

Comparison of Particle Size in the Feces of Various Herbivores

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Introduction

Herbivorous animals can be divided into pregastric fermentors and hindgut fermentors according to their digestive system for plant fiber. The former can be further divided into ruminants and non-ruminants. A forestomach allows fibrous feeds to be retained longer, allowing a greater extent of fermentation and more effective absorption of fermentation products. Ruminant animals regurgitate the contents of the rumen for remastication. Particle size reduction of rumen contents increases surface area allowing greater exposure to microorganisms, and is thus more convenient for thorough fermentation. It also promotes a more rapid passage of indigestible fiber. It is considered that rumination is a major factor in particle size reduction of digesta in ruminants⁴⁾.

In the present study, particle size in the feces of several herbivores, including ruminants, non-ruminant pregastric fermentors and hindgut fermentors, is compared.

Materials and Methods

The animals and rations used in this study were the same as those reported by Okamoto⁵⁾. Feces were collected from a giraffe (*Giraffa camelopardalis*), a camel (*Camelus dromedarius*), a llama (*Lama glama*), a hippopotamus (*Hippopotamus amphibius*) and a tapir (*Tapirus indicus*) at Maruyama Zoo, Sapporo; and the feces from a cattle, a sheep and a horse were collected from the Research Farm of Rakuno Gakuen University.

About 30g of fecal samples were wet sieved using 5 sieves of different pore size ranging from 0.15 to 2.36mm. During wet sieving, a water spray was applied for 15minutes. Particles were removed from the sieves onto tared filter papers which were then dried at 95°C overnight and weighed. Very small particles which passed through the 0.15mm screen were calculated by difference.

Particulate data was expressed as a percentage of total dry matter. The raw data were treated according to the following methods: Modulus of fineness (MF) and modulus of uniformity (MU) were calculated as described by ASAE²⁾. The logarithmic normal distribution adopted by Waldo et al.⁷⁾ was used to calculate mean particle size (MPS) and its standard deviation (MSD). Geometric mean diameter (GMD) and geometric standard deviation (GSD) were calculated by the method described by ASAE³⁾.

Results and Discussion

Particle size distribution in the feces as expressed by three different methods is shown in Table 1. MF and MU indicated that particle size in the feces from the horse and the hippopotamus was greater than that of the others, and that about 60% of the particles ranked as large particles. About 90% of the particles in the feces from the llama were made up of fine particles. Feces from the cattle, the giraffe, the sheep, the tapir and the camel were made up of intermediate size particles.

MPS and MSD indicated that particle size in the feces from the hippopotamus was greatest

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Table 1 Particle size in feces for several herbivores

	MF	MU	MPS	MSD	GMD	GSD
giraffe	1.98	2:2:6	309	10.5	280	13.6
cattle	2.04	3:1:6	234	60.3	290	27.6
sheep	1.86	0:3:7	380	1.9	400	2.0
camel	1.49	2:1:7	66	56.2	80	47.5
llama	0.50	0:1:9	58	4.6	60	4.3
hippopotamus	3.22	6:0:4	24130	38138	>30000	—
horse	3.59	6:0:4	7079	61.7	9000	100
tapir	1.81	2:1:7	195	20.9	200	17.0

MF: modulus of fineness, MU: modulus of uniformity.
MPS: mean particle size (μm), MSD: standard deviation of MPS.
GMD: geometric mean diameter (μm), GSD: standard deviation of GMD.

and showed greatest variation, followed by that of horse feces. Camelid feces from the llama and the camel were made up of fine particles, and those from the ruminants, the giraffe, the cattle and the sheep, were of intermediate size. Particle size in the feces from the tapir was pretty fine, between that of the ruminants and the camelids.

GMD and GSD indicated similar results to that of MPS and MSD.

Van Soest⁶⁾ has listed particle size index for feces from some animal species. According to this index, particle size for heifers and sheep feces was greater than in our results on MPS and GMD, while it was smaller for horse feces. These differences may be due to the different calculation methods used. Similar results to the present study for cattle feces were reported by Allen et al.¹⁾ using the MPS and GMD.

Despite the limited data, the present study suggests that camelids and ruminants which ruminate the contents of the rumen, excrete feces made up of finer particles than those of non-ruminants, except the tapir. The tapir used in the present study excreted particles as fine as those of the ruminants.

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References

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要 約

円山動物園で人工飼育されているキリン、ラクダ、ラマ、カバおよびバクと酪農学園大学で飼育されているウシ、ウマおよびヒツジ各1頭より新鮮糞を採取した。これを目開き0.15~2.4 mmの分析ふるいを用いて、湿式ふるい分析し、modulus of fineness (MF), modulus of uniformity (MU), 対数正規分布による平均径 (MPS) および標準偏差 (MSD), 幾何平均径 (GMD) および標準偏差 (GSD) を算出した。

その結果、糞の粒度はMFを指標とするとウマが最も粗く、カバがこれについて粗かったが、他の指標ではカバが最も粗く、ウマがこれに続いた。最も細かな粒子よりなる糞は、いずれの指標においても、ラマより排泄されたものであった。飼料構成が異なり、供試頭数が各1頭と少なく、詳細な比較はでき

ないが、一般にカバやウマなどの反芻をしない動物の糞はキリン、ウシ、ヒツジ、ラクダ、ラマなどの反芻をする動物より粗い粒子により構成されている

傾向にあった。ただし、本研究に供試したバクの糞は反芻動物と同等の細かさであった。