UNIVERSIDADE FEDERAL DO PIAUÍ

CAMPUS "PROFª. CINOBELINA ELVAS"

PROGRAMA DE PÓS-GRADUAÇÃO EM ZOOTECNIA

PARÂMETROS METABÓLICOS E COMPORTAMENTAIS PRÉ E PÓS-PARTO DE OVELHAS DESLANADAS SUPLEMENTADAS A PASTO

TAIRON PANNUNZIO DIAS E SILVA

BOM JESUS-PI

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Co-orientadora: Profa. Dra. Jacira Neves da Costa Torreão

Dissertação apresentada ao *Campus* Prof.ª Cinobelina Elvas da Universidade Federal do Piauí, como parte das exigências do Programa de Pós-Graduação Zootecnia, na área de Produção Animal (linha de pesquisa Nutrição e produção de alimentos), para obtenção do título de Mestre.

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CERTIFICADO DE APROVAÇÃO

Título: Parâmetros metabólicos e comportamentais pré e pós-parto de ovelhas deslanadas suplementadas a pasto

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DEDICATÓRIA

*Em especial a **Vitória Dias da Silva** que me fez persistir e sempre acreditou na vitória, me apoiando nas tomadas de decisões e comigo visualizando um amanhã melhor.*

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Percebi, com o passar dos anos, que a busca por ideais está no prazer e na oportunidade de adquirir o verdadeiro conhecimento, e não na obrigatoriedade de alcançar tais objetivos, assim consegui compreender um pouco do sentido da vida.

BIOGRAFIA DO AUTOR

Tairon Pannunzio Dias e Silva, filho de Alcebias Marques da Silva e Vitória Dias da Silva, nasceu em Bom Jesus, Piauí, no dia 19 de Junho de 1988 e morou em Curimatá até 2004, retornando a Bom Jesus para cursar o Ensino Médio e curso Técnico em Agropecuária no Colégio Técnico de Bom Jesus.

Em março de 2007 ingressou no Curso de Medicina Veterinária da Universidade Federal do Piauí, Campus Professora Cinobelina Elvas e em Janeiro de 2012 recebeu o Título de Médico Veterinário.

Em março de 2012 iniciou o Mestrado no Curso de Pós-Graduação em Zootecnia, na área de Produção Animal, na Universidade Federal do Piauí, Campus Professora Cinobelina Elvas tendo como orientador o Prof. Dr. Carlo Aldrovandi Torreão Marques.

No dia 06 de dezembro de 2013 defendeu a dissertação de mestrado intitulada "Parâmetros metabólicos e comportamentais pré e pós-parto de ovelhas deslanadas suplementadas a pasto" sendo aprovado.

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SILVA, T.P.D. Parâmetros metabólicos e comportamentais pré e pós-parto de ovelhas deslanadas suplementadas a pasto. 2013. 95 f. Dissertação (Mestrado em Zootecnia) – Universidade Federal do Piauí, Bom Jesus, 2013.

Objetivou-se determinar em ovelhas deslanadas mantidos em pastagem de *Andropogon gayanus* e recebendo diferentes níveis de suplementação concentrada, qual o plano alimentar empregado durante a gestação e na lactação exerce influência sobre parâmetros metabólicos e comportamento ingestivo. O experimento foi conduzido utilizando 28 ovelhas pluríparas vazias, sendo 14 da raça Morada Nova e 14 da raça Santa Inês distribuídas em DIC em arranjo fatorial 2x2, duas raças (Santa Inês e Morada Nova) e dois planos alimentares (0,5 e 1,5% do peso vivo), tanto na gestação como na lactação. A suplementação concentrada foi fornecida com base no peso vivo (PV) das ovelhas (0,5 e 1,5%). As amostras de sangue foram colhidas a cada 14 dias para avaliação dos níveis séricos de glicose, triglicerídeos, colesterol, uréia e creatinina no pré e pós-parto. Nos mesmos períodos foram avaliados o consumo de concentrado e de pasto, com base no peso vivo e metabólico. No registro do tempo dispendido com o comportamento adotou-se o método de amostragem focal com registro temporal em intervalos de dez minutos durante 10 horas contínuas, com três repetições, sempre se iniciando as 07h00 da manhã, o que totalizou 180 registros por animal. O consumo de concentrado e consumo de matéria seca total foi superior (P<0,05) pelas ovelhas Santa Inês, e nos animais submetidos a 1,5% de suplementação, onde o avançar da gestação promoveu o decréscimo progressivo do CMS, com diminuição de 12,30%. Na lactação O consumo de concentrado (g/dia) durante o período lactacional diferiu (P<0,05) entre grupamento racial e nível de suplementação, com ovelhas SI e o maior nível de suplementação apresentando valores superiores. O consumo de matéria seca total foi afetado (P<0,05) pela raça em estudo e tratamentos a qual esses animais foram submetidos. Houve efeito da raça (P<0,05) sobre as concentrações séricas de glicose, triglicerídeos, colesterol, ureia e creatinina durante o período gestacional, no entanto, as duas raças apresentaram mesma tendência de mobilização das reservas corporais com diminuição (P<0,05) no escore de condição corporal próximo ao parto. Porém a suplementação não exerceu influência sobre os metabólitos. Os parâmetros metabólicos

avaliados durante a lactação diferiram em função da raça (P<0,05) com superioridade de valores para as ovelhas SI, contudo a suplementação concentrada não influenciou (P>0,05) os valores séricos destes metabólitos. Na avaliação do comportamento ingestiva das ovelhas, verificou-se que os tempos de pastejo e ruminação não foram afetados (P>0,05) pelos níveis de suplementação. Em avaliação do efeito de turno do dia, verifica-se diferença apenas para tempos de ruminação, com superioridade para animais SI, indicando boa adaptabilidade ás condições experimentais. Ocorre variação nos parâmetros metabólitos com o avançar da gestação, independente da raça, com valores condizentes aos de referência, podendo-se garantir a evolução dos índices produtivos com 0,5% de suplementação concentrada. A suplementação concentrada foi eficaz para manter a normalidade das concentrações séricas, diferindo entre raças dentro dos padrões permitidos, indicando alta adaptação ao pós-parto.

Palavras-chave: eficiência produtiva, metabólitos sanguíneos, ovinos nativos

GENERAL ABSTRACT

SILVA, T.P.D. Metabolic and behavioral parameters pre-and post-partum of wooless sheep supplementation at grazing. 2013. 95 f. M.Sc. Dissertation – Universidade Federal do Piauí, Bom Jesus, 2013.

This study aimed to determine wooless kept sheep grazing Andropogon gayanus and receiving different levels of concentrate supplementation, which food plan used during pregnancy and lactation influences metabolic parameters and feeding behavior. The experiment was conducted using 28 empty pluriparous sheep, 14 of Morada Nova breed and 14 Santa Inês distributed in DIC in a factorial arrangement 2x2, two races (Santa Inês and Morada Nova) and two feeding levels (0.5 and 1.5% of body weight), both in pregnancy and lactation. The concentrate supplement was based on body weight (BW) of sheep (0.5 and 1.5 %). Blood samples were taken every 14 days to assess the serum levels of glucose, triglycerides, cholesterol, urea and creatinine in pre-and postpartum. In the same periods the intake of concentrate and pasture, based in vivo and metabolic weight were evaluated. In record time spent with the behavior we adopted the method of focal sampling time record in ten minute intervals for 10 continuous hours, with three replications, always starting 07h00 in the morning, totaling 180 records per animal. The concentrate intake and total dry matter intake was higher ($P<0.05$) by the Santa Inês ewes, and in animals subjected to 1.5% supplementation, where the advance of pregnancy promoted the progressive decrease of CMS, with decreased 12.30%. The lactation concentrate intake (g/day) during the lactation period differed ($P<0.05$) between breed group and level of supplementation with sheep SI and the highest level of supplementation showed greater values. The total dry matter intake was affected ($P<0.05$) by breed and study treatments which these animals were submitted. There was no breed effect ($P<0.05$) on serum glucose, triglycerides, cholesterol, urea and creatinine during pregnancy, however, the two strains showed the same trend of mobilization of body reserves to decrease ($P<0.05$) in body condition score at calving next. However, supplementation did not influence metabolites. The metabolic parameters evaluated during lactation differed depending on the breed ($P<0.05$) superiority of SI values for sheep, however the concentrate supplementation did not affect ($P>0.05$) serum levels of these metabolites. In assessing the ingestive behavior of sheep, it was found that the grazing and ruminating times were not affected ($P>0.05$) by

supplementation. In evaluating the effect of day shift, there is difference only for rumination time, with superiority to animals SI, indicating good adaptability to experimental conditions. Variation in parameters metabolites occurs with advancing gestation, regardless of race, consistent with the reference values, and we can ensure the development of production rates with 0.5% of concentrate supplementation. The concentrate supplementation was effective in maintaining normal serum concentrations, differing between races within allowable standards, indicating high adaptation to postpartum.

Keywords: blood metabolites, native sheep, production efficiency

Considerações Iniciais

O entendimento dos componentes inerentes ao sistema produção animal é fundamental para a potencialização do desempenho de ovinos a pasto, sendo necessário melhorar e aperfeiçoar o aproveitamento das pastagens e definir estratégias de manejo nutricional tornando o sistema altamente produtivo, visto que o nordeste do Brasil concentra grande parte do rebanho de ovinos, sendo necessária a introdução de novas tecnologias para fortalecimento da cadeia produtivo.

A utilização de animais nativos da região, como as raças Morada Nova e Santa Inês, torna-se imprescindível por possuírem elevada adaptabilidade às condições semiáridas podendo estabelecer índices produtivos e reprodutivos altamente satisfatórios, dentro de suas expectativas.

Porém, durante a gestação e lactação ocorrem diversas e intensas modificações metabólicas onde a subalimentação das ovelhas pode afetar negativamente o tamanho da placenta, o crescimento fetal e a deposição de reservas energéticas para uso durante o pós-parto levando a um menor desenvolvimento da glândula mamária, produção de colostro e leite. Esse fato pode ser mais grave quando se trabalha com animais a pasto, devido à alta estacionalidade da produção de forragem nas regiões semiáridas, e ocorrências de parições nessas épocas.

Para suprir essa demanda a utilização de visa complementar a dieta e evitar o déficit nutricional a qual esses animais passam, visto que na maioria das situações, a forragem disponível na pastagem não contém todos os nutrientes essenciais, na proporção adequada, de forma a atender integralmente as exigências dos animais em pastejo, onde os níveis adequados de proteína na alimentação animal são essenciais para ótimo crescimento microbiano e síntese de proteínas promovendo a mantença e crescimento fetal.

Portanto, é necessário o conhecimento dessas estratégias tecnológicas sobre indicadores fisiológicos e nutricionais de ovelhas criadas em sistema de pastejo no final da prenhez e início de lactação, visando uma melhor caracterização de parâmetros metabólicos e comportamentais e, consequênntemente, obtenção de resultados positivos do sistema.

Capítulo 1 – Revisão bibliográfica

1. Importância das raças Morada Nova e Santa Inês para o semiárido do Nordeste do Brasil

Dentre os fatores de produção que determinam a eficiência no processo produtivo de carne ovina em um dado sistema de criação, a escolha da raça ideal é o que mais influência a quantidade e a qualidade do produto final, motivo pelo qual esta seleção é essencial a uma exploração comercial bem sucedida, de alta produtividade e, ecologicamente sustentável, sob condições ambientais adequadas. Entretanto, constitui-se um desafio essa busca, haja vista que nenhuma raça consegue reunir, em sua plenitude, todas as características econômicas e produtivas desejáveis.

Entre as raças nativas de ovinos deslanados do Nordeste do Brasil com exploração designada, principalmente, para a produção de carne e pele as raças Morada Nova e Santa Inês constituem-se as principais. Pela sua adaptação às condições climáticas do semiárido, boa prolificidade e conversão alimentar, além da resistência principalmente a infestação endoparasitárias, estes animais são importantes nas criações efetuadas em pequenas propriedades, constituindo uma fonte imprescindível de proteína na alimentação da população rural (Vilpoux et al. 2013).

Neste sentido, estes genótipos apresentam-se economicamente importantes nos sistemas de produção de carne ovina e, em virtude do aumento do mercado consumidor, têm-se observado maiores interesse e investimentos por parte dos produtores na exploração desses animais (Costa et al., 2012), devido ser, do ponto de vista biológico, material genético novo, principalmente na realização de cruzamentos com raças altamente especializadas, além da melhoria genética, no que se refere à qualidade de sua carcaça (Biagiotti et al., 2013).

2. Consumo de Nutrientes

A região semiárida do Nordeste do Brasil caracteriza-se pela ocorrência de duas estações climáticas bem diferenciadas, uma estação das águas, com duração de quatro a seis meses, e uma estação seca, que dura de seis a oito meses. Durante a estação das águas, desenvolvem-se pastos abundantes e de boa qualidade, permitindo que os rebanhos alcancem elevadas taxas de crescimento. Por outro lado, na estação seca, os

animais, em geral, perdem peso, devido à acentuada e progressiva escassez de pasto, associada à perda de qualidade da forragem (Almeida, 2010).

Além disso, o uso de gramíneas tropicais, de forma exclusiva, pode não atender às exigências nutricionais dos animais, principalmente as categorias de maior exigência, nos períodos de maior exigência nutricional. Na busca pelo avanço da produtividade e competitividade na produção de ovinos, diversas alternativas tecnológicas têm sido propostas e, dentre elas, a utilização de suplementação a pasto tem assumido posição de destaque. Neste caso, a suplementação com concentrado poderá ser uma alternativa importante. Por sua vez, o uso da suplementação concentrada para animais em pastejo deve obedecer a condições básicas, como o potencial genético dos animais, a qualidade e a quantidade de forragem disponível, o preço do concentrado e o preço do produto animal produzido (Voltolini et al., 2008).

Visando a manutenção da homeostase metabólica e da condição corporal da ovelhas gestantes, visto que a gestação é uma fase muito importante na vida reprodutiva e produtiva dessas fêmeas, já que as transformações que ocorrem afetam não somente o aparelho reprodutivo, mas também todo o organismo, deve-se oferecer condições que favoreçam a uma ingestão adequada de nutrientes (Macedo Junior et. al., 2009).

Em virtude dessas alterações, a nutrição pré-natal interfere não só no neonato, mas, principalmente, sobre a ovelha. Animais mal nutridos durante a gestação apresentam maior tempo de recuperação, o que causa aumento no período de retorno à atividade cíclica reprodutiva, menor número de partos duplos, dentre outros problemas (Macedo Junior et al., 2009).

