the field of dairy cow nutrition and management. Competency in nutritional science is essential for veterinarians to be able to promote and maintain good health in all types of livestock. The development of new teaching methods to improve education in animal nutrition is needed because insufficient teaching hours are being toward animal nutrition in veterinary schools. Muca et al. [55] developed an innovative student-centered approach (flipped classroom and peer-assisted learning, FC/PAL) to improve knowledge. They concluded that most of the students were satisfied with the FC/PAL activity carried out.

5. Conclusions

Overall, the results of this study reveal that calf health should become a central issue for dairy farmers and in herd health consultancy.

Calves with excellent immunity (TSP ≥ 6.2 g/dL) at 3 days after birth had lower calfhood health disorders, and a greater ADG and BW at 30 days and 62 days of age.

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