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Effects of maternal nutrition in the final third of gestation on performance and body composition of progeny at slaughter

Efeito da nutrição materna no terço final da gestação sobre a composição corporal da progênie ao abate

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Abstract
This study aimed to assess how maternal nutrition in the final third of gestation affects progeny weight performance and body composition. Forty-one steers were included, born to cows subjected to different nutritional levels during this period: 13 cows without supplementation and under nutritional restriction (RES), 16 cows supplemented to meet 100% of requirements (REQ), and 12 cows supplemented to meet 150% of requirements (HIGH). The study design was completely randomized. Progeny performance was not influenced by maternal nutrition during gestation (P > 0.05). However, RES animals excelled during challenging periods, while REQ and HIGH animals performed better in nutritionally favorable environments. Maternal nutrition in the final third of gestation did not impact the contribution of non-carcass components (16.42%) and internal organs (3.17%). RES and HIGH steers had a higher relative weight of the rumen (2.48%) compared to REQ steers (2.24%), resulting in a greater proportion of the gastrointestinal tract (8.25% vs. 7.63%). Carcass characteristics did not differ significantly between treatments (P > 0.05), with an average hot carcass weight and yield of 304.28 kg and 57.80%, respectively. The primary fore, side, and hind cuts represented 39.22%, 10.64%, and 50.67% of the carcass, respectively. Overall, maternal nutrition during gestation affects fetal development, leading to modifications in body composition and, consequently, the productive potential of the offspring.
Keywords: carcass yield; gastrointestinal tract; slaughter weight; vital organs

Resumo
O objetivo do estudo foi avaliar os efeitos da nutrição materna no terço final da gestação sobre o desempenho ponderal e a composição corporal da progênie. Foram utilizados 41 novilhos de vacas submetidas a diferentes níveis nutricionais durante o terço final de gestação: 13 vacas sem suplementação sob restrição nutricional (RES); 16 vacas suplementadas para atender 100% das exigências (REQ); 12 vacas suplementadas para atender 150% das exigências (HIGH). O delineamento experimental foi inteiramente casualizado. O desempenho da progênie não foi influenciado pela nutrição materna na gestação (P > 0,05), porém, animais RES se sobresaem em períodos desafiadores, enquanto que os REQ e HIGH desempenharam melhor em ambientes nutricionalmente favoráveis. A nutrição materna no terço final da gestação não influenciou a participação dos componentes não carcaça (16,42%) e órgãos internos (3,17%). O peso relativo do rúmen foi maior nos novilhos RES e HIGH (2,48%) em relação aos novilhos REQ (2,24%), resultando em maior participação do trato gastrointestinal (8,25 vs 7,63%, respectivamente). As características quantitativas da carcaça foram semelhantes entre os tratamentos (P > 0,05), com peso médio de carcaça quente e rendimento equivalente a 304,28 kg e 57,80%. A participação dos cortes primários dianteiro, lateral e traseiro foi de 39,22, 10,64 e 50,67%, respectivamente. Diante do exposto, concluímos que a nutrição materna na gestação afeta a formação fetal de modo a modificar a composição corporal e consequentemente o potencial produtivo dos descendentes.
Palavras-chave: órgãos vitais; peso de abate; rendimento de carcaça; trato gastrointestinal

1. Introduction

Recently, there has been significant research into the impact of maternal nutrition on progeny development during gestation. Reynolds and Caton [(1)] referred to changes in the uterine environment as fetal programming, which can have long-term effects on the progeny's life by altering the structure and function of their body organs and tissues.

Assessing progeny body composition is typically done during the intrauterine period and early months of life when the effects are more readily observable [(2)]. Brameld et al. [(3)] suggested that given enough time during postnatal life, animals can largely overcome or

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compensate for these early differences, resulting in minimal residual effects of fetal programming on the offspring's body composition during later stages of growth.