Consequentemente à gestação, é de extrema importância também a maximização do consumo de nutrientes por ovelhas em lactação, visando o atendimento dos requerimentos de manutenção e produção destas. Contudo, geralmente, a capacidade do retículo-rúmen pode determinar limitação do consumo e, consequentemente, da produção. Segundo Jung e Allen (1995), o consumo voluntário de alimentos é inversamente relacionado à concentração de parede celular da dieta. Assim, o fornecimento de alimentos concentrados é um fator de fundamental importância para potencializar a produção de leite, evitando excessiva mobilização das reservas corporais do animal. Entretanto, dietas compostas por pequenas frações de alimentos volumosos podem ocasionar distúrbios ruminais com reflexos negativos sobre a produção animal (Mertens, 2002).

3. Comportamento ingestivo a pasto

A região semiárida do Nordeste do Brasil é caracterizada por baixa quantidade e irregularidade das precipitações pluviométricas. Essa condição compromete a disponibilidade de recursos alimentares para o rebanho nos períodos de entressafra e impõe aos produtores a necessidade de utilização de alimentos alternativos, derivados de cultivos adaptados à região, visando minimizar os custos de produção para manter o equilíbrio nutricional dos animais através da maximização da produtividade animal. Sendo assim, o comportamento ingestivo é uma ferramenta de grande importância na avaliação das dietas, pois possibilita ajustar o manejo alimentar dos animais a pasto para obtenção de melhor desempenho produtivo (Figueiredo et al., 2013).

Quando se trata da natureza da dieta, são evidentes comportamentos distintos dos animais em relação a ingestão. Esse fato recorre, principalmente, em relação a alimentos ricos em energia, em que os animais despendem de uma hora para o seu consumo, ou até mais de seis horas para alimentos com baixo teor de energia (Costa et al., 2011).

As atividades diárias dos ovinos compreendem períodos que alternam alimentação, ruminação e ócio. Os períodos de ruminação e ócio ocorrem entre as refeições, existindo diferenças entre indivíduos quanto à duração e repetição dessas atividades, que parecem estar relacionadas às condições climáticas e de manejo, ao apetite dos animais, à exigência nutricional e, principalmente, à relação volumoso: concentrado da dieta (Silva et al., 2010).

Dessa forma, faz-se necessário o conhecimento dos padrões de comportamento dos animais, seja para escolha ou eletividade do alimento a ser ingerido, uma vez que o potencial do alimento a ser ingerido pelo animal depende da interação entre ingestão, comportamento animal e meio ambiente (Pereira et al., 2009).

4. Ajustes fisiológicos no período de transição

O período de transição é considerado umas dessas fases do ciclo de produção na qual ocorrem intensas e variadas alterações no metabolismo e fisiologia dos animais ruminantes, que posteriormente poderão influenciar o desempenho produtivo, reprodutivo e a saúde dos animais. Isso ocorre porque o aumento da

produção de leite é mais rápido que a capacidade de regulação do consumo de matéria seca desde a gestação (Hayirli et al., 2002).

Ovelhas no terço final da gestação requerem forragens com um maior teor de nutrientes e maior digestibilidade, em consequência do crescimento fetal e diminuição da capacidade do rúmen para acomodar grandes quantidades de alimento (Antunović et al., 2001).

Sendo assim, deve-se dar atenção às questões nutricionais. Isso porque, devido às elevadas necessidades alimentares, especialmente durante as últimas seis semanas, que segundo Russel (1969) ocorre acelerado desenvolvimento fetal (70%). Nessa fase também ocorre incremento das necessidades maternas de nutrientes para o desenvolvimento do úbere e da própria manutenção (El-Sherif e Assad, 2001). O tipo de gestação e a nutrição podem ser responsáveis por alterações metabólicas em fêmeas em atividade reprodutiva, por isso é de extrema importância utilizar mecanismos que possam monitorar o processo metabólico nas diferentes fases fisiológicas (Brito et al., 2006; Balikci et al., 2007).

As mudanças metabólicas próximas ao parto (Quadro 1) são controladas e coordenadas pelo sistema endócrino, que direciona os nutrientes para o tecido materno, suprimento fetal e desenvolvimento da glândula mamária (Gluckman, 1997).

Quadro 1. Alterações metabólicas associadas com a transição em ovinos (Adaptado de Harðarson e Ingvartsen, 2005)

Processo ou metabolismo	Resposta	Tecido envolvido
Metabolismo de gordura	• Diminuição da Síntese *denovo*; • Diminuição de ácidos graxos pré formados; • Diminuição da Re-esterificação dos ácidos graxos; • Aumento da lipólise; • Aumento da utilização de lipídios como energia.	Tecido adiposo
Metabolismo de glicose	• Aumento do tamanho do fígado; • Aumento do fluxo sanguíneo; • Aumento da taxa de gliconeogênese; • Diminuição da utilização de glicose como energia.	Fígado

Metabolismo de proteína	• Diminuição da síntese proteica; • Aumento da proteólise; • Aumento da síntese proteica.	Tecido muscular
Ingestão de alimento	• Diminuição ingestão - pré-parto; • Aumento ingestão – pós-parto.	Sistema nervoso central
Digestão	• Hipertrofia do trato digestivo; • Aumento capacidade de absorção; • Aumento da atividade metabólica.	Sistema digestivo

Uma notável característica de ajuste metabólico relacionada ao pós-parto, em ovelhas lactantes, é a mudança no comportamento da ingestão de alimentos, com gradativo aumento da capacidade de consumo (Chilliard, 1999) acompanhada por uma hipertrofia da mucosa gastrintestinal, o que permite uma maior eficiência na absorção e da taxa de troca de nutrientes com a circulação sanguínea (Mellado et al., 2006). A estratégia utilizada pelos ruminantes é aumentar o tempo de pastejo e, consequentemente, aumentar a ingestão para satisfazer às suas necessidades energéticas (Bergman et al., 2001).

5. Parâmetros metabólicos sanguíneos no período de transição

A composição bioquímica do sangue reflete de forma confiável o equilíbrio dos nutrientes nos tecidos animais (González, 2000). Em casos de desequilíbrio de nutrientes, a composição bioquímica do sangue reflete alteração da homeostase sanguínea (Suttle, 1986; Caldeira, 2005).

Segundo Balikci et al. (2007) identificar alterações no metabolismo das ovelhas durante a gestação para prever e evitar a ocorrência de doenças, como Toxemia da Prenhez e de outros problemas pré e pos-parto, são algumas das vantagens em se determinar o perfil metabólico nessa espécie.

A distribuição dos nutrientes no organismo animal se apresenta de três formas: o órgão estoque, o reservatório homeostático, representado na maioria das vezes pelo sangue, e o reservatório funcional, onde geralmente o nutriente desenvolve seu papel principal no organismo. Em casos de desequilíbrio de nutrientes, a composição bioquímica sanguínea nos dá informação de possíveis perturbações da homeostase do sangue (Suttle, 1986).

O manejo alimentar que os animais são submetidos também podem provocar alterações na dinâmica dos parâmetros sanguíneos. Animais que recebem dieta rica em

carboidratos possuem um aumento na concentração de propionato e hiperinsulinemia (Arai, 2007). A redução dos níveis de ureia plasmática pode ocorrer pela diminuição da produção, como em casos de redução da proteína dietética e hipoproteinemia (Lopes et al., 2007). Enquanto que, um nível de ureia alto indica excesso de proteína ou um déficit energético (Ricco, 2004).

As informações oriundas da dinâmica do perfil metabólico em conjunto com a avaliação da condição corporal, fase do ciclo produtivo e dietas utilizadas permite aferir a adequação de planos alimentares implementados, possibilitando correções imediatas ou alterações dos ciclos produtivos seguintes (Caldeira, 2005). Para uma mais eficiente avaliação é fundamental o conhecimento de outros fatores, que afetam a concentração destes, tais como idade, sexo, raça, estágio de gestação, fase da lactação, devendo-se agrupar os animais de acordo com essas características para uma eficiente interpretação dos resultados do teste (Herdt, 2000).

Na avaliação do status energético, não se deve considerar apenas uma variável sanguínea para predizer o *status* energético devido à complexidade do metabolismo energético. Geralmente recomenda-se a avaliação da glicose, dos ácidos graxos livres (AGLs) e de corpos cetônicos no plasma (Payne e Payne 1987; Herdt, 2000).

Os ácidos graxos livres (AGLs) são considerados os metabólitos sanguíneos que estão mais diretamente associados com o balanço energético (González et al., 2000; Herdt, 2000; Kaneko et al., 2008). Tem origem da hidrolise dos triglicérides depositados nos adipócitos, sendo liberados para corrente sanguínea e transportados pela albumina (Spector et al., 1969). Em ovinos, os AGLs são melhores correlacionados com o consumo de energia do que as concentrações de glicose (Rowlands, 1980).

O β-hidroxibutirato (BHB) é o corpo cetônico de escolha para a avaliação clínica devido a sua estabilidade no plasma ou no soro, embora ele seja melhor indicador de distúrbio latente do que do *status* energético (Herdt, 2000).

Cardoso et al. (2010) descrevendo o comportamento do perfil metabólico de ovelhas da raça Santa Inês em diferentes tempos do periparto, verificou que as equações de regressão para o beta-hidroxibutirato, apresentaram um comportamento quadrático apresentando valores mais elevados tanto nos dias que antecederam o parto, quanto nos que sucederam ao parto. Sabendo-se que este é o período de maior intensidade de mobilização de reservas corpórea, que comumente as ovelhas entram em balanço energético negativo (Ingvartsen, 2006).

Mesmos resultados foram evidenciados por Brito et al. (2006), onde ressaltaram que os níveis de ureia plasmática mostraram-se estatisticamente diferentes entre a gestação e a lactação, sendo a maior concentração aos 90 dias de gestação. Foi relatado também que houve uma maior utilização de glicose por parte das ovelhas, e consequentemente uma maior mobilização de corpos cetônicos como o beta-hidroxibutirato no final da gestação. Mecanismo quase que inevitavelmente utilizado nesse período, onde a ovelha requer um maior aporte de nutrientes para suprir as exigências para mantença, bem como, para o desenvolvimento fetal, devendo-se ressaltar que é nesse período onde ocorre 70% do seu desenvolvimento.

Nesse mesmo trabalho, foi visto que com o avanço da lactação, houve diminuição da glicose plasmática e aumento do colesterol, concluindo que o período de transição apresenta as maiores exigências metabólicas.

Em estudo avaliando o perfil metabólico de ovelhas da raça Akkaraman com partos simples e duplo durante a gestação e pós-parto foi observado menores valores de glicose sanguínea nos 100 e 150 dias de gestação, comparados com os outros períodos em ambos os grupos de ovelhas, e menores valores de proteína total e ureia também foram encontrados nos 150 dias de gestação. Enquanto que colesterol plasmático e triglicérides aumentaram no final da gestação, sendo que os maiores valores foram observados nas ovelhas prenhes de gêmeos (Balikci et al., 2007).

São indicadores úteis do status proteico, de uma forma geral, a ureia, albumina, globulina e proteína séricas totais (Payne e Payne, 1987). Nos ruminantes a ureia sérica e destaca como metabólito sanguíneo de melhor relação com o *status* protéico, pois tem relação especial com a digestão protéica e com o metabolismo dos microrganismos ruminais (Rowlands, 1980; Herdt, 2000). Parte da proteína dietética é hidrolisada e desaminada pelos microrganismos ruminais gerando peptídeos e amônia livre no rúmen. Uma porção desta última é absorvida e metabolizada em uréia, o restante é incorporado à proteína microbiana ruminal.

A ureia é intimamente dependente do nível de consumo dietético, portanto se altera rapidamente em função desta, refletindo o *status* protéico em curto prazo, já a albumina é um indicador para alterações no *status* protéico em longo prazo (Rowlands, 1980; Payne e Payne, 1987).

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CAPITULO 2 - Intake and some indicators of the metabolic status of native ewes in pregnancy and supplemented in grazing system

Elaborado de acordo com as normas da Revista African Journal of Agricultural Research

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Intake and some indicators of the metabolic status of native ewes in pregnancy and supplemented in grazing system

Abstract

The present study is to evaluate the effect of level of concentrate supplementation on the intake and some indicators of the metabolic parameters of native ewes in pregnancy and supplemented in a grazing system. 28 lactating ewes were selected: 14 Morada Nova (MN) and 14 Santa Inês (SI) were distributed in an experimental design completely randomized in 2x2x3 factorial arrangement with two breeds (MN and SI), two levels of supplementation (0.5 and 1.5% body weight) and three experimental periods (75, 105 and 135 days of pregnancy). Blood samples were collected from 75 days of pregnancy to parturition on every 14 days. Serum glucose, triglycerides, cholesterol, urea and creatinine were analyzed. The concentrate intake and total dry matter intake was higher ($P < 0.05$) on Santa Inês ewes and, in animals supplemented with 1.5% of concentrate, where the pregnancy progresses promoted the progressive decrease of DMI. There was breed effect ($P < 0.05$) on metabolic parameters evaluated during the pregnancy, in which the two breeds presented the same trend of mobilization of body reserves with decrease ($P < 0.05$) in the body condition score close of parturition. However, supplementation did not influence in the metabolic parameters. The metabolic parameters were influenced by breed, however, with normal values, indicating a good adaptability of the Morada Nova and Santa Inês breeds at the experimental conditions, promoting an evolution of production rates with 0.5% of concentrate supplementation.

Key words: blood metabolites, native sheep, nutrition, pregnancy

INTRODUCTION

Sheep farming is an important activity that contributes to the food supply in semiarid region of northeastern of Brazil, generating occupations, income and improved quality of life. It is also necessary to develop economic importance through little arable land by characterizing extensive production system. However, it results maximum production with minimum cost due to animals mostly depends on natural pastures and use of non-specialized genotypes.

Intensified use of Morada Nova and Santa Inês breeds are being important for their good prolificacy, feed conversion, endoparasites resistant and climate adaptation of semiarid region (Vilpoux et al. 2013). However, demand for production system improvements is mainly depends on nutritional requirements of sheep intensifies mainly during the final third of pregnancy, which fetal growth maintenance and development of the mammary gland that contribute to possible occurrence of negative energy balance in the postpartum.

Use of concentrate supplementation is one of strategy to solve several problems on current livestock issues (Souza et al., 2013). Concentrate and pasture has been widely used for desired level of

performance. However it is essential to consider feeding methods and nature of the diet offered to the animals (Gipson et al., 2007; Paim et al., 2013).

