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**UNIVERSIDADE ESTADUAL PAULISTA – UNESP
CÂMPUS DE JABOTICABAL**

**DIGESTA PASSAGE RATE IN SAANEN GOATS: A META-
ANALYTIC APPROACH**

Marcelo Gindri
MSc in Animal Science

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**UNIVERSIDADE ESTADUAL PAULISTA – UNESP
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ANALYTIC APPROACH**

Student: MSc Marcelo Gindri

Advisor: Prof. Dr Izabelle Auxiliadora Molina de Almeida Teixeira

Co-advisor: Prof. Dr Carla Joice Härter

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TÍTULO DA TESE: DIGESTA PASSAGE RATE IN SAANEN GOATS: A META-ANALYTIC APPROACH

AUTOR: MARCELO GINDRI

ORIENTADORA: IZABELLE AUXILIADORA MOLINA DE ALMEIDA TEIXEIRA

COORIENTADORA: CARLA JOICE HÄRTER

Aprovado como parte das exigências para obtenção do Título de Doutor em ZOOTECNIA, pela Comissão Examinadora:

Profa. Dra. IZABELLE AUXILIADORA MOLINA DE ALMEIDA TEIXEIRA
Departamento de Zootecnia / FCAV / UNESP - Jaboticabal



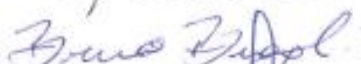
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Embrapa Caprinos / Sobral/CE



Dra MÁRCIA HELENA MACHADO DA ROCHA FERNANDES
Departamento de Zootecnia / FCAV / UNESP - Jaboticabal



Dr. BRUNO BIAGIOLI
Departamento de Zootecnia / FCAV / UNESP - Jaboticabal



Prof. Dr. ALBERTO STANISLAO ATZORI
Dipartimento di Agraria/Università degli Studi di Sassari / Sassari/Itália



Jaboticabal, 16 de março de 2020

BIOGRAPHY

MARCELO GINDRI was born on December 02, 1991, in São Francisco de Assis, Rio Grande do Sul, Brazil. From 2009 to 2013, he did his undergraduate study in Animal Science at Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil. During his undergrad, he completed an internship at Instituto Nacional de Investigación Agropecuaria del Uruguay, Tacuarembó, Uruguay, from March to June 2013. He became a graduate student at Universidade Federal de Santa Maria and concluded his Master's degree in Animal Science in February 2016. He focused on developing faecal near-infrared spectroscopy models for estimating the nutritional value of ingested diets by free-ranging sheep in southern Brazil under the supervision of Dr Gilberto Kozloski. In 2016, he began his doctoral degree at Universidade Estadual Paulista, Jaboticabal, São Paulo, Brasil, and he has been working on a meta-analysis of digesta passage rate in growing Saanen goats under supervision of Dr Izabelle Auxiliadora Molina de Almeida Teixeira. He also completed a graduate internship at The Ohio State University, Columbus, Ohio, USA, from July 2018 to June 2019 under supervision of Dr Luis Moraes.

... Mostremos valor, constância
Nesta ímpia e injusta guerra
Sirvam nossas façanhas
De modelo a toda Terra...

Chorus of the Rio-Grandense
anthem composed by Francisco
Pinto da Fontoura

To my family for giving me love,
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DIGESTA PASSAGE RATE IN SAANEN GOATS: A META-ANALYTIC APPROACH

ABSTRACT: The digesta passage rate (k_p) in ruminants is a fractional passage of digesta per hour, i.e. /h. The k_p is a very complex and dynamic process and affects feed digestion and the environmental impact of livestock. In this study, we aimed to understand the factors related to k_p in the whole gastrointestinal tract (GIT) of growing goats and goats fed with feeding levels and propose equations for predicting k_p of particles and solutes in reticulorumen. For that, we used a database from two studies with Saanen goats that was split into two different databases: database Growth was composed by individual records of castrated males ($n = 36$), females ($n = 34$), and intact males ($n = 33$) fed ad libitum and slaughtered at 15, 22, 30, 37, and 45 kg body weight (BW); and, database Feeding Levels was composed by individual records of castrated males ($n = 38$), females ($n = 33$), and intact males ($n = 36$) fed ad libitum, 75 or 50% of ad libitum over 109 ± 10 days. Our results demonstrated digesta passage rate had different responses whether evaluated in growing goats or goats fed with feeding levels over long-term. Reticulorumen k_p of particles was not affected by growth or feeding level. However, reticulorumen k_p of particles and large intestines k_p of particles and solutes were positively related among them in growing goats. Reticulorumen k_p of solutes decreased with aging followed by increasing on reticulorumen capacity and reducing on dry matter (DM) intake level and chewing investment (chews/g DM intake). Moreover, goats fed with feeding levels over long-term had k_p of solutes in all GIT segments positively related to feeding levels and capacity. Sex effect on k_p seemed to be dependent on chewing investment, however, it must be further investigated. According to developed models, reticulorumen k_p of solutes demonstrated to be more dependent on feed intake level than reticulorumen k_p of particles, that demonstrated to be more dependent on diet composition and k_p of solutes.