Understanding how animals adapt to nutrient supply during the fetal period becomes crucial for evaluating their productive potential after birth. According to Reynolds et al. [4], bodily changes facilitate the rapid adaptation of the fetus to the uterine selection pressure during its formation. Greater emphasis is being placed on organs such as the gastrointestinal tract and those involved in nutrient metabolism, as they play a significant role in nutrient digestion, absorption, and utilization. Duarte et al. [5] observed that the offspring of cows subjected to nutritional restriction exhibited compensatory changes in the formation of the digestive tract, particularly in the small intestine, where both the length of the small intestine and the intestinal villi increased. When evaluating the effects of maternal protein during pregnancy, Da Cruz et al. [6] noted a trend towards greater villus height and increased expression of genes related to nutrient absorption in the small intestine of progeny from cows that received only 75% of the protein requirements during gestation.

Symonds et al. [7] argued that unfavorable conditions in the uterine environment during the early stages of gestation can result in alterations to the homeostatic mechanisms of the liver and pancreas, affecting the progeny's ability to metabolize nutrients Prezotto et al. [8] observed compensatory liver growth in fetuses that experienced nutritional restriction during the first and/or second trimester, leading to a higher relative weight of this organ. Similarly, nutritional restriction towards the end of pregnancy may stimulate compensatory organ growth in newborn animals due to the increased need to absorb nutrients from low-quality diets.

While organogenesis is most active during the early stages of gestation, the final maturation of organs takes place in the last third of gestation, making them susceptible to nutritional changes in the pregnant female. Funston et al. [9] stated that critical events for normal fetal development, including fetal organogenesis and placental development, occur during the second half of gestation. Given the potential long-term impact of these changes on adult offspring, the objective of this study was to assess the effects of nutritional levels during the final third of gestation on weight performance and body composition of progeny at slaughter.

2. Materials and methods

The study was conducted at the Beef Cattle Laboratory of the Animal Science Department of the Federal University of Santa Maria (UFSM). It is situated in the Central Depression of the state of Rio Grande do Sul (Brazil), at 29° 43' south latitude and 53° 42' west longitude. All experimental procedures were approved by the Ethics Committee on Animal Use of the UFSM, under protocol 2531070319.

Data collection and animal finishing phase in feedlots were carried out between April and June 2019. The finishing phase commenced with 14 days of animal adaptation to diets and facilities, followed by three subsequent periods of 28 days each.

Forty-one non-castrated steers obtained from crossbreeding between the Charolais (CH) and Nellore (NE) breeds were used in this study. The crossbred animals belonged to the fifth and sixth generations, including the following genetic compositions: CH, NE, 21/32 CH, 11/32 CH, 43/64 CH, and 21/64 CH. The steers were approximately 17 months old, weighed about 403 kg, and were born from cows subjected to different nutritional levels in the final third of pregnancy. Specifically, there were 13 cows without supplementation on native pasture meeting approximately 75% of energy and protein requirements (RES), 16 cows supplemented to meet approximately 100% of energy and protein requirements (REQ), and 12 cows supplemented to meet approximately 150% of energy and protein requirements (HIGH).

The diets were formulated based on the requirements outlined by the National Research Council – NRC [10] for 475 kg beef cows during the final third of gestation, consuming 2.1% of dry matter body weight. Each treatment group of cows had the same gestation age (190 days), weight (460 kg), and initial body score (2.84 points), and they were kept in a single paddock according to the tested nutritional level. The REQ and HIGH cows received supplementation during late gestation at rates of 0.28% and 0.98% of the animal's live weight, respectively. These nutritional plans allowed for daily weight gains of about -0.103 kg/day, 0.025 kg/day, and 0.207 kg/day during the final third of pregnancy and resulted in body scores at the birth of 2.81, 2.92, and 2.99 points for the RES, REQ, and HIGH treatments, respectively. The calves were born in October and November of the same year and were maintained under similar conditions until slaughter. Further information on maternal production and early progeny development can be found in Klein et al. [11].