According to González (2000) suggested that, it is vital to assess blood metabolic parameters for identification and adaptation of suitable diet to the ewes during pregnancy. Therefore, Objective of the present study is to evaluate the effects of native ewes supplement with different level of concentrate and blood metabolic parameters in pregnancy under semiarid grazing system.

MATERIAL AND METHODS

The experiment was conducted at Research Unit in Small Ruminants of Campus Cinobelina Elvas, Federal University of Piauí, Bom Jesus – PI (09º04'28" South Latitude and 44º21'31" West Longitude; at an altitude of 277 m and 635 km distant) from the capital Teresina. The experiment was conducted with the approval of the ethical committee for animal experimentation of Federal University of Piauí (ECAE/UFPI) under the number 091/2010.

Twenty four ewes (12 Santa Inês and 12 Morada Nova) were used with pluriparous pregnancy inseminated artificially at fixed time (AIFT) with Dorper Breed semen. After 30 days of artificial insemination, pregnancy diagnosis was performed through trans-abdominal ultrasound and pregnant ewes from each genetic group were selected. These sheep remained until the middle of pregnancy in Andropogon pasture grass (*Andropogon gayanus*) paddocks and afterwards allocated in collective pens with cement floor. Water were provided *ad libitum* level until next day.

Experiment initiated at 75 days of pregnancy, sanitary management were followed by deworming and vaccination against clostridial diseases along with routine preventive care. During experimental period, Ewes were kept morning at Andropogon pasture grass (*Andropogon gayanus*) paddocks and allocated to individual pens for concentrate supplementation in the afternoon period (Table 1) depends on the ewes weight (0.5% and 1.5% of body weight) being adjusted weekly.

Table 1. Chemical composition of experimental ingredients, concentrate supplement and Andropogon *(Andropogon gayanus).*

Ingredients	Chemical composition (% DM)							
	DM	CP	EE	TDN	NDF	ADF	Ca	P
Corn meal	87.19	9.98	5.19	67.50	24.55	5.87	0.05	0.49
Soybean meal	88.48	48.76	1.75	80.73	15.37	9.64	0.33	0.57
[1]Mineral mixture	97.91	-	-	-	-	-	18.00	13.00
Concentrate	88.04	19.17	4.06	67.43	21,02	6,51	0.90	1.13
Pasture (Andropogon)	27.45	7.50	2.02	53.56	74.70	41.97	0.33	0.11

DM = Dry matter; CP = Crude protein; EE = Ether extract; TDN = Total digestible nutrients; NDF = Neutral detergent fiber; ADF = Acid detergent fiber; Ca = Calcium; P = Phosphorus. [1]Mineral mixture: 1,600 mg zinc, 600 mg copper, 1,500 mg manganese, 1,100 mg iron, 10 mg cobalt, 27 mg iodine and 22 mg selenium. q.s.p. 1,000 g.

Treatments were formed based on percentage of concentrate supplementation according to recommendations (NRC, 2007) for pregnant animals. It is, confirmed a total requirements of protein and metabolizable energy was found to be 146g / day and 3.86 Mca /day respectively. in which the level of 1.5% BW concentrated provided approximately 70% of the daily requirements.

The body weight of the ewes and body condition score (BCS) were weekly performed as per the method described by Thompson and Meyer (2006). Later, averages were calculated for the periods 75, 105 e 135 days of pregnancy. The measurements were made on a scale from 1 to 5 (1 = underweight and 5 = overweight). Blood samples were collected from 75 days of pregnancy for every 14 days. Blood was collected in the morning, before the sheep were released to grazing by jugular venipuncture using needles coupled to vacuum tubes (10 mL) without anticoagulant. The serum was obtained after the centrifugation at 3500 rpm during 15 minutes in a refrigerated centrifuge and stored in micro tubes at -20 ° C until the time of laboratory analysis, which consisted of determinations of serum glucose, triglycerides, cholesterol, urea and creatinine.

All the biochemical analysis were performed in semi-automatic biochemical analyzer (Espectrum BS- 001 000 013) using commercial kits of Labtest® following the manufacturer's recommendations.

To estimate the intake and apparent digestibility of nutrients, internal indicator was used as indigestible dry matter (iDM). In order to estimate the levels of indigestible components of feed (grass: 0.4 g; concentrate: 0.4 g) and feces (0.4 g) were filled in 50-µm nylon bags (8x12). iDM was obtained after 264 h of incubation under "in situ" conditions (Casali et al. 2009), being used one rumen cannulated animal under the same production system.

After bags were removed from rumen and washed with water until disapperance of unwanted material. Bags were immediately transferred to the forced-ventilation greenhouse (60^{o}C) during 48 hours. Sequentially, it is dried in a non-ventilated oven (105 ° C for 45 minutes) and kept in a desiccator and weighed (Detmann *et al.*, 2001) for obtaining undigested MS. NDF and ADF were determined as per methods described by Van Soest et al. (1991).

The content of iDM was obtained by the difference of dry weight of the material before incubation and dry weight of the residue after incubation.

Pooled feces were collected daily from the rectum based on the pre-dry weight per animal. During collection period, daily samplings of feed were collected properly. Samples were frozen then dried (60 °C) processed in a grinder with a 1-mm sieve and determination of DM, CP, NDF, ADF were carried out according to the methodology described by Silva and Queiroz (2002).

Calculations of digestibility and DM intake through the following equations:

- DDM (%) = 100 – [100 x (indicator in the diet / indicator in the feces)]
- Fecal output (g/day) = [ingested indicator (g) / indicator in the feces (g/g DM)]
- DMI (g/day) = {[(DMfecal x % indicator in the feces) – indicator in the diet]} + DMIsuppl. % indicator in the forage

Where: DDM – Digestibility of dry matter, DMI – Dry matter intake, DMIsuppl. – Dry matter intake of supplementation.

To evaluate the intake, variation among weight gain as well as body condition score with the experimental design was randomized into 2x2x3 factorial arrangement with two breeds (MN and SI), two supplementation levels (0.5 and 1.5% body weight) and three experimental periods (75, 105 and 135 days of pregnancy). The data were evaluated using analysis of variance and means were compared by Tukey's test at a 5% probability SAS - Statistical Analysis System (2003).

For blood variables, a randomized design was used in which the blood samples were evaluated using a split-plot arrangement. The main plot was supplementation and the secondary plot, harvest periods with measures repeated in time. The comparison between the levels of supplementation was carried by SNK's test at a 5% probability. The results were submitted to ANOVA using the PROC GLM procedure of SAS (SAS, 1999) according to the following statistical model:

$Y_{ijk} = \mu + S_i + B_j + (SR)_{(ij)} + P_k + (SP)_{(ik)} + (SRP)_{(ijk)} + e_{(ijk)}$, where:

Y_{ijk} = value observed for the characteristic analyzed;

μ = overall average;

S_i = effect of the level of concentrate supplementation i = 1, 2;

B_j = effect of breed j = 1, 2;

$SB_{(ij)}$ = effect of the interaction level of and breed i;

P_k = effect of period k = 1, 2 and 3;

$SP_{(ik)}$ = effect of interaction between concentrate supplementation j i and period k;

$SRP_{(ijk)}$ = effect of interaction between concentrate supplementation i, effect of breed j, and effect of period k;

$e_{(ijk)}$ = random error associated with the observation Yijk.

RESULTS AND DISCUSSION

The values for average weight (kg) and body condition score (BCS) for different breeds, levels of concentrate supplementation and gestational periods were presented in table 2.

In body weights at different periods showed significant effect ($P < 0.05$) with an increase during the second period, which probably due to fetal development and associated membranes. However, at 135 days, ewes showed a decrease ($P < 0.05$) in weight due to result of higher utilization of body reserves coupled with the ability to lower food intake may be compression rumen by the fetus (Agenas et al., 2003).

Table 2. Averages body weight (kg) and body condition score (BCS) of Morada Nova and Santa Inês ewes based on breed, supplementation level and period of pregnancy

	Morada Nova		Santa Inês	
	Body weight			
Periods	0.5%	1.5%	0.5%	1.5%
75 days	31.8 ± 1.8bB	32.1 ± 1.4bB	56.6 ± 2.1bA	55.7 ± 1.2cA
105 days	34.6 ± 1.4aC	36.1 ± 1.5aC	58.0 ± 1.9aB	63.5 ± 2.5aA
135 days	32.1 ± 1.9bC	31.5 ± 1.9bC	52.4 ± 2.3cB	58.2 ± 1.4bA
	body condition score			
75 days	2.9 ± 0.3aBC	3.5 ± 0.2aA	3.0 ± 0.1aBC	3.1 ± 0.2aB
105 days	2.5 ± 0.2bD	3.4 ± 0.3aA	2.9 ± 0.1abC	3.1 ± 0.2aB
135 days	2.5 ± 0.3bC	3.1 ± 0.3bA	2.8 ± 0.2bB	2.9 ± 0.1bB

*Means followed by same letter, lowercase in the columns and uppercase in the rows, are not significantly different from Tukey´s test at a 5% probability

There was concentrate supplementation effect (P <0.05) on weight of Santa Inês ewes for the periods of 75 and 105 days. However, there was less dry matter intake due to compression by fetus and level of 1.5% supplementation promoted better weight maintenance during period of higher nutritional requirement.Zambom *et al.* (2006) reported that, fundamental for increased intake of energy and protein avoiding mobilization of body tissues and to minimize the consequences of BEN.

Table 2 shows that the body condition score were decrease near parturition with regardless of breed and level of supplementation. It may be justified due to higher mobilization of reserves as a result of the need for nutrients (Husted et al., 2008).

Morada Nova ewes supplemented with 1.5% presented superiority (P <0.05) in scores in all period of pregnancy and maintaining the pattern of score for controlled breeding program or insemination (Thompson e Meyer, 2006). Better nutrient management with maintenance of body condition score near parturition and improvement in a nutrient balance of all functions in adverse conditions (stress, negative energy balance, lactation). However, there is a necessary to provide, higher amount of milk for their offspring and higher performance of lambs at an early return to reproductive activity (Costa et al., 2009).During pregnancy, concentrated intake estimated by indigestible dry matter (iDM) was higher (P <0.05) in Santa Inês ewes, which was expected due to larger size. Thus greater the consumption capacity (Silva Sobrinho, 2006; Facó et al., 2008) indicating that weight gain not only depends on the genetic potential of the animals but also quantity and quality contained in the diet (Table 3).

Table 3. Estimated intake of ewes grazing in different periods of pregnancy

Item	Supplementation levels								
	0.5%			1.5%					
	Periods			Periods					
	75 days	105 days	135 days	75 days	105 days	135 days	T	P	T*P
	Morada Nova								
DMI (g/dia)	159.01bB	173.0bB	160.50bB	481.83aB	543.21aB	484.17aB	**	ns	ns
DMI (g/kg$^{0.75}$)	11.86bB	12.12bB	11.89bB	35.59aB	36.71aB	35.64aB	**	ns	ns
DMIc (g/dia)	146.56bB	159.45bB	147.93bB	444.10aB	500.67aB	446.26aB	**	ns	ns
DMIc (g/kg$^{0.75}$)	10.94bB	11.17bB	10.96bB	32.81aB	33.84aB	32.85aB	**	ns	ns
	Santa Inês								
DMI (g/dia)	283.06bA	285.07bA	273.81bA	828.90aA	952.04aA	871.75aA	**	ns	ns
DMI (g/kg$^{0.75}$)	13.70bA	13.69bA	13.55bA	40.55aA	42.30aA	41.27aA	**	ns	ns
DMIc (g/dia)	260.90bA	263.02bA	252.37bA	763.99aA	877.49aA	803.49aA	**	ns	ns
DMIc (g/kg$^{0.75}$)	12.63bA	12.62bA	12.49bA	37.38aA	38.98Aa	38.04aA	**	ns	ns

* Means followed by the same letter lowercase in rows and uppercase in columns did not differ, for effect of treatment, from Tukey´s test at a 1% probability

In the evaluation of the concentrate supplementation, ewes submitted to 1.5% BW showed higher intake and also being different (P <0.05) for all variables.

In the present study it was a significant effect (P <0.05) on concentrate intake among periods. Morada Nova and Santa Inês ewes showed a variation in the intake with advancing pregnancy indicating that mainly due to the inability of distension ruminal as a result of compression by the fetus and higher demand for nutrients for maintenance and fetal growth (Agenas et al., 2003). These may cause substitutive effect on roughage intake, once Andropogon grass had good nutritional percentage of stems and green leaves in the period evaluated does not supply needs of the ewes in this phase, according to Menezes et al. (2010). Hence, this is unsuitable roughage diet for the animals in present study even these grass highly diffused in semiarid region due to great climate adaptation.

It is also observed that Santa Inês ewes exhibit a linear intake behavior with decreasing values near parturition in contrast to the Morada Nova ewes. However, results were evaluated carefully and emphasize about the total intake. (i.e), effects of level offered on forage intake, pasture and also checked if there is excess offer of concentrate, thereby reducing the roughage intake. Nonetheless, this is the period of highest fetal growth and, main factor that restricts the roughage intake.

In the evaluation of dry matter intake (DMI) in g/day and concentrate intake was significant effect (P <0.05) on breed with Santa Inês ewes consuming larger quantities (Table 4).

Table 4. Estimated intake of total dry matter based on indigestible dry matter (iDM) in Morada Nova and Santa Inês ewes supplemented on pasture at different periods of pregnancy

Item	Supplementation levels								
	0.5% PV			1.5% PV					
	Period			Period					
	75 days	105 days	135 days	75 days	105 days	135 days	T	P	T*P
	Morada Nova								
DMI (g/dia)	628.07Ba$^{\phi}$	518.72Ba$^{\phi}$	565.55Ba$^{\phi}$	775.77Aab$^{\phi}$	814.41Aa$^{\phi}$	728.20Ab$^{\phi}$	*	*	*
DMI (g/kg$^{0.75}$)	47.16Ba$^{\phi}$	36.35Bb$^{\phi}$	41.96Bab$^{\phi}$	57.60Aa$^{\phi}$	55.37Ab$^{\phi}$	54.15Aa$^{\phi}$	*	*	**
DMI (%PV)	1.99Bab$^{\phi}$	1.49Ba$^{\phi}$	1.76Bab$^{\phi}$	2.43Aa$^{\phi}$	2.26Aa$^{\phi}$	2.28Aa$^{\phi}$	*	*	*
	Santa Inês								
DMI (g/dia)	1401.79Ba†	1297.38Ba†	1176.21Ba†	1665.63Aab†	1694.06Aa†	1476.21Ab†	*	*	ns
DMI (g/kg$^{0.75}$)	68.06Bab†	63.82Bab†	59.41Bb†	81.80Aab†	75.43Aab†	71.27Aab†	*	*	ns
DMI (%PV)	2.48Bab†	2.34Bb†	2.20Bb†	2.99Aa†	2.67Aa†	2.60Aa†	*	*	ns

-Means followed by the same lowercase letter in rows did not differ, for effect of period, from Tukey's test (* -1%; ** - 5% of probability).