Key words: dairy goat, digesta kinetic, feed intake, sex, equation

TAXA DE PASSAGEM DE DIGESTA EM CAPRINOS SAANEN: UMA ABORDAGEM META-ANALÍTICA

RESUMO: A taxa de passagem da digesta (k_p) em ruminantes é a passagem fracionada da digesta por hora, isto é /h. A k_p é um processo complexo e dinâmico e afeta a digestão dos alimentos e o impacto ambiental da produção animal. Neste estudo, objetivamos compreender os fatores relacionados à k_p em todo o trato gastrointestinal (TGI) de caprinos em crescimento e caprinos alimentados com níveis de alimentação e propor equações para prever k_p de partículas e solutos no retículo-rúmen. Para isso, utilizamos um banco de dados de dois estudos com caprinos Saanen, que foi dividido em dois bancos de dados diferentes: o banco de dados Crescimento foi composto por registros individuais de machos castrados ($n = 36$), fêmeas ($n = 34$) e machos intactos ($n = 33$) alimentados ad libitum e abatidos aos 15, 22, 30, 37 e 45 kg de peso corporal (PC); e, o banco de dados níveis de alimentação foi composto por registros individuais de machos castrados ($n = 38$), fêmeas ($n = 33$) e machos intactos ($n = 36$) alimentados ad libitum, 75 ou 50% ad libitum durante 109 ± 10 dias. Nossos resultados demonstraram que a taxa de passagem da digesta tem respostas diferentes, quando avaliada em cabras em crescimento ou cabras alimentadas com níveis de alimentação a longo prazo. O k_p de partículas no retículo-rúmen não foi afetado pelo crescimento animal ou pelo nível de alimentação. No entanto, o k_p de partículas no retículo-rúmen e o k_p de partículas e solutos no intestino grosso demonstraram ser positivamente relacionados nos animais em crescimento. O k_p de solutos no retículo-rúmen diminuiu com o crescimento animal, seguido pelo aumento da capacidade do retículo-rúmen e redução do nível de ingestão de matéria seca (MS) e investimento na mastigação (mastigação/g de ingestão de MS). Já os caprinos alimentados com níveis de alimentação a longo prazo demonstraram k_p de solutos em todos os segmentos do TGI positivamente relacionados aos níveis de alimentação e capacidade do TGI. O efeito do sexo no k_p pareceu depender do investimento em mastigação, no entanto, isso deve ser investigado mais detalhadamente. De acordo com modelos desenvolvidos para retículo-rúmen, o k_p de solutos demonstrou ser mais dependente do nível de ingestão de alimento do que o k_p de partículas, que demonstrou ser mais dependente da composição da dieta e do

k_p de solutos.

Palavras-chave: cabra leiteira, cinética da digesta, consumo de ração, sexo, equação

CHAPTER 1 – General considerations

INTRODUCTION

Digesta passage rate (k_p) in ruminants is a fractional passage of digesta per hour, i.e. /h. Digesta passage rate is a dynamic process and affects feed digestion and the environmental impact of livestock. Digesta passage rate in ruminants is negatively related to the extent of digestion of feeds because it is negatively related to the length of time that feed components are exposed to digestion and absorption. In reticulorumen, where most of the fibre and protein is digested, k_p is yet positively associated to reticulorumen microbes' growth and feed digestion rate and negatively related to methane emission per unit of digested fibre (Clauss and Hummel, 2017; Grandl et al., 2018). Moreover, in the distal tract, k_p is also positively associated with water losses by faeces (Clauss et al., 2016). Digesta passage rate has been considered dependent on feed intake, body weight (BW), gastrointestinal tract (GIT) capacity, sex, age, physical and chemical composition of the diet, animal's physiological state (i.e. pregnancy and lactation) and behaviour, and weather. However, all these factors are related among them and they synergistically act on k_p . Moreover, k_p can be methodologically split into particles and solutes or also in each of the chemical components of digesta, and each of these k_p has an individual behaviour in the GIT segments, and they can also be related among them within or between GIT segments. All these factors have made the understand and prediction of k_p in ruminants a challenge.

The k_p can be predicted by internal or external markers of feed, considering a steady-state condition, in which the markers are constantly administrated and the concentration of the markers are measured in the GIT segments, or also by an unstable condition over time, in which a pulse dose of markers is administrated and based on their excretion curve the k_p is estimated accounting for dependency between pools of digesta. Moreover, k_p can also be estimated with empirical or mechanistic models, that usually consider the effects of animal and diet as predictor variables. There are few models in the literature for predicting k_p in goats, and most of them are empirical models and have feed intake and diet composition as predictor variables. However, none of them considers the digesta fractions (i.e. solutes and particles) have different

k_p , and that GIT capacity also affects k_p . Moreover, based on own brief literature review of models for predicting k_p in the reticulorumen segment of cattle, mechanistic models have demonstrated over twice better behaviour than empirical equations, based on root mean square prediction error. This demonstrates reticulorumen k_p is a very complex and dynamic process, and for accurately predicting k_p , all the related factors must be taken into consideration.

Thus, the objective of this review is demonstrating, in a mechanistic steady-state condition, how those factors stated above (i.e., feed intake, BW, GIT capacity, sex, age, physical and chemical composition of the diet, and animal's physiological state and behaviour) are related to k_p in ruminants and a review about models for predicting k_p in reticulorumen of goats.

CONCLUSIONS

The proposed empirical models demonstrated intake and capacity are important in predicting reticulorumen k_p , and they could be summarized by intake level. Moreover, our proposed models demonstrated the importance of diet composition and k_p of solutes on predicting k_p of particles. Despite our proposed models were built with database compose by growing goats fed with similar diets, the predictor variables of the models suggest the models can be used with different diets. However, to confirm

this, the ability of the models to predict k_p of goats fed with different diets must be further evaluated.

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