Before the feedlot period, a preventive control measure against ticks (*Boophilus microplus*) was implemented through an immersion bath using a syrup composed of the commercial product Colosso FC30™ (Fenthion + Cypermethrin + 30% Chlorpyrifos). This was followed by the application of the Pour-on product Fluatac DUO™, containing Fluazuron + Abamectin, at a dosage of 1 mL/10 kg of live weight. Additionally, strategic endoparasite control was administered using the commercial product Evol™ (Ivermectin + Albendazole Sulfoxide) at a dosage of 1 mL/20 kg of body weight.

The steers were finished in a confined system, with an initial 14-day adaptation period followed by an additional 84 days of experimental evaluation, totaling 98 days. The steers were housed in individual stalls measuring 10 m², paved with reinforced concrete, and inclined at a slope of 3%. The diet was formulated according to the nutritional requirements defined by the National Research Council – NRC [12], aiming for a daily weight gain of about 1.50 kg/day for young steers. A roughage: concentrate ratio of 40:60 was employed, with whole corn plant silage used as a roughage source (Table 1). Daily dry matter intake of steers was recorded, with an average intake of 9.68 kg/day.

Animal weight performance was evaluated throughout the production cycle to identify fetal programming effects on offspring adaptability. Progeny performance was represented by average daily weight gain (kg/day), and this productivity index was calculated as the quotient of total weight gain divided by the number of days between weighings.

Table 1. Chemical composition and ingredient participation in the diet of feedlot-finished steers

Ingredient	Chemical composition, %					Participation, %
	DM	MM	CP	TDN[1]	NDF	
Corn silage	30.40	4.60	5.65	65.70	60.10	42.00
Ground corn	86.70	1.70	9.00	89.80	12.00	33.30
Whole grain white oat	87.20	2.55	14.69	71.00	19.60	20.50
Soybean meal	86.35	7.10	54.20	88.70	12.30	3.60
Calcitic limestone	96.00	99.00	-	-	-	0.40
Salt	96.00	99.00	-	-	-	0.20
Total diet [2]	48.70	3.90	10.40	75.30	33.80	100.00

[1]Total digestible nutrients by the digestible organic matter method. [2]Final composition based on ingredients and their participation in the diet. DM, dry matter; MM, mineral matter; CP, crude protein; TDN, total digestible nutrients, and NDF, neutral detergent fiber.

The animals were slaughtered in a state-inspected commercial slaughterhouse located about 20 km from the farm. The slaughter weight was obtained after a 14-hour fasting period from solids and liquids. The process followed the standard procedures of the commercial slaughterhouse, including sprinkling bath and stunning before bleeding.

During the slaughter, all parts of the animal's body were separated and individually weighed following the methods described by Cattelam et al. [13]. These included: 1) set of external components (head, paws, ears, tail broom, testicles, and hide); 2) set of vital organs (lungs, liver, kidneys, heart, and spleen); 3) set of internal fats (subcutaneous fat, inguinal fat, kidney fat, and heart fat); 4) set of empty digestive tract (rumen + reticulum, omasum, abomasum, intestines); 5) blood. The sum of all body parts, along with the hot carcass weight, corresponded to the animal's empty body weight (EBW), which was used to assess the contribution of each organ set in the animal's body. Additionally, the volumes of the vital organs (heart, kidneys, and liver) were measured by water displacement in a known volume container.

Before entering the cooling chamber, the two half-carcasses were identified and weighed to determine the hot carcass weight (HCW). After 24 hours of cooling at temperatures ranging from 0 to 1ºC, they were weighed again to obtain the cold carcass weight (CCW). Based on these measurements, hot and cold carcass yields were calculated, as well as the cooling loss. The left half-carcass was then divided into primary commercial cuts: forequarter, rib, and hindquarter, following the methods described by Müller [14]. Each cut was weighed to determine its proportion concerning the cold carcass.