-Means followed by the same uppercase letter in rows did not differ, for effect of treatment, from Tukey´s test (* -1%; ** - 5% of probability).

-Means followed by the same symbol in columns are not significantly different, for effect of breed, by Tukey´s test (* -1%; ** - 5% of probability).

-DMI = Dry matter intake; DMIc = Dry matter intake of concentrate

-T = Effect of treatment; P = Effect of period; T*P = Interaction between treatment and period.

In the effect of concentrate supplementation was observed significant difference between treatments with dry matter intake (g/day) was higher in ewes receiving 1.5% BW. However, it was verified that the sheep supplemented with 0.5% BW had a higher utilization of roughage intake. In contrast, we have occurred substitutive effect of intake, ewes that were fed 1.5% of concentrate supplementation tended to a lower forage intake during grazing. Further, replacement of roughage intake by the concentrate affects the ruminal homeostasis due to modifying the microbiota in this compartment. Therefore, ratio of short-chain fatty acids may cause changes in the serum concentrations of metabolites (Costa et al., 2009).

In evaluating DMI (g/kg$^{0.75}$) had significant effect (P <0.05) of breed and treatment with advancing pregnancy. Morada Nova ewes exhibited a lower consumption according to Santos et al. (2009) reporting that near parturition, there was a decrease without any metabolic disorder has been confirmed. This fact emphasizes the adaptive capacity of these animals with little decrease in the DMI, once that the low offer of energy derived from the diet associated with a decrease in nutrient intake could promote serious metabolic disorders.

In order to verify such situation, the effects of interaction between DMI (g/kg$^{0.75}$) and periods of pregnancy was carried, with the pregnancy progresses was verified a decreased progressive in the DMI

($g/kg^{0.75}$) except in the 105 days in Morada Nova supplemented (0.5% BW) with an increase in the roughage intake.

Morada Nova ewes showed less intake due to smaller size, selection of better feed, according to Lachica and Aguilera (2005) in adult animals. These breed needs higher energy requirements, emphasizing that the requirements for pregnancy and lactation could be lower due to the high metabolic capacity adjustment in this phase.

The results showed effects of genetic group ($P < 0.05$) on the dynamics of some energy and protein parameters during pregnancy (Table 5). However, the supplementation level did not influence on blood concentrations of metabolites evaluated. We, assuming that, regardless of the concentrate level both the homeorrético as homeostatic adjustments were similar throughout pregnancy. In contrast to the present experiment with sheep of different breeds and requirements (Tanaka et al., 2008), as well as of experiment carried with sheep in physiological period, breed and similar nutritional requirements (Torreão et al., 2008).

Table 5. Averages of serum concentrations of metabolic parameters of ewes during pregnancy according to breed and supplementation level

	GLI (mmol/L)	TRI (mmol/L)	COL (mmol/L)	URE (mmol/L)	CRE (µmol/L)
Reference Values **	1.7-3.6	---	1.05-1.50	3.0-10	70-105
Breed					
Morada Nova	2.94[b]	0.40[a]	1.37[b]	7.31[b]	61.62[b]
Santa Inês	3.18[a]	0.29[b]	1.52[a]	5.46[a]	72.68[a]
Supplementation level					
0.5% BW	3.00	0.35	1.44	6.32	66.92
1.5% BW	3.12	0.33	1.39	6.45	67.38
Variation sources					
Breed	*	*	*	*	*
Supplementation level	ns	ns	ns	ns	ns
Breed x Supplementation level	ns	ns	ns	ns	ns

-Means followed by the same letter in columns are not significantly different from test Student-Newman Keuls (SNK); *- significant ($p<0.05$); ns– not significant ($p<0.05$);

**Kaneko et al. (2008)

-Glucose - GLU, triglycerides - TRI, cholesterol - CHO, Urea – URE, Creatinine – CRE

Higher values ($P < 0.05$) of glucose in Santa Inês ewes, although the values were within normal range (Kaneko, 2008). Regardless of breed or concentrate level observed in this study and others experiments (Peixoto et al., 2010; Catunda et al., 2013) the glucose is less reliable due to the efficient homeostatic mechanism of digestive physiology of ruminants. However, according to González e Silva (2006) reported glucose is the constituent that represents the most energy mechanisms in mammals.

Triglycerides concentrations in Morada Nova were 27.5% higher than Santa Inês ewes indicating a higher accumulation in the liver with the objective to supply the deficit between energy intake and requirements in this exceptional period. Probably, Santa Inês ewes are promoting greater use of this mechanism for fetal growth, whereas, 80% occurs in this phase (final third of pregnancy) to the mammary gland for colostrum synthesis (Kozloski et al., 2001) and still the maintenance requirements.

The significant difference (P <0.05) in cholesterol levels demonstrates that the Morada Nova ewes have more effective homeostatic mechanisms during pregnancy than Santa Inês ewes, however, both breeds were presented normal values according to Kaneko (2008).

In experimental conditions and animals with 0.5% of supplementation was effective in the maintaining of urea level normal, but it is not require a supply of higher levels of concentrate for maintaining homeostasis during this period of intense mobilization. Important results in terms of efficiency of the productive system mainly depend to reduce the production costs.

The serum creatinine was higher (P <0.05) for Santa Inês ewes may be due to higher intake of concentrate or mobilization of body reserves as result of this phase.

Conclusions

Metabolic parameters were influenced by breed and better adaptability of the Morada Nova and Santa Inês breeds at the experimental conditions, which promotes production rates with 0.5% of concentrate supplementation.

Conflict of interest

The authors have not declared any conflict of interest

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CAPITULO 3 - Intake, digestibility, milk yield and indicators of the metabolic status of native ewes supplemented in grazing system

Elaborado de acordo com as normas da Revista Italian Journal of Animal Science

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Intake, digestibility, milk yield and indicators of the metabolic status of native ewes supplemented in grazing system

Abstract

The current assay evaluates the effect of the level of concentrate supplementation on the metabolic parameters of native ewes in lactation and supplemented in a grazing system. 28 lactating ewes were selected: 14 Morada Nova (MN) and 14 Santa Inês (SI), distributed in an experimental design completely randomized in 2x2x2 factorial arrangement with two breeds (MN and SI), as well as two levels of supplementation (0.5 and 1.5% body weight) and two experimental periods (30 and 60 days postpartum). Blood samples were collected from birth to 70 days of lactation, with collections every 14 days. Laboratory analyses consisted of the determinations of serum glucose, triglycerides, cholesterol, urea and creatinine. The concentrate intake (g/day) during the lactation differed ($p<0.05$) between the breed group and level of supplementation with SI ewes, and 1.5% of supplementation showed greater values. The total dry matter intake was affected ($p<0.05$) by breed and the treatments to which these animals were submitted. Emphasis must be placed on the MN ewes, which presented lower intake than did the SI, an expected fact due to their smaller size. Serum concentrations of glucose, triglycerides, cholesterol, urea and creatinine differed between breeds ($p<0.05$) with superiority of values for SI ewes; however, the concentrate supplementation did not affect ($p>0.05$) the serum levels of these metabolites. During this phase, there was a more pronounced use of these metabolites by Santa Inês ewes submitted to 0.5% supplementation seeking to adapt to metabolic stress and to promote milk yield in sufficient quantity and quality for nutritional demands of their offspring. Nonetheless, the concentrate supplementation was effective to maintain within normal standards the serum concentrations, indicating high adaptation to postpartum.

Key words: concentrate, metabolites, milk production, Morada Nova, postpartum, Santa Inês

Introduction

The establishment of small ruminant production is essential for the human survival in semiarid regions. Breeds adapted to the edaphic climatic conditions of this region can improve the profitability of local livestock. As an example, there are the breeds Morada Nova and Santa Inês, native animals, native to northeastern Brazil and used for the production of meat and skin, both highly valued in the international market (Souza *et al.*, 2011).

Despite the great cattle, rates of productivity, production and profitability show that the semi-arid northeastern Brazil has much to advance in this segment. Currently, production systems are characterized as extensive based on the feed native to the Caatinga. Maintained in these conditions, the animals showed lower rates of weight gain, high mortality and low reproductive efficiency (Moreira *et al.*, 2008).

One decisive practice for the advance of these production systems is related to food handling animals with the aim to provide food and nutrients in quantity and quality to reduce the slaughter age and improve product quality. As the use of tropical pastures, uniquely, cannot supply the nutritional requirements of the animals, mainly the categories of higher nutritional requirement, the concentrate supplementation may be an important alternative. Meanwhile, its use for animals at grazing must comply with basic conditions, such as genetic potential of animals, the quality and quantity of forage available, the concentrate price and the final price of the product (Voltolini *et al.*, 2008; Pompeu *et al.*, 2012).

This management is important because it consists of the fact that supplementation during the early lactation aims to improve the availability of glucogenic precursors in the rumen, resulting in increased weight gain as well as body condition, impacting positively on milk production and production index, thus increasing the reproductive

efficiency. In this case, the animal with insufficient energy intake may launch compensation means of metabolism by mobilizing its corporeal reserves (Ramin *et al.*, 2005).

The current assay evaluates the effect of the level of concentrate supplementation on the metabolic parameters of native ewes in lactation and supplemented in a grazing system.

Material and Methods

Animals, feeding plans and management

The experiment was conducted at the Research Unit in Small Ruminants of Campus Cinobelina Elvas of the Federal University of Piauí, Bom Jesus – PI (09º04'28" South Latitude and 44º21'31" West Longitude), at an altitude of 277 m.

The experiment was conducted with the approval of the ethical committee for animal experimentation of the Federal University of Piauí (ECAE/UFPI) under the number 091/2010.

Twenty-eight sheep were used, of same parity, being 14 Santa Inês and 14 Morada Nova, with an average initial body weight of 52.6 ± 6.54 and 31.3 ± 3.74 kg, respectively, artificially inseminated at fixed time (AIFT) with Dorper Breed semen. After 30 days of artificial insemination, the pregnancy diagnosis was performed through trans-abdominal ultrasound and pregnant ewes from each genetic group were selected, with same type of birth. These sheep remained until the middle of pregnancy in paddocks formed by Andropogon pasture grass (*Andropogon gayanus*), being collected in the late afternoon and allocated in collective pens with cement floor, covered and surrounded with a screen containing feeders and collective waterers and water *ad libitum* until the next day.

The experiment began at birth, the sanitary management consisted of the deworming and vaccination against clostridial diseases, in addition to routine preventive care. During the experimental period, the sheep remained in paddocks formed by Andropogon pasture grass (*Andropogon gayanus*), being collected in the late afternoon and allocated to individual pens where they received concentrate supplementation (Table 1) according to the weight of ewes (0.5% and 1.5% of body weight), being adjusted weekly.

Table 1. Chemical composition of experimental ingredients, concentrate supplement and Andropogon *(Andropogon gayanus)*.

Ingredients	DM	CP	EE	TDN	NDF	ADF	Ca	P
Corn meal	87.19	9.98	5.19	67.50	24.55	5.87	0.05	0.49
Soybean meal	88.48	48.76	1.75	80.73	15.37	9.64	0.33	0.57
[1]Mineral mixture	97.91	-	-	-	-	-	18.00	13.00
Supplement	88.04	19.17	4.06	67.43	21,02	6,51	0.90	1.13
Andropogon	27.45	7.50	2.02	53.56	74.70	41.97	0.33	0.11

DM = Dry matter; CP = Crude protein; EE = Ether extract; TDN = Total digestible nutrients; NDF = Neutral detergent fiber; ADF = Acid detergent fiber; Ca = Calcium; P = Phosphorus. [1]Mineral mixture: 1,600 mg zinc, 600 mg copper, 1,500 mg manganese, 1,100 mg iron, 10 mg cobalt, 27 mg iodine and 22 mg selenium. q.s.p. 1,000 g.

The treatments were formed based on the percentage of concentrate supplementation, according to the recommendations by the NRC (2007) for animals in reproduction.

Body weight and body condition score

The body weight of the ewes was registered weekly, the body condition score (BCS) was evaluated at the moment of the weekly weighing, being performed according to the method described by Thompson and Meyer (2006). Later, the averages were calculated

for the periods 30 and 60 days postpartum. The measurements were made on a scale from 1 to 5 (1 = underweight and 5 = overweight).

Determination of intake and digestibility

To estimate the intake and digestibility of nutrients, we used as internal indicator the indigestible dry matter (iDM). In order to evaluate the levels of indigestible components of food (grass: 0.4 g and concentrate: 0.4 g) and feces (0.4 g), they were packed in 50-μm nylon bags (8x12). The iDM was obtained after the bags were kept for 264 hours of incubation "in situ" of the supplied feed and feces according to Casali *et al.* (2009), being used one animal cannulated in the rumen under the same production system.

After the removal of the rumen, the bags were washed with water until full clearance and immediately transferred to the forced-ventilation greenhouse (60^{o}C) during 48 hours. Sequentially, they were dried in a non-ventilated oven (105 ° C for 45 minutes), put in a desiccator and weighed (Detmann *et al*., 2001) for obtaining undigested MS. The determination of NDF and ADF followed the methods described by Van Soest *et al.* (1991).

The content of iDM was obtained by the difference of the dry weight of the material before incubation and the dry weight of the residue after incubation.

Fecal production was obtained from an external indicator, the hydroxyphenylpropane - LIPE® (Saliba *et al.,* 2003). The LIPE® was given to animals at dose of 250 mg, before the first meal of the day, with two days for adaptation and five days to collect the feces. The feces were collected directly in the rectum once a day, after a composite sample was formed based on the pre-dry weight per animal. During the collection period, the daily samplings of food were carried. These samples were properly frozen and then dried (60 °C) processed in a grinder with a 1-mm sieve and submitted to laboratory analysis. The analyses for the determination of DM, CP, NDF

and ADF were conducted according to the methodology described by Silva and Queiroz (2002).

The calculations of digestibility and DM intake were made according to the following equations:

- DDM (%) = 100 – [100 x (indicator in the diet / indicator in the feces)]
- Fecal output (g/day) = [ingested indicator (g) / indicator in the feces (g/g DM)]
- DMI (g/day) = {[(DMfecal x % indicator in the feces) – indicator in the diet]} + DMIsuppl. % indicator in the forage

Where: DDM – Digestibility of dry matter, DMI – Dry matter intake, DMIsuppl. – Dry matter intake of supplementation.

Milk yield

Milk yield was determined using the protocol described by Doney *et al.* (1979). Once a week, after being separated from their lambs the ewes were injected intramuscular with 5 IU synthetic oxytocin (0,5mL) and milked immediately by hand milking. After the first milking, the ewes were returned to their paddock, while their lambs were kept in separate pen, out of sight from their mothers. After 2 h, the ewes received a second intramuscular injection of synthetic oxytocin (5 IU) and the milk output at the second milking was recorded using a graduated cylinder. The yielded volume was then multiplied by 12 to calculate daily milk production and, consequently, multiplied by 7 to calculate week milk production.

Determination of blood parameters

Blood samples were collected from birth, every 14 days, to 70 days of lactation. Blood was collected always in the morning, before the sheep were released to graze, by jugular venipuncture using needles coupled to vacuum tubes (10 mL) without anticoagulant. The serum was obtained after the centrifugation at 3500 rpm during 15

minutes in a refrigerated centrifuge and stored in micro tubes at -20 ° C until the time of laboratory analysis, which consisted of the determinations of serum glucose, triglycerides, cholesterol, urea and creatinine.

All the biochemical analysis were performed in semi-automatic biochemical analyzer (Espectrum BS- 001 000 013), using commercial kits of Labtest®, following the manufacturer's recommendations.

Statistical procedures

To evaluate the intake, Digestibility, milk yield and variation in weight gain as well as in the body condition score, the experimental design was a randomized 2x2x2 factorial arrangement with two breeds (MN and SI), two supplementation levels (0.5 and 1.5% body weight) and two experimental periods (30 and 60 days postpartum).

Factor analysis were carried out using data of Supplementation level, body weight, body condition score, intake, Digestibility, week of lactation and milk yield. The factor analysis performs a variety of common factor and component analyses, with measures carried out using as multivariate data. The first two factors that explained the greater proportion of data variation were selected. The results of the factors, therefore, show the relationship between the variables in the study. The statistical analyses were carried out using MIXED and FACTOR procedures of the SAS (Statistical Analysis System, version 9.3) and the means were compared by Tukey's test at a 5% probability.

For the blood variables, a randomized design was used in which the blood variables were evaluated using a split-plot arrangement. The main plot was the supplementation and the secondary plot, the harvest periods, with measures repeated in time. The comparison between the levels of supplementation was carried by SNK's test at a 5% probability. The results were submitted to ANOVA using the PROC GLM procedure of SAS (SAS, 1999) according to the following statistical model:

$Y_{ijk} = \mu + S_i + B_j + (SR)_{(ij)} + P_k + (SP)_{(ik)} + (SRP)_{(ijk)} + e_{(ijk)}$, where:

Y_{ijk} = value observed for the characteristic analyzed;

μ = overall average;

S_i = effect of the level of concentrate supplementation i = 1, 2;

B_j = effect of breed j = 1, 2;

$SB_{(ij)}$ = effect of the interaction level of and breed i;

P_k = effect of period k = 1, 2;

$SP_{(ik)}$ = effect of interaction between concentrate supplementation j i and period k;

$SRP_{(ijk)}$ = effect of interaction between concentrate supplementation i, effect of breed j and effect of period k;

$e_{(ijk)}$ = random error associated with the observation Yijk.

Results and discussion

The average body weight (kg) and body condition score of the ewes during lactation were influenced (P<0.05) by period, breed and level of supplementation (Table 2).

Table 2. Body weight (kg) and body condition score (1-5) of Morada Nova and Santa Inês ewes based on breed, supplementation level (0.5% and 1.5% BW) and period of lactation (30 and 60 days).

	Morada Nova		Santa Inês	
Body weight (BW)	0.5% BW	1.5% BW	0.5% BW	1.5% BW
Initial BW (kg)	28.1 ± 1.9	29.4 ± 1.1	45.3 ± 1.4	53.6 ± 1.3
30 days	28.9 ± 1.1ac	30.1 ± 1.3ac	45.1 ± 0.9aB	54.1±1.3aA
60 days	28.7 ± 1.5ac	29.5 ± 1.1ac	43.5 ± 1.2bB	54.2±1.5aA
Body condition score (BCS)				
Initial BCS	2.1 ± 0.2	2.9 ± 0.2	2.1 ± 0.1	2.7 ± 0.2
30 days	1.8 ± 0.1bD	2.9 ± 0.1aA	2.3 ± 0.2aC	2.5 ± 0.3bB
60 days	2.2 ± 0.1aB	2.9 ± 0.2aA	2.2 ± 0.1aB	2.9 ± 0.2aA

* Means followed by same letter, lowercase in the columns and uppercase in the rows, are not significantly different from Tukey's test at a 5% probability.

Santa Inês ewes submitted to 0.5% of supplementation showed weight loss (P<0.05) between periods, which did not occur with ewes of the same breed supplemented to 1.5%, mainly, due to the intense energy and protein metabolism that always occurs during lactation by the demand for nutrients to yield milk.

The BCS differed between periods in Morada Nova ewes supplemented to 0.5% and Santa Inês ewes to 1.5% and, in both treatments, an increased body condition occurred in the 60 days of lactation. In this period, Santa Inês ewes supplemented to 1.5%, had probably recovered from postpartum stress, with satisfactory uterine involution, presenting a greater DMI, promoting good recovery of body condition (Torreão *et al.*, 2008).

In the immediate postpartum, Morada Nova ewes supplemented to 1.5% exhibited better BCS (P<0.05) compared to treatment of 0.5%, as well as in relation the Santa Inês ewes. Also, in the second period, they kept their score and Santa Inês ewes receiving 1.5% presented similar scores (P>0.05).

The concentrate intake in grams/day (DMI) during lactation is shown in Table 3. Difference (P<0.05) between breed and level of supplementation was verified, with higher values for Santa Inês ewes and concentrated supplementation to 1.5%.

Table 3. Dry matter intake of ewes supplemented (0.5 and 1.5% BW) in grazing system at different periods (30 and 60 days) of lactation.

Parameters	0.5% BW		1.5% BW		Effect		
	30 days	60 days	30 days	60 days			
Morada Nova					T	P	T*P
DMI (g/day)	142.66Bb#	142.41Bb#	448.96Ba#	443.76Ba#	**	ns	ns
DMI (g/kg^{0,75})	11.54Bb#	11.55Bb#	35.03 Ba#	34.91Ba#	**	ns	ns
DMIc (g/dia)	131.49Bb#	131.26Bb#	413.80 Ba#	409.01Ba#	**	ns	ns
DMIc (g/kg^{0,75})	10.64Bb#	10.64Bb#	32.28Ba#	32.18Ba#	**	ns	ns
Santa Inês							
DMI (g/day)	225.0Ab°	217.70Ab°	806.61Aa°	813.05Aa°	**	ns	ns
DMI (g/kg^{0,75})	12.91Ab°	12.81Ab°	40.35Aa°	40.53Aa°	**	ns	ns
DMIc (g/day)	207.38Ab°	200.65Ab°	743.45Aa°	749.39Aa°	**	ns	ns
DMIc (g/kg^{0,75})	11.90Ab°	11.81Ab°	37.19Aa°	37.35Aa°	**	ns	ns

-Means followed by the same letter lowercase (treatment effect) and uppercase in rows (for effect of period) did not differ, from Tukey´s test at a 5% probability.
-Means followed by the same symbol in columns are not significantly different, for effect of breed, from Tukey´s test at a 5% probability.
-DMI = Dry matter intake; DMIc = Dry matter intake of concentrate
-T = Effect of treatment; P = Effect of period; T*P = Interaction between treatment and period.

This superiority in concentrate intake presented by Santa Inês ewes reflects the greater need for intake due to the larger size. Santa Inês ewes are more demanding than Morada Nova animals, Santa Inês ewes demands better forage quality and/or higher amount of concentrate supplementation (Silva Sobrinho, 2006; Facó *et al.*, 2008)

As the ewes of this experiment were submitted to the same conditions and pasture quality, the Santa Inês ewes tried to supply the deficiency of this type of pasture with a higher ($P<0.05$) concentrate intake in metabolic size unit. Such results corroborate with Menezes *et al.* (2010), comparing the Andropogon grass with other grasses, verifying increased intake of concentrate supplementation possibly due to this lower nutrient

quality of the Andropogon, especially in this critical period, which demands a highly balanced diet to avoid to big losses arising the negative energy balance (NEB).

The DMI was not influenced (P>0.05) by advancing lactation, indicating that the concentrate levels of this experiment supplied the consumption requirements, once there is an increase in nutritional requirements during this period, due to the gradual increase in milk production towards the peak of production in addition to maintenance needs and possible NEB recovery. Another factor would be the return of the total capacity of the rumen fill, which was prevented during the final third of pregnancy, characterized by 80% of fetal growth (Robinson *et al.*, 1999).

The DMI based on indigestible dry matter (iDM) was affected (P<0.05) by breed and concentrate supplementation levels to which these sheep were submitted (Table 4).

Table 4. Total dry matter intake and digestibility based on indigestible dry matter (iDM) in Morada Nova and Santa Inês ewes supplemented (0.5 and 1.5% BW) in grazing system at different periods (30 and 60 days) of lactation.

Parameters	0.5% BW		1.5% BW		Effect		
	30 days	60 days	30 days	60 days			
Morada Nova					T	P	T*P
DMI (g/day)	600.79Ba #	394.96Bb #	820.77Aa #	691.28Ab #	*	*	*
DMI (g/kg^{0,75})	49.28Bb #	32.13Bcd #	64.20Ab #	54.71Aab #	*	*	**
DMI (%BW)	2.14Ab #	1.39Aa #	2.75Bb #	2.35Bab #	*	*	*
DMS (%)	56.66b #	57.50 #	68.00a #	63.33 #	**	ns	**
Santa Inês							
DMI (g/day)	1191.74Ba°	878.91Bb°	1623.82Aa°	1352.02Ab°	*	*	*
DMI (g/kg^{0,75})	69.73Ba°	52.19Bb°	82.47Aa°	68.29Ab°	*	*	**
DMI (%BW)	2.71Ba°	2.04Ba°	3.07Aa°	2.53Ab°	*	*	*
DMS (%)	70.00°	65.50°	76.00°	78.00°	ns	ns	ns

- Means followed by the same letter lowercase (treatment effect) and uppercase in rows (period effect) did not differ, from Tukey´s test at a 5% probability.

-Means followed by the same symbol in columns are not significantly different, for effect of breed, by Tukey´s test (* -1%; ** - 5% of probability).
-DMI = Dry matter intake; DMIc = Dry matter intake of concentrate
-T = Effect of treatment; P = Effect of period; T*P = Interaction between treatment and period.

Evaluating the ewes intake, it is verified that there was an increase (P>0.05) in the forage intake by the animals that received the highest supplementation level, corroborating with Rodrigues *et al.* (2007). In general, it is verified that the animals showed adverse behavior, which was not expected to animals under 1.5% of concentrate supplementation, possibly be due to excess rumen degradable protein, the animals resorted to grazing in an attempt to compensate excess protein and maintain a good relation between protein: fermentable carbohydrate to maintain ruminal homeostasis; therefore, DMI is controlled by physiological factors of short and long term, in which the control is done by the nutrient balance diet, specifically related to the energy balance maintenance (Mertens, 1994; Van Soest, 1994).

This current study shows that there was a negative effect (P<0.05) in consumption with the advance of postpartum; a curious fact, which after uterine involution and capacity of maximum rumen fill occurred a decrease in roughage intake for both breeds in the two treatments, without compensation in the concentrate intake (P>0.05) in the same periods.

The breed factor was decisive (P<0.05), where Santa Inês ewes consumed a greater amount of forage, as well as, concentrate intake, being that its larger size may provide this difference.

The dry matter digestibility (Table 4) was higher (P<0.05) in Santa Inês ewes, However, the supplementation influenced only in Morada Nova ewes, with higher digestibility in animals fed high concentrate, due to increased availability of nitrogen compounds in the rumen and, consequently, greater proliferation of microorganisms

that degrade fiber. In addition, Van Soest (1994) reports the gradual replacement of Neutral detergent fiber of corn silage by non-fiber carbohydrates of the concentrate, due to rapid and high digestion in the digestive tract. This result corroborate with Macedo Junior *et al.* (2007) who cites influence of the concentrate level, low-fiber quality diet in sheep, especially ewes lactating, can affect intake and digestibility of dry matter.

This current study, Santa Inês ewes produced more (P<0.05) Kg of milk than Morada Nova ewes (Table 5) due to the larger size, higher production capacity, higher intake, in addition, a possible, high demand for development of their lambs. According to Torreão *et al.* (2014), there was a significant effect (P<0.05) of the breed (Santa Inês vs Morada Nova) on the weight gain of lambs at 7, 14 and 21 days, as well as on the total weight gain during the maternal-dependent phase, with superiority for Santa Inês lambs.

Table 5. Milk Yield (kg/week) of native ewes supplemented (0.5 and 1.5% BW) in grazing system during the maternal-dependent phase.

Week of lactation	Morada Nova breed		Santa Inês breed	
	0.5% BW	1.5% BW	0.5% BW	1.5% BW
01	5.73±1.38Aa °	5.18±1.28Aa °	7.66±0.91Cb #	10.78±1.18Ba #
02	6.02±1.38Aa °	5.60±1.28Aa °	9.29±0.91Bb #	11.37±1.18BAa #
03	5.64±1.38Aa °	6.23±1.28Aa °	10.59±0.91BAb #	11.96±1.18Aa #
04	3.46±1.38Aa °	5.32±1.28Aa °	11.46±0.91Ab #	12.93±1.18Aa #
Total milk yield (kg)	20.85±1.38 °	22.33±1.28 °	39.00±0.91b #	47.04±1.18a #

-Means followed by the same letter lowercase (treatment effect) and uppercase (week of lactation effect) in rows did not differ, from Tukey´s test at a 5% probability.
-Means followed by the same symbol in rows did not differ, breed effect, by Tukey´s test at 5% of probability.