The experimental design employed a completely randomized design with three treatments and a varying number of repetitions. Residual normality was assessed using the Shapiro-Wilk test, and transformations and elimination of outliers were performed as needed. The following variables were transformed: tail broom (logarithmic function), testicles (inverse), and intestines (second power). Outliers were removed if their dispersion fell outside the range of ± 2 standard deviations (SD). The data were then subjected to analysis of variance using the F-test through the PROC GLM procedure. When significance was found, means were compared using the Tukey test at a 5% probability level, and the averages were compared using the least squares method. Statistical analyses were performed using the SAS™ Studio University Edition statistical package [15] with the following mathematical model:

$$Yijk = \mu + Ni + Zj + \varepsilon ij$$

Wherein: *Yijk* represents the dependent variable, μ is the mean of all observations, *Ni* is the effect of the i^{-th} prepartum nutritional level, *Zj* is the percentage of Nellore breed as a co-variable effect, and *εij* represents the residual random error effect.

3. Results

Figure 1 depicts the performance of animals and illustrates the productive response of the progeny throughout different growth phases until slaughter. This highlights the impact of fetal development during pregnancy on the potential for production and adaptation in diverse environments.

During the forage transition and initial adaptation to confinement, RES animals exhibited a productive advantage. Conversely, programmed REQ and HIGH animals showcased their production potential under nutritionally favorable conditions, such as in confinement. In these situations, the daily weight gains were 1.384 kg/day, 1.398 kg/day, and 1.503 kg/day for the RES, REQ, and HIGH treatments, respectively.

Table 2 presents the non-carcass components. Maternal nutrition during the final third of gestation did not have a significant influence (P > 0.05) on the participation of non-carcass parts concerning the empty body weight (EBW). The EBW represents the combined weight of all parts of the animal along with the hot carcass weight (HCW), which had an average value of 449.5 kg. On average, the non-carcass components accounted for 16.42% of the EBW.

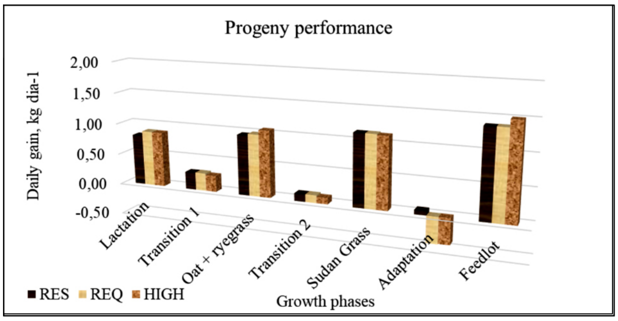

Figure 1. Progeny performance and growth stages of beef cows subjected to different nutritional levels in the final third of gestation.

[1] breastfeeding period (165 days); [2] post-weaning period until entering the oat + ryegrass pasture (105 days); [3] period in oat + ryegrass pasture (65 days); [4] period after Oats + Ryegrass pasture until entering the Capim Sudão pasture (50 days); [5] period in Sudan grass pasture (110 days); [6] period after Grass Sudan pasture until the beginning of the experimental period (15 days); [7] confinement termination period (84 days).

Table 2. Non-carcass components of the progeny from beef cows subjected to varying nutritional levels in the final third of gestation

Non-carcass component	Maternal nutritional level			MSE	P-value
	RES	REQ	HIGH		
Empty body weight, kg	445.9	454.9	447.3	6.38	0.7641
Blood, %	2.62	2.47	2.54	0.06	0.6540
Paws, %	2.33	2.43	2.45	0.03	0.6465
Ears, %	0.15	0.14	0.14	0.01	0.6274
Tail broom, %	0.06	0.07	0.05	0.01	0.1405
Testicles, %	0.27	0.26	0.28	0.01	0.5490
Leather, %	10.02	9.87	9.71	0.15	0.6720
Head, %	3.62	3.64	3.72	0.07	0.9239
Total external components, %	16.47	16.27	16.53	0.15	0.7451

Means followed by distinct letters in the row differ from each other by the Tukey-Kramer test at 5% probability (P < 0.05). MSE, means standard error; RES, cows without supplementation on native pasture under nutritional restriction; REQ, supplemented cows to meet 100% of the requirements; HIGH, supplemented cows to meet 150% of requirements. Non-carcass components are expressed relative to empty body weight (EBW).