The Supplementation affected (P<0.05) milk production of the Santa Inês ewes, with superiority in ewes submitted to 1.5% BW. Milk yield in the present study was superior that some studies reviewed (Ribeiro *et al.*, 2007; Araujo *et al.*, 2008; Pulina *et al.*, 2012). For this production level, even supplemented, these ewes may have used body reserves reflected by smaller body condition score at that stage (Table 2).

Evaluating the lactation progress, it is verified a significant increase (P<0.05) in Santa Inês ewes, this behavior reflects a normal lactation curve, that shows an increase to reach peak yield and according to Ribeiro *et al.* (2007) the peak yield of the Santa Inês ewes was reached at 37 days of lactation.

According to the results concerning the metabolic parameters evaluated during lactation, it is verified that serum glucose, triglycerides, cholesterol, urea, creatinine differ (P<0.05) according to the genetic group (Table 6).

Table 6. Averages of serum concentrations of metabolic parameters of ewes during lactation according to breed and supplementation level.

	GLU (mmol/L)	TRI (mmol/L)	CHO (mmol/L)	URE (mmol/L)	CRE (µmol/L)
Reference Values **	1.7-3.6	---	1.05-1.50	3.0-10	70-105
Breed					
Morada Nova	3.55[b]	0.28[a]	1.23[b]	5.24[b]	66.58[b]
Santa Inês	4.08[a]	0.22[b]	1.47[a]	6.47[a]	75.64[a]
Supplementation level					
0.5% BW	3.80	0.24	1.37	6.31	69.07
1.5% BW	3.75	0.26	1.33	5.90	63.14
Variation sources					
Breed	*	*	*	*	*
Supplementation level	ns	ns	ns	ns	ns
Breed x Supplementation level	ns	ns	ns	ns	ns

-Means followed by the same letter in columns are not significantly different from test Student-Newman Keuls (SNK); *- significant ($p<0.05$); ns– not significant ($p<0.05$); **Kaneko et al. (2008)
-Glucose - GLU, triglycerides - TRI, cholesterol - CHO, Urea – URE, Creatinine – CRE

There was no influence ($P>0.05$) of concentrate supplementation on serum levels of these metabolites during the postpartum in those ewes. At this stage, negative energy balance becomes more pronounced (Caldeira *et al.*, 2007; Kaneko *et al.*, 2008; Scarpino *et al.*, 2014). Therefore, the sheep needs to produce milk in sufficient quantities to their offspring. Knowing that in the synthesis of milk is involved the glucose that is a representative of energy metabolism, all this mechanism occurs as consequence of the main objective of the adaptation process to the negative energy balance to limit the mobilization of muscle proteins for the gluconeogenesis maintenance (Herdt, 2000; Kaneko *et al.*, 2008). Thus, during the NEB, the muscles get the energy derived from fat, including non-esterified fatty acids (NEFA) and ketone bodies, although the ruminant may be less efficient in the use of NEFA than are other species. Changing the energy sources, the utilization of glucose is reduced, helping the maintenance of the plasma concentrations (Lemor *et al.*, 2009).

There was no effect ($P>0.05$) of supplementation on glucose serum concentrations. An opposite result was reported by Balaro *et al.* (2012), who describe an elevation of levels according to supplementation and according to Van Soast (1994), to whom a consequent increase in the synthesis of propionate in the rumen occurs, indicating that the higher consumption and availability of protein coming from the diet, the higher tends to be glucose levels.

In the postpartum period, for the higher level of supplementation, there was a lower concentration of glucose. This fact can occur due to the more pronounced energy deficit, greater mobilization of body reserves and consequently, higher glucose values

for ewes supplemented to 0.5%, possibly in the attempt to promote milk yield in sufficient quantity and quality for nutritional demands of their offspring. Hence, the glucose demand for lactation increases proportionally to the amount produced, and the glycaemia tends to be maintained as long as there are reserves to supply such a demand, declining when the nutrition is not enough and the reserves are minimal (Carolino *et al.*, 2003; Caldeira *et al.*, 2007).

Evaluating the different breeds, an effect ($P<0.05$) is noticed for the glucose levels that remained with higher serum levels for Santa Inês ewes with values above the cited by Kaneko *et al.* (2008). Similar results were reported by Bizelis *et al.* (2000), noting that the demand for glucose to the mammary gland is so great that decreased serum concentration of this metabolite can occur when compared with the phase of pregnancy; However, in this study, that was not verified.

The knowledge of these physiological alterations, which are well pronounced in the lactation and which are additional to the uterine involution and milk yield, the animal organism takes a certain period of time to return to its full capacity of feed intake and until that occurs, a balance between the ingress and egress of nutrients, as well as other metabolites, is also mobilized to supply the energy demand (Scarpino *et al.*, 2014).

The interaction between breed and periods ($P<0.05$) of the metabolites evaluated in this study are presented in Figures 1, 2, 3, 4 and 5.

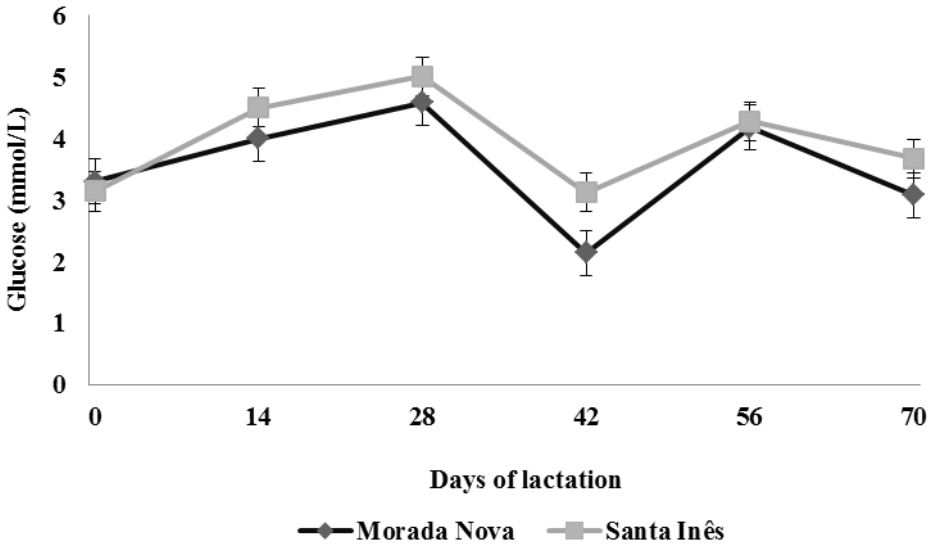

Figure 1. Plasma concentration of glucose in native ewes during the lactation period.

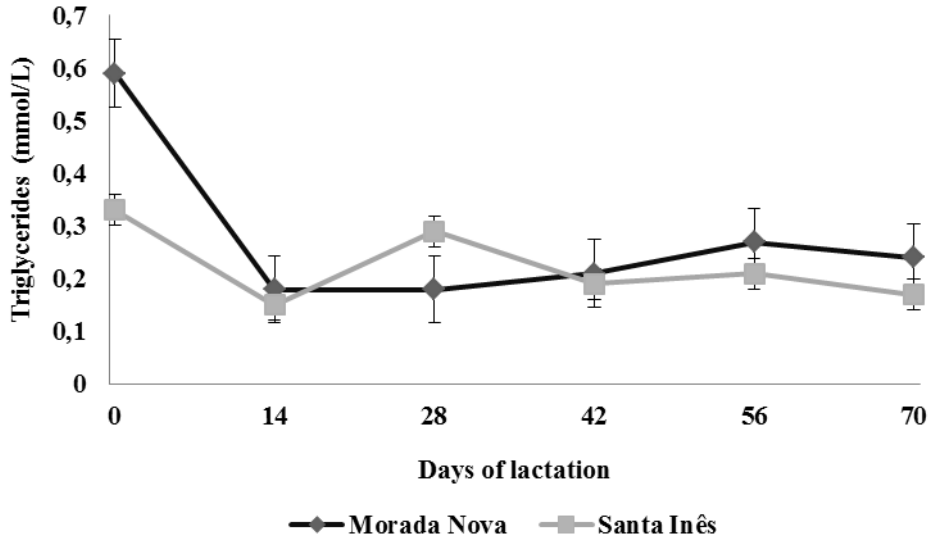

Figure 2. Plasma concentration of triglycerides in native ewes during the lactation period.

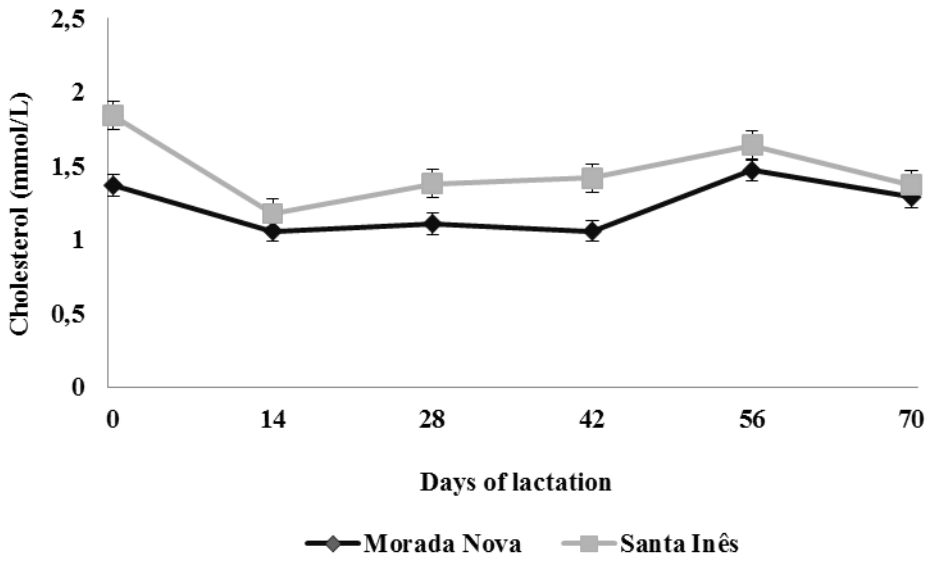

Figure 3. Plasma concentration of cholesterol in native ewes during the lactation period.

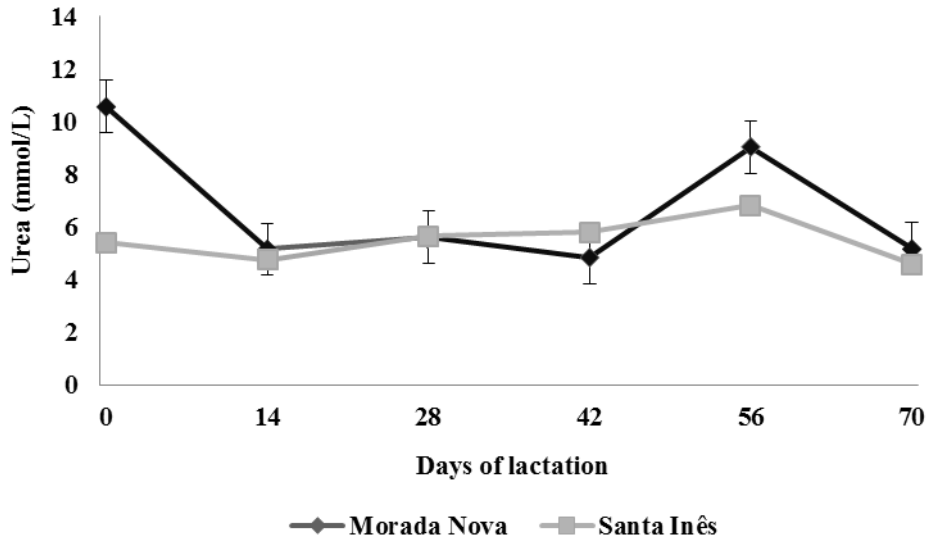

Figure 4. Plasma concentration of urea in native ewes during the lactation period.

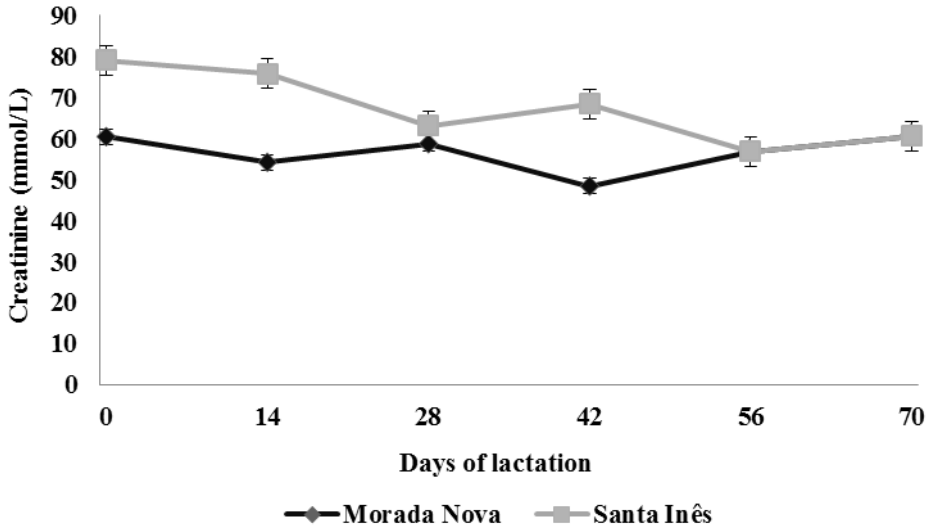

Figure 5. Plasma concentration of creatinine in native ewes during the lactation period.

It is verified that the Santa Inês ewes during the postpartum period showed higher serum glucose values when compared to Morada Nova ewes. However, there was a similar trend between the breeds, with rising levels up to 28 days of lactation, probably, due to the greater availability of glucose for the sheep to reach its (peak yield) according to Cardoso *et al.* (2010).

Based on data on the concentration of triglycerides, effect of breed (P>0.05) was observed with the highest concentrations for Morada Nova sheep. Looking at Figure above, it is perceived that the highest values were found at birth stabilizing in the 14 day of lactation. Highest concentrations were found in Morada Nova ewes, by the highest capacity to accumulate, its adaptation to the experimental conditions is a determinant, however, The SI ewes were probably using in higher intensity this metabolite during the pregnancy to supply the needs in the postpartum.

In analysis of cholesterol (Table 6 and Figure 5), the breed factor influenced the concentrations of this metabolite. It is known that in the synthesis of triacylglycerols,

the circulating NEFA can be esterified, mainly in triacylglycerols, phospholipids and esters of cholesterol, resulting in rapid accumulation of these substances in the organ (Caldeira *et al.*, 2007).

Thus, it can be perceived that the Morada Nova ewes exhibited lower cholesterol values than the Santa Inês ewes in the different periods ($P<0.05$), possibly due to the lower demand of utilization, consequently, the lower mobilization of hepatic triglycerides.

The serum urea showed ratio inversely proportional to the concentrate supplementation levels, although there was no difference ($P>0.05$) between treatments, results that corroborate with Ziguer *et al.* (2012). However, when was we evaluated the effect of breed, it is verified higher in Santa Inês ewes ($P<0.05$). According to Vosooghi-poostindoz *et al.* (2014), the urea can be a good indicator of the protein status in sheep and varies with the level of element intake. However, in this study, effect of diet on the urea concentration was not observed.

It is verified that concentrations showed different behaviors between the breeds. Santa Inês ewes exhibited constant levels during all postpartum. Contrary to that, there is a fluctuation in values relating to Morada Nova ewes, with greater amplitude at the birth, probably due to the higher protein catabolism to supply the appropriate levels in the moment (birth) and immediate postpartum (Contreras *et al.*, 2000).

A deficient nutrition in energy can lead to increasing concentrations of urea (Andrews *et al.*, 1996), due to increased catabolism of endogenous nitrogen compounds in order to reverse energy deficiency. It should be reported that overnutrition may exhibit high concentrations of urea and cause an increase in ammonia production in the rumen with excess of nitrogenous compounds absorbed in the intestine. Opposite to

that, a decrease in urea concentrations can be observed when there is drastic reduction in food intake or a minimum mobilization of protein reserves (Caldeira *et al.* 2007).

In evaluating creatinine levels, higher concentrations were observed for Santa Ines ewes ($P<0.05$) reflecting in higher concentrations of serum glucose (Table 6). In animals submitted to energy deficiency, mobilization of lipid reserves occurs and may occur mobilization of body protein, increasing the creatinine concentration in an attempt to maintain homeostasis and, mainly, the levels of blood glucose (Rodrigues *et al.*, 2007).According to Brito *et al.* (2006), the body reserves are considered mobile portion of the body weight of the individuals and, in deficiency or imbalance productive, can be mobilized to supply this deficiency.

The factors Analysis (Figure 6) shows that the first factor indicates a positive correlation among body weight, DMIc, DDM and Milk Production, being verified that animals of larger size had higher forage intake and concentrate with a consequent improvement in the Protein-Carbohydrate Interaction, promoting an increase in population of rumen micro-organisms (Van Soest, 1994; Voltolini *et al.*, 2008), high degradation rates (Mertens, 1994) and high digestibility (Medeiros *et al.*, 2007).

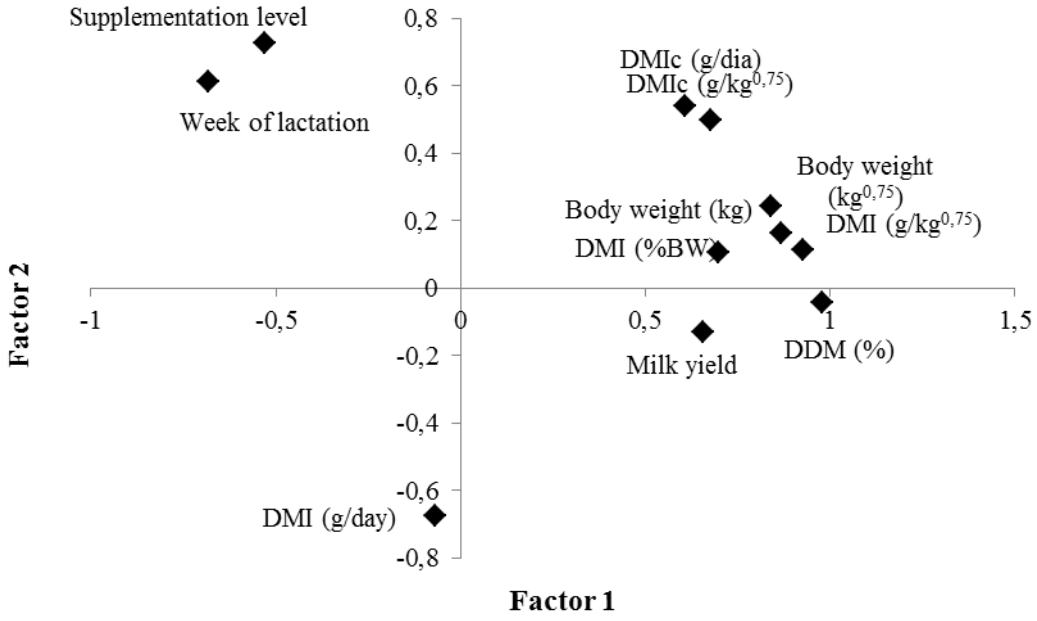

Figure 6. Two first factors of ewes Supplementation level, week of lactation and DMI (g/day); body weight (kg $kg^{0,75}$), DMI (%BW and $g/kg^{0,75}$), DMIc (g/day and $g/kg^{0,75}$) DDM (%) and Milk yield

According to the second fator, a high supplementation level promoted a decrease in the dry matter intake (g/day) may be in function of the substitution effect with high concentrate intake (Voltolini *et al.* 2009).

Conclusions

Milk yield was affected by breed, with superiority in Santa Inês ewes. In addition, there was an increase in milk yield in ewes submitted to 1.5% of concentrate supplementation.

Metabolic parameters were not affected by concentrate supplementation, which was effective for the maintenance of normal serum concentrations. However, these values

differ between breeds within the permissible standards, indicating a high adaptation to postpartum.

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CAPÍTULO 4 - Ingestive Behavior in a Ewe Grazing System Under Different Levels of Concentrate Supplementation

Elaborado de acordo com as normas da Revista South African Journal of Animal Science

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Ingestive Behavior in a Ewe Grazing System Under Different Levels of Concentrate Supplementation

Abstract

This study aimed to evaluate the influence of concentrate supplementation on the ingestive behavior of grazing ewes. We used 12 pregnant pluriparous sheep, six of which were Santa Inês and six of which were Morada Nova. The supplement was formulated so that the animals were subjected to two food plans (0.5 and 1.5% of body weight). The experimental design was a randomized 2x2x2 factorial arrangement (two breeds, two supplementation levels and two shifts, morning and afternoon) with six replicates per treatment, totaling 24 experimental units. The focal sampling method was used to record the amount of time spent on the adopted behavior in ten-minute intervals for 10 continuous hours with three replications, totaling 180 records per animal; the sampling always began at 07:00 h. The time spent grazing, ruminating and resting did not correlate with the level of concentrate supplementation; we expected the concentrate supplementation to reflect directly on the forage intake due to the substitution effect, which causes the sheep with an underestimated nutritional requirement of net energy to have a greater grazing intensity. Assessing the behavior between breeds, the time spent ruminating or lying was different, with the Santa Inês sheep being superior. Assessing these results, in turn, highlights the greater intensity of grazing and ruminating in the morning, which is directly related to the climatic conditions of the region. This shift is a factor that imposes limitations on the feeding behavior patterns of ewes that are supplemented at pasture.

Keywords: breed, grazing, Morada Nova, Santa Inês, season

Introduction

The success of the production system of grazing ruminants is conditioned by changes in feeding behavior under the limiting conditions of pasture intake, resulting from the inability to maintain a high rate of dry matter intake. Knowledge of the feeding behavior of grazing animals provides appropriate strategies for pasture and animal management and provides the ability to interfere positively with production results (Hao *et al.*, 2013).

Considering that food is one of the most limiting factors to obtaining good results, both for its quality and characteristics of production, including cost, the study of ingestive behavior in grazing systems deserves special attention as manmade changes tend to modify it (França *et al.*, 2009) .

The choice of breed is a determining factor in production success. Research in this area has found that, in general, the daily activities of sheep include, in alternating periods, grazing, ruminating and idling. The intensity and distribution of these activities are influenced by or dependent on a number of factors, such as the availability and nutritive value of the pasture, its management type and category and the activity of the animals in the group, as well as the predominant climatic conditions (Silva *et al.*, 2008).

The use of concentrated supplementation for ruminant grazing can influence the production and animal behavior to stimulate or inhibit the consumption of the material because the response to the type of supplementation, both in terms of energy and protein, causes changes in the behavioral habits of the animals, influencing their performance (Camilo *et al.*, 2013).

The patterns of ingestive behavior of ruminants can influence the digestion of food and its rate of passage through the gastrointestinal tract. However, animals can change their behavior by modifying one or more components of food to overcome the limiting conditions for consumption and get the required amount of nutrients, according to Pompeu *et al*. (2009). Information is scarce for sheep grazing, especially in semi-arid regions, regarding the behavior of the animals during the day and under different management conditions. Moreover, the ruminant animals find it easy to adapt to varying conditions of feeding, handling and setting, modifying their feeding behavior parameters to achieve a certain level of consumption that is compatible with the nutritional requirements, especially that of energy.

Thus, understanding the behavior of the grazing animal upon receiving concentrate supplementation may enable improved bioeconomic indices of production in grazing systems. Based on this assumption, the authors aimed to evaluate the influence of concentrate supplementation on the ingestive behavior of grazing ewes.

Materials and methods

The experiment was conducted at the Research Unit in Small Ruminants Campus Professor Cinobelina Elvas (CPCE), Federal University of Piauí (FUPI), Bom Jesus - PI (09 º 04'28 "south latitude and 44 º 21'31" west longitude) at an altitude of 277 meters, in the period of March to April 201.

We used 12 pregnant pluriparous sheep, in the final third of gestation, six Santa Ines and six Morada Nova. During the experimental period, the sheep remained in pasture paddock of Andropogon (*Andropogon gayanus*), under coupage continues, in area with 3.3 hectares (ha) and approximately 0.81 animal unit (AU) / ha, from 07:00 to 17:00 h, were collected in the late afternoon and were allocated to individual pens measuring 1.75 m^2. The sheep received supplementation with concentrated ground corn (70%), soybean meal (25%) and mineral

supplement (5%), based on the dry matter (Table 1). The experiment lasted 42 days, with twenty days for adaptation of the animals.

Table 1 Chemical composition of experimental ingredients, concentrate supplement and Andropogon *(Andropogon gayanus)*

Ingredients	Chemical composition (% DM)							
	DM	CP	EE	TDN	NDF	ADF	Ca	P
Corn meal	87.19	9.98	5.19	67.50	24.55	5.87	0.05	0.49
Soybean meal	88.48	48.76	1.75	80.73	15.37	9.64	0.33	0.57
[1]Mineral mixture	97.91	-	-	-	-	-	18.00	13.00
Supplement	88.04	19.17	4.06	67.43	21,02	6,51	0.90	1.13
Andropogon	27.45	7.50	2.02	53.56	74.70	41.97	0.33	0.11

DM = Dry matter; PB = Crude protein; EE = Ether extract; TDN = Total digestible nutrients; Ca = Calcium; P = Phosphorus. [1]Mineral mixture: 1,600 mg zinc, 600 mg copper, 1,500 mg manganese, 1,100 mg iron, 10 mg cobalt, 27 mg iodine and 22 mg selenium. q.s.p. 1,000 g.

Analyses of the amount of dry matter (DM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF), calcium (C) and phosphorus (P) in the concentrate and forage were performed according to the procedures described by Silva & Queiroz (2002).

The concentrate supplement was formulated according to the recommendations of the NRC (2007) such that the animals were subjected to two eating plans: one plan in which the nutritional requirement of net energy was underestimated (supplemented with 0.5% of the live weight of the animals) and another plan in which the nutritional requirement of net energy was overestimated (supplemented with 1.5% of the live weight of the animal), on natural matter basis.

To estimate of the total forage availability, three collections of samples of the pasture were made in the respective day trial of ingestive behavior. For this estimate, the forage was randomly divided into five areas within the pickets using a metallic square of 1.0 m² (1.0 × 1.0 m).

Samples from each square were weighed, divided into sub-samples, which were then used to form composite samples in a duplicate per period, packed in plastic bags, identified and frozen to assess the total availability of dry matter (DM). Of each pair of forage samples, one was used for the separation of components into green leaf, stem green, dried leaf and stem dry,

which were weighed, stored in plastic bags, frozen and subsequently analyzed to determine the chemical characteristics.

The mass of the leaf and stem material was identified by the separation and quantification of the dry weight of each component. The samples were weighed fresh, placed in a forced-air oven and kept for 72 h at 55°C for the quantification of the dry weight.

To evaluate the chemical composition of the forage consumed by the animals, samples were collected via the manual simulation of grazing. The processing of samples and chemical analyses were performed at the Laboratory of Animal Nutrition of the CPCE - UFPI.

The determination of the potentially digestible dry matter (DM_{PD}) was subsequently performed according to Paulino *et al.* (2005) as follows: DM_{PD} (% DM) = {0.98 × (100 - NDF)} + (NDF - iNDF), where NDF = neutral detergent fiber (% DM) and INDF = indigestible neutral detergent fiber (% DM). Being who, iNDF was determined according to the methodology described by Casali *et al*. (2009).

The averages of meteorological variables measured in the respective days and hours of evaluation the behavior of sheep are shown in Table 2, which were obtained from surface automatic weather station located at the site of the research.

The focal sampling method was used to record the amount of time spent on the adopted behavior in ten-minute intervals for 10 continuous hours with three replications (days), at weekly intervals, always starting seven in the morning and ending at five hours of Afternoon, which totaling 30 hours of evaluation and consequently, 180 records per animal, according to the methodology described by Johnson & Combs (1991). The ingestive behaviors have been considered mutually exclusive because for each record, each animal was classified into only one activity (Carvalho *et al.*, 2004). From these data, the average time spent eating, ruminating and resting was analyzed, observing also the number of times the animal walked, defecated and urinated.