Similarly, maternal nutrition in the final third of gestation did not affect the participation of internal organs in steer carcasses (Table 3). Relative weights of the heart, kidneys, and liver were 0.32%, 0.19%, and 1.11% of the EBW, respectively. The volume of these organs was measured through water displacement in a container of known volume, and it was not influenced by maternal nutrition during pregnancy (P > 0.05). The set of internal organs and internal fats accounted for 3.17% and 1.86% of the EBW, respectively.

Table 3. Internal components in the carcass of the progeny from beef cows subjected to varying nutritional levels in the final third of gestation

% EBW	Maternal nutritional level			MSE	P-value
	RES	REQ	HIGH		
Heart, %	0.31	0.31	0.33	0.01	0.3347
Heart fat, %	0.05	0.05	0.05	0.01	0.8256
Kidneys, %	0.19	0.19	0.20	0.01	0.1264
kidney fat, %	0.74	0.71	0.78	0.03	0.5947
Lungs, %	1.24	1.20	1.26	0.02	0.4835
Spleen, %	0.29	0.30	0.30	0.01	0.7980
Liver, %	1.11	1.10	1.12	0.01	0.8558
Inguinal fat, %	0.53	0.49	0.56	0.02	0.2383
Dressing fat, %	0.57	0.53	0.57	0.02	0.5537
Total internal organs, %	3.15	3.14	3.23	0.03	0.5561
Total internal fats, %	1.89	1.76	1.93	0.05	0.3925
Total internal components, %	5.05	4.90	5.16	0.06	0.2540
Heart volume, cm^3	132.61	139.95	143.80	2.94	0.3979
Kidney volume, cm^3	84.60	88.45	91.92	1.92	0.2648
Live volume, cm^3	454.46	472.06	480.67	8.87	0.5719

Means followed by distinct letters in the row differ from each other by the Tukey-Kramer test at 5% probability (P < 0.05). MSE, means standard error; RES, cows without supplementation on native pasture under nutritional restriction; REQ, supplemented cows to meet 100% of the requirements; HIGH, supplemented cows to meet 150% of requirements; EBW, empty body weight.

The relative weight of the gastrointestinal tract and its constituents was influenced by maternal nutrition in the final third of gestation (Table 4). REQ steers exhibited a lower proportion of rumen-reticulum concerning the EBW compared to RES and HIGH steers (2.24% vs. 2.45% and 2.50%, respectively). Additionally, there was a trend (P = 0.0622) for lower abomasum weight in REQ steers (0.80%), while the HIGH steers had the abomasum representing 0.94% of the EBW. Consequently, the participation of organs comprising the gastrointestinal tract was lower in REQ steers compared to RES and HIGH steers, with respective values of 7.63% vs. 8.22% and 8.28% (P = 0.0184).

The slaughter weight was 526.1 kg (P > 0.05), and the hot (HCW) and cold (CCW) carcass weights were 304.3 kg and 296.1 kg, respectively (Table 5). There was a trend towards higher hot carcass yield (P = 0.1071) and cold carcass yield (P = 0.1038) for REQ steers, with yields of 58.51% and 56.92%, respectively. The weight loss during carcass cooling was 2.67%.

Maternal nutrition in the final third of gestation did not influence the primary carcass cuts of the steers (Table

5). The percentages of forequarters, ribs, and hindquarters in the cold carcass were 39.22%, 10.64%, and 50.67%, respectively.