The experimental design was a randomized 2x2x2 factorial arrangement (two breeds, two supplementation levels and two shifts day, morning and afternoon) with 6 replications per treatment, totaling 24 experimental units. The data were evaluated by an analysis of variance, and the means were compared by Tukey's test at a 5% probability. The experimental data were analyzed using the computer program SAS - Statistical Analysis System (2003), according to the statistical model:

$Y_{ijk} = \mu + B_i + S_j + (BS)_{(ij)} + T_k + (BT)_{(ik)} + (BST)_{(ijk)} + e_{(ijk)}$, where:

Y_{ijk} = value observed for characteristic analyzed;

μ = overall average;

B_i = effect of breed I = 1, 2;

S_j = effect of level of concentrate supplementation j = 1, 2;

T_k = effect of turn k = 1, 2;

$BS_{(ij)}$ = effect of the interaction between breed i and level of concentrate supplementation j;

$BT_{(ik)}$ = effect of the interaction between breed i and turn k;

$BST_{(ijk)}$ = effect of the interaction between breed i, level of concentrate supplementation j, and turn k;

$e_{(ijk)}$ = aleatory error associated with the observation Y_{ijk}.

Results and discussion

In the data analysis of the temperature and relative humidity, the afternoon conditions were outside the thermal neutral zone and within the effective upper critical limit of 35°C (Baêta & Sousa, 2010). The relative humidity is directly and inversely related to the temperature; therefore, when there is an increase in the air temperature, there is a reduction in the relative humidity (Table 2).

Table 2 Averages of the meteorological variables and indices of temperature and humidity as recorded by the weather station during the trial period

Variables	Turns	
	Morning	Afternoon
Air temperature (°C)	22.67 ± 1.59^b	30.57 ± 1.74^a
Relative humidity (%)	90.87 ± 6.13^a	59.27 ± 8.80^b
Index of temperature and humidity	71.96 ± 2.12^b	78.92 ± 1.18^a

Means followed by the same letters within rows do not differ by Tukey's test at a 5% probability.

Heat stress was classified by Armstrong (1994) according to the index of temperature and humidity (ITU) as mild (72-78), moderate (79-88), or severe (89-98). He further stressed that values below 72 do not characterize thermal stress. Thus, we can report that the afternoon conditions were unfavorable for grazing animals, making the activity of this time lower than that of the morning.

Eustáquio Filho *et al.* (2011) conducted a survey in Southwest Bahia, where Santa Inês sheep were subjected to an environment with a controlled microclimate. This microclimate was highlighted as a condition of comfort for the sheep, being an environment with a temperature of 25°C and a humidity of 65%, which are more conducive conditions to animal production than those found in this work.

Assessing the pasture availability (Table 1) for pregnant sheep, there are considerable rates of herb mass with greater proportions of leaves and green stems (maturity), favoring a higher rate of digestibility. This higher rate leads to a better utilization of nutrients by rumen

microorganisms and better sheep nutrition, especially during the final third of gestation, the period of greatest demand and of greater fetal development.

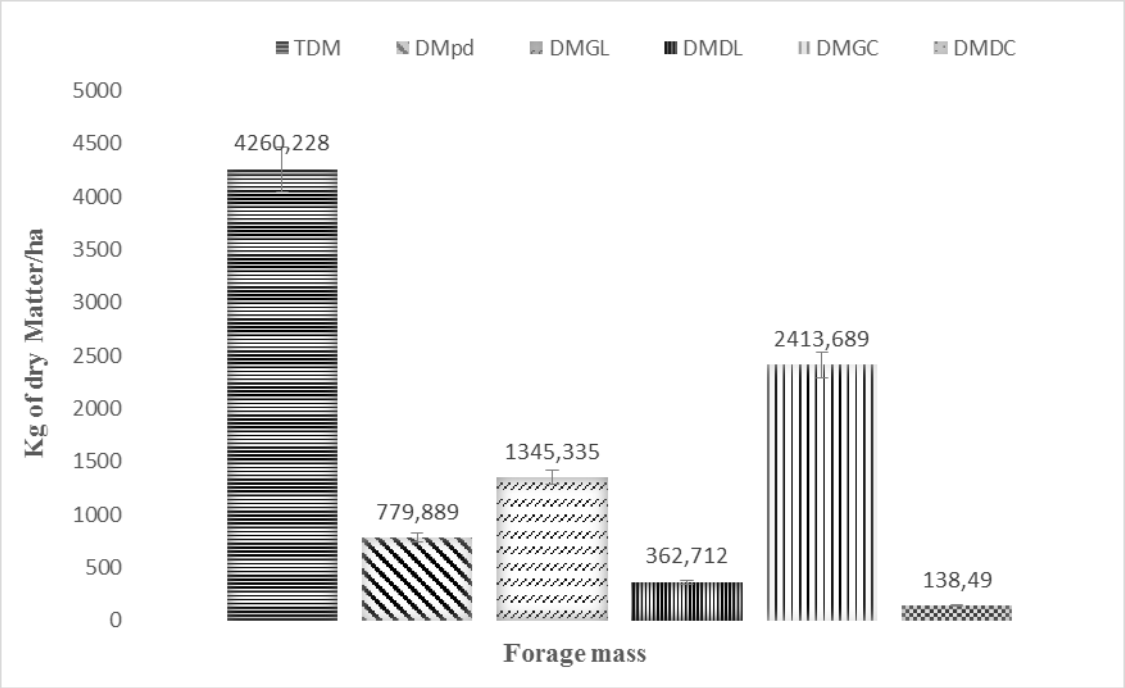

Figure 1 Mean values of the availability of the total dry matter (TDM), potentially digestible dry matter (DMpd), dry matter of green leaf (DMGL), dry matter of dry leaf (DMDL), dry matter of green culm (DMGC) and dry matter of dry culm (DMDC), during the experimental period.

In an experiment performed by Menezes *et al.* (2010), sheep that were supplemented with concentrate and allowed to graze on Andropogon grass *(Andropogon gayanus)* during a drought period had a lower production performance than sheep grazing on Aruana *(Panicum maximum cv. Aruana)* and Tanzania *(Panicum maximum)*. Thus, in the modal system of the region under study, animal performance is limited not only by the reduced amount of leaf mass but also by the low nutritional value of the forage, emphasizing the need for supplementation during that critical period.

Confortin *et al.* (2010) mentions that the patterns of animal feeding behavior under diets supplemented or not depend on the structural characteristics of the pasture throughout the grazing period to which they are subjected.

Assessing the behavioral patterns of sheep, it appears that the grazing time was not affected (P>0.05) by supplementation (Table 3). In general, the supplemented and non-supplemented animals showed similar behavior, possibly due to an excess of rumen-degradable protein in the supplement causing the animals to resort to the pasture to compensate for the

excess protein and maintain a good protein:fermentable carbohydrate ratio to maintain homeostasis in the rumen, data corroborate with Macmanus *et al.* (2011).

Table 3 Influence of concentrate supplementation on the ingestive behavior (hours) of grazing ewes during pregnancy

Treatments	Activities							
	GRAZ	RUMF	RUML	STAN	LYIN	WALK	URI	DEF
0.5% BW	5.92[a]	0.92[a]	0.86[a]	1.1[a]	0.38[a]	0.78[a]	0.02[a]	0.02[a]
1.5% BW	5.98[a]	0.89[a]	0.83[a]	1.18[a]	0.35[a]	0.77[a]	0.00[a]	0.00[a]

*Means followed by the same letters within rows do not differ by Tukey's test at a 5% probability.
GRAZ-grazing; RUMF–ruminating on foot; RUML-ruminating lying down; STAN-standing idle; LYIN-lying idle; WALK-walking; URI-urinating; DEF-defecating; BW- Body weight.

The concentrate supplementation was expected to reflect directly on the forage intake due to the substitution effect, which causes the sheep with an underestimated nutritional requirement of net energy to have a greater grazing intensity.

The supplement that was fed to the sheep reduces the diurnal grazing time and increases the time devoted to other activities without changing their patterns of consumption, displacement and demand (Confortin *et al.*, 2010).

The rumination time was not affected (P>0.05) by supplementation, regardless of the manner in which the animals ruminated, either standing or lying down, which is expected based on the fact that the grazing behavior did not differ between treatments (Table 3).

In a study conducted by Pompeu *et al*. (2009), the behavior of sheep fed a diet supplemented with concentrate was evaluated for the effect of different levels of supplementation on the rumination time. In this study, these sheep devoted more time to ruminating on foot in an attempt to dissipate the excessive heat caused by the high daytime temperature, which is different from the results of this research. Likewise, other variables were not affected by the level of supplementation (P>0.05).

The feeding behavior between breeds was also studied (Table 4), and the diurnal time spent on grazing was similar between breeds (P>0.05). Breeds that have a high degree of adaptability to the climatic conditions of the semi-arid region, besides its rusticity, possibly explaining the great similarity in the grazing patterns between these breeds.

Table 4 Effect of breed on the feeding behavior (hours) of grazing ewes subjected to concentrate supplementation during pregnancy

Breed	Activities							
	GRAZ	RUMF	RUML	STAN	LYIN	WALK	URI	DEF
Morada Nova	5.90[a]	0.62[a]	0.90[b]	1.5[a]	0.28[a]	0.58[a]	0.02[a]	0.02[a]
Santa Inês	5.96[a]	0.68[a]	1.36[a]	1.1[b]	0.32[a]	0.58[a]	0.00[a]	0.00[a]

*Means followed by the same letters within rows do not differ by Tukey's test at a 5% probability.
GRAZ-grazing; RUMF–ruminating on foot; RUML-ruminating lying down; STAN-standing idle; LYIN-lying idle; WALK-walking; URI-urinating; DEF-defecating.

The time spent on and intensity of grazing are closely related not only to the morphological characteristics of grasses, the time spent in arrest and the time spent reducing the particle size of the cake but also to the characteristics of the concentrated food supplement. However, the frequency of feeding and rumination is related to the feeding habits of each species and can vary between breeds.

The similarity of the grazing characteristics of the studied breeds is based on the high degree of adaptability of these animals to the environmental conditions of the Gurguéia Valley region, as well as to the type of grazing used and whether the animals are native to northeastern Brazil.

Assessing the time spent ruminating, it is clear that the time spent performing this activity while lying down was significantly different ($P<0.05$) between breeds, with the Santa Inês sheep being superior (Table 4).

The periods spent on food intake are interspersed with one or more periods of rumination or idleness, and the supply of food influences the rate of rumination, which is higher at night. The differences between individuals regarding the duration and division of activities may be conditioned by the appetite of the animals, their anatomy and the supply of energy requirements that would be affected by the forage:concentrate ratio (Fischer *et al.*, 2000).

In addition, changes in food consumption can be evidenced through the evaluation of feeding behavior and reflect directly on the animal productivity. However, new techniques for modifying feeding behavior alter not only the feed but also the physical and metabolic characteristics of the animal. Thus, patterns of behavior reflect the adaptation of animals to various environmental factors and may indicate methods for improving animal productivity through different managements.

The activity of standing idle differed ($P<0.05$) among genetic groups, and the Morada Nova sheep spent more time not performing any activity, as reflected in other variables seen in Table 2. This behavior of the Morada Nova sheep is possibly due to the search for a greater dissipation of heat produced via the heat increment of the diet and environmental conditions,

aside from the fact that the animals that belong to that breed have a lower sized specific characteristic of adaptation to semiarid region.

Assessing the effect of shifts on the behavior of sheep grazing, a greater intensity of grazing occurred in the morning (P<0.05) (Table 5), directly related to the climatic conditions of the region. The region has a high incidence of solar radiation during the afternoon, combined with a decrease in the relative humidity, which greatly influences the food intake by ruminants and, therefore, their productive functions. Thus, the morning is more favorable to grazing and greater herbage intake by the animals, as observed in this study.

Table 5 Effect of the time of day on the behavior (hours) of grazing ewes receiving concentrate supplementation during pregnancy

Turns	Activities							
	GRAZ	RUMF	RUML	STAN	LYIN	WALK	URI	DEF
Morning	3.49[a]	0.32[a]	0.25[a]	0.44[b]	0.07[b]	0.42[a]	0.01[a]	0.00[a]
Afternoon	2.72[b]	0.23[b]	0.20[b]	0.89[a]	0.56[a]	0.40[a]	0.00[a]	0.00[a]

*Means followed by the same letters within rows do not differ by Tukey's test at a 5% probability.
GRAZ-grazing; RUMF–ruminating on foot; RUML-ruminating lying down; STAN-standing idle; LYIN-lying idle; WALK-walking; URI-urinating; DEF-defecating.

Oliveira *et al.* (2013) evaluated the behavior of Santa Ines sheep subjected to an environment with and without the availability of shade and found that the number of animals in the sun was reduced by 20% during the hottest times of the day, coinciding precisely with the period in which there was a greater variation in the global temperature index. The highest grazing intensity was observed in the early morning and late afternoon, behavior that is likely related to the fact that these times present mild bioclimatic conditions, which may have favored a higher intake by grazing animals with a lower rate of caloric increase.

Significant effects (P<0.05) were found regarding the rumination activity, both standing and lying down, with a superiority in the morning for both. Such behavior may be due to the influence of heat transfer from the environment to the animal, with a lesser effect on the production of heat (Pines & Phillips, 2013)

Idleness was considered the period in which the animals remained standing without performing any activity. The time in which the animals remained in idle while standing or lying was greater (P<0.05) in the afternoon. It is possible that the influence of increased solar radiation discouraged the sheep from grazing until the environmental conditions were favorable to other activities. This phenomenon was quoted by Zanine *et al.* (2006), who asserted that

sheep prefer to stay idle during the hottest hours, mainly due to a better energy utilization of food consumed and an increase in the dissipation of heat.

Conclusions

The ingestive behavior of ewes on pasture during pregnancy was not affected by concentrate supplementation. However, their behavioral activities were influenced by breed and the time of the day.

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Considerações finais e implicações

A utilização de ovelhas Morada Nova e Santa Inês no sistema produtivo é de suma importância no semiárido brasileiro, principalmente quando se busca a produção de cordeiros precoces. Visto que, suas características adaptativas às condições características do semiárido nordestino, seu elevado potencial reprodutivo, devem ser utilizadas em cruzamentos com animais mais precoces para melhorarem o potencial reprodutivo e a adaptabilidade dos produtos oriundos desses cruzamentos.

Um manejo nutricional adequado é extremamente importante no período de transição em ruminantes no semiárido nordestino, mesmo que se trabalhe com adaptados as condições desta região, pois esse período é marcado por intensas e marcantes alterações metabólicas que inevitavelmente acarretam perdas no sistema produtivo.

Para tanto, é de suma importância avaliar o comportamento ingestivo desses animais a pasto, visto que a suplementação pode exercer influência nos tempos de pastejo, bem como no consumo de nutrientes.

Contudo, deve-se avaliar o perfil metabólico da geração F1 oriunda do cruzamento de ovelhas deslanadas com animais introduzidos, para melhor avaliação do grau de desempenho desses mestiços sob tais condições de produção.