Table 4. Gastrointestinal tract of the progeny from beef cows subjected to varying nutritional levels in the final third of pregnancy

% EBW	Maternal nutritional level			MSE	P-value
	RES	REQ	HIGH		
Rumen-reticulum, %	2.45a	2.24b	2.50a	0.03	0.0015
Omasum, %	1.04	0.98	0.99	0.02	0.3683
Abomasum, %	0.89	0.80	0.94	0.02	0.0622
Intestines, %	3.84	3.60	3.84	0.06	0.2485
Total gastrointestinal tract, %	8.22a	7.63b	8.28a	0.10	0.0184

Means followed by distinct letters in the row differ from each other by the Tukey-Kramer test at 5% probability ($P < 0.05$). MSE, means standard error; RES, cows without supplementation on native pasture under nutritional restriction; REQ, supplemented cows to meet 100% of the requirements; HIGH, supplemented cows to meet 150% of requirements; EBW, empty body weight.

Table 5. Quantitative carcass traits of the progeny from beef cows subjected to varying nutritional levels in the final third of

Carcass trait	Maternal nutritional level			MSE	P-value
	RES	REQ	HIGH		
Slaughter weight (SW), kg	522.4	532.4	523.6	7.72	0.7744
Hot carcass weight (HCW), kg	300.5	311.8	300.6	4.91	0.5023
Cold carcass weight (CCW), kg	292.5	303.3	292.3	4.80	0.5044
Loss on cooling, %	2.67	2.71	2.65	0.02	0.6400
Hot carcass yield, %	57.49	58.51	57.41	0.23	0.1071
Cold carcass yield, %	55.97	56.92	55.82	0.22	0.1018
Fore quarter, kg	114.3	120.2	114.2	2.16	0.4052
Rib, kg	31.1	31.9	31.4	0.57	0.8547
Hindquarter, kg	148.7	152.8	148.2	2.33	0.5956
Fore quarter, %	39.04	39.55	39.08	0.20	0.5643
Rib, %	10.66	10.52	10.74	0.10	0.7140
Hindquarter, %	50.84	50.42	50.75	0.18	0.6421

Means followed by distinct letters in the row differ from each other by the Tukey-Kramer test at 5% probability ($P < 0.05$). MSE, means standard error; RES, cows without supplementation on native pasture under nutritional restriction; REQ, supplemented cows to meet 100% of the requirements; HIGH, supplemented cows to meet 150% of requirements. Primary carcass cuts (Forequarter, Ribs, and Hindquarter) are expressed relative to the cold carcass weight.

4. Discussion

Previous studies have used body component analyses to assess the impact of fetal programming on organ and tissue development in offspring and their association with production potential. Reynolds et al. [4] noted that maternal nutrition during pregnancy influences organ formation, maturation processes, and physiological function in the offspring, allowing for rapid adaptation to uterine environmental pressures.

In our study, we evaluated the body composition of RES, REQ, and HIGH cow progeny at the time of slaughter, and we did not observe significant changes. Hytel et al. [16] suggested that fetal programming primarily affects organogenesis during the first half of gestation, with the final third responsible for organ and system function maturation. Additionally, compensatory growth and adaptations may occur [17, 18], making more accurate assessments often necessary at younger ages.

Our study demonstrates minimal effects of fetal programming on progeny body composition at the time of slaughter. However, maternal nutrition during the final third of pregnancy can induce significant changes that prepare the fetus for varying challenges in postnatal life, facilitating rapid adaptation to the uterine environment [4].

These fetal adaptations to the uterine environment influenced postnatal environmental adaptability, resulting in different productive responses across developmental stages. Nutritional restriction during pregnancy favored RES progeny during less favorable nutritional periods, such as forage transition and initial confinement adaptation (Figure 1), while favorable nutritional phases enhanced the performance of REQ and HIGH animals. The average daily gain during the post-adaptation phase to confinement until slaughter was 1.384, 1.388, and 1.503 kg/day, respectively.

These differences in progeny responsiveness to the environment or rearing system may be strongly linked to organ formation and development. Despite similar relative weights (Table 3), HIGH steers exhibited 8.43%, 8.65%, and 5.76% higher heart, kidney, and liver volumes, respectively, compared to RES, which could be associated with the greater productivity of progeny raised in confinement. These results suggest increased development and maturation of these organs, potentially contributing to the higher metabolic capacity of these animals in intensive feeding systems. Vaag et al. [19] supported this notion, stating that progeny exposed to nutritional restriction during gestation face challenges in nutrient metabolism within intensive systems, increasing the risk of metabolic diseases.

Literature generally indicates a relatively greater development of vital organs in restricted progeny during gestation, as these organs take priority over other body systems. Prezotto et al. [8] found increased liver weight at 254 days of gestation in fetuses of cows subjected to nutritional restriction during the first and/or second trimester, demonstrating compensation in liver growth compared to body growth. Similarly, Duarte et al. [5], when testing different nutritional levels during pregnancy, observed compensatory effects on the digestive tract formation of progeny from cows subjected to nutritional restriction, including an increase in small intestine length and intestinal villi.

Similar findings were reported by Da Cruz et al. [6], who observed an inclination towards greater villus length and increased expression of genes associated with nutrient absorption in the small intestine of progeny from cows subjected to protein restriction during gestation. These results help elucidate the compensatory nutrient absorption exhibited by restricted progeny during pregnancy, which may have enabled their adaptation to more challenging postnatal environments, ultimately contributing to compensatory gains and minimal differences in progeny performance at slaughter [20].

Generally, nutritional restriction during gestation leads to the development of a conservative fetal phenotype characterized by a body constitution capable of enduring prolonged food shortages. Du et al. [21] noted that visceral fat formation initiates in the second trimester and continues until birth, with adipocyte hyperplasia influenced by maternal nutrition. Consequently, inadequate nutrition during gestation promotes the formation of lipogenic cells that efficiently store energy in the animal's body. The slight increase in visceral fat deposition observed in RES progeny may be attributed to their survival instinct.

Mohrhauser et al. [17] suggested that changes in adipose tissue composition reflect the development of an "economical" phenotype, allowing progeny to prepare for challenging postpartum periods and establish a more efficient body composition for storing readily available energy. These findings align with the hypothesis proposed by Maresca et al. [22], who suggested that altered carcass composition could be a consequence of greater abdominal fat deposition in progeny from cows subjected to protein restriction during pregnancy.

Several factors could contribute to the absence of differences in progeny body composition. Fetal adaptation and maternal compensation to nutritional challenges, accomplished through greater mobilization of body reserves and weight loss in pregnant cows during nutritional restriction [18], are likely influential. Additionally, Klein et al. [2] mentioned in a literature review that the effects of fetal programming are more prominent during the initial months of progeny life, and compensatory growth in restricted progeny, as discussed earlier, may also play a role.

To comprehensively understand the physiological and functional changes induced by nutritional insults during pregnancy, further advanced studies are warranted. Such research would elucidate the effects of these insults on growth rates, productive efficiency, and the quality of the final product in progeny.

5. Conclusion

During the final third of gestation, maternal nutrition does not affect non-carcass components or the contribution of internal organs to the overall body composition of animals. However, it does influence body formation, which in turn impacts the production potential of offspring during the rearing phases. When 100% of the energy and protein requirements (REQ) are provided at the end of gestation, there is a decrease in the relative rumen weight of the offspring. It is important to note that maternal nutrition during gestation does not alter carcass metrics or the composition of commercial primary cuts in the final third of gestation.

Conflict of interest

The authors have no conflicts of interest to declare.

Author contributions

Conceptualization: J. L. Klein. *Data curation*: J. L. Klein, S. M. Adams and J. M. Cocco. *Investigation*: J. L. Klein, S. M. Adams and J. M. Cocco. *Methodology*: S. M. Adams and J. M. Cocco. *Project administration*: D. C. A. Filho, I. L. Brondan and Luiz Â. D. Pizzuti. *Software*: J. L. Klein. *Validation*: D. C. A. Filho, I. L. Brondani and Luiz Â. D. Pizzuti. *Visualization*: I. L. Brondani. *Supervision*: D. C. A. Filho, I. L. Brondani and Luiz Â. D. Pizzuti. *Writing (original draft, review & editing):* J. L. Klein

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