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IN VITRO RUMEN AND RABBIT CECUM DIGESTIBILITIES: III. SELECTED FEED INGREDIENTS

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Abstract

Six selected feed ingredients used in rabbit nutrition were analyzed for chemical components and used as substrates for in vitro cecal and rumen digestion studies in order to observe the relationship between their chemical composition, in vitro cecal and in vitro rumen digestibilities. In vitro rumen dry matter digestibility (IVRDMD) and organic matter digestibility (IVROMD) values were higher than in vitro cecal digestibility values (IVCDMD and IVCOMD, respectively). IVCDMD among the ingredients ranged in the order: corn > soybean meal > wheat mill run > alfalfa meal > ammoniated annual ryegrass straw > untreated annual ryegrass straw, while IVRDMD ranged in the order: soybean meal = corn > wheat mill run > alfalfa meal > ammoniated ryegrass straw > untreated ryegrass straw. IVCOMD ranged in the order: corn = soybean meal > wheat mill run > alfalfa meal = ammoniated annual ryegrass straw > untreated annual ryegrass straw, while IVROMD ranged in the order: soybean meal > corn > wheat mill run > alfalfa meal > ammoniated annual ryegrass straw > untreated annual ryegrass straw. Cecal and rumen digestibilities of the feed ingredients were, in general, directly related to the cell contents (CC) and inversely related to the acid detergent fiber (ADF) contents. Cecal digestibility as percentage of rumen digestibility was similarly related to CC and ADF. The ADF and CC of feed ingredients could serve as indirect measure of their in vitro cecal or rumen digestibility potentials.

Introduction

The use of in vitro rabbit cecal fermentation as preliminary evaluation of the nutritive value of feedstuffs for rabbits has recently received considerable attention (Aderibigbe et al., 1992a and 1992b) and has been found to be effective. However, the percent in vitro cecal digestibility is usually found to be lower than rumen digestibility. Optimum in vitro cecal fermentation also requires a longer period (> or = 48 h) than rumen fermentation. The objectives of this study were (a) to compare the in vitro cecal digestibilities of selected feed ingredients commonly used in rabbit nutrition with their in vitro rumen digestibilities at the same length of incubation period and (b) to observe the relationship between the chemical composition of the various ingredients and their in vitro cecal and rumen digestibilities.

Materials and Methods

Six feed ingredients which are commonly used in rabbit nutrition (alfalfa meal, wheat mill run, yellow dent corn, soybean meal, untreated annual ryegrass straw and ammoniated ryegrass straw) were ground through a Wiley mill (1 mm screen) and analyzed for dry matter (DM), crude protein (CP) and ash as described by the Association of Official Agricultural Chemists (AOAC) (1975). Acid detergent fiber (ADF) was determined by the method of Van Soest (1963) as described in the modified micro-procedure of Waldern (1971). Cell wall constituents and cell contents (CC) were determined by the method described by Van Soest and Marcus (1964). Organic matter was determined in the usual manner.

Pentiplicate samples (1 g DM basis) of each ingredient were used as substrates for in vitro rabbit cecal and cattle rumen fermentations using the methods described by Aderibigbe et al. (1992a). Close in vitro incubations were conducted for 48 h. The percent in vitro cecal and rumen dry matter digestibilities (IVRDMD and IRCDMD, respectively) and organic matter digestibilities (IVROMD and IVCOMD, respectively) were analyzed by use of a two-way analysis of variance as described by Neter and Wasserman (1974). Means were compared using the Duncan's Multiple Range test as outlined by Steel and Torrie (1980).

Results and Discussion

The chemical composition of the various feed ingredients are shown in Table 1. Table 2 shows the comparison between in vitro cecal dry matter digestibility (IVCDMD) and in vitro rumen dry matter digestibility (IVRDMD) of the various feed ingredients. IVCDMD values for the various ingredients were lower than IVRDMD values ($P < .05$). This supports the findings of Aderibigbe et al. (1992a and 1992b) who observed that in vitro rumen digestibility values were higher than in vitro cecal digestibility values. IVCDMD among the ingredients ranged in the order: corn > soybean meal > wheat mill run > alfalfa meal > ammoniated annual ryegrass straw > untreated annual ryegrass straw ($P < .05$), while IVRDMD ranged in the order: soybean meal = corn > wheat mill run > alfalfa meal > ammoniated ryegrass straw > untreated ryegrass straw ($P < .05$).

In vitro cecal organic matter digestibility of the feed ingredients (IVCOMD, Table 3) were also lower than their in vitro rumen organic matter digestibility (IVROMD) values ($P < .05$). IVCOMD among the ingredients ranged in the order: corn = soybean meal > wheat mill run > alfalfa meal = ammoniated annual ryegrass straw > untreated annual ryegrass straw ($P < .05$), while IVROMD values ranged in the order: soybean meal > corn > wheat mill run > alfalfa meal > ammoniated annual ryegrass straw > untreated annual ryegrass straw ($P < .05$). Comparison between chemical composition and in vitro cecal or rumen digestibility of the feed ingredients showed that in vitro digestibilities were, in general, directly related to the cell contents (CC) and inversely

Table 1. Chemical composition of the feed ingredients used as substrates for cecal and rumen digestion studies.

Item	Ingredient					
	Alfalfa Meal	Wheat Mill Run	Maize (Yellow Dent)	Soybean Meal	Untreated Annual Ryegrass Straw	Ammoniated Annual Ryegrass Straw*
Dry matter (DM, %)	92.2	90.7	90.1	90.	90.6	85.4
Organic matter (OM, %)	83.1	85.0	88.8	83.0	84.9	78.8
Analyses, % of DM:						
Crude protein (CP)	18.7	18.8	9.5	53.7	5.8	11.0
Acid detergent fiber (ADF)	34.1	13.4	3.2	7.0	47.0	44.7
Cell contents (CC)	55.7	58.1	85.0	91.8	27.2	31.5
Ash	9.1	5.7	1.3	7.1	5.7	6.6

* Annual ryegrass straw was ammoniated by applying 4% urea, 1% raw soybean and 20% water (W/W) to the straw, and kept in sealed plastic bags for three months.

related to the acid detergent fiber (ADF) contents. Thus, the ADF and CC of feed ingredients could serve as indirect measures of their in vitro cecal or rumen digestibility potentials.

The results of IVCDMD as percentage of IVRDMD, and IVCOMD as percentage of IVROMD for the various feed ingredients are shown on Table 4. IVCDMD as percentage of IVRDMD ranged in the order: corn > soybean meal = wheat mill run > alfalfa meal = ammoniated annual ryegrass straw > untreated annual ryegrass straw with an overall mean of 64.5, while IVCOMD as percentage of IVROMD ranged in the order: wheat mill run = corn > soybean meal > ammoniated annual ryegrass straw > alfalfa meal with an overall mean of 66.6. Thus, in vitro cecal digestibility as percentage of in vitro rumen digestibility of the various feed ingredients was, in general, directly proportional to the CC and inversely proportional to the ADF contents.

Table 2. In vitro cecal versus rumen dry matter digestibilities of the various feed ingredients.

	In Vitro Cecal Dry Matter Digestibility (IVCDMD, %)	In Vitro Rumen Dry Matter Digestibility (IVRDMD, %)
Alfalfa meal	$32.1^{a,e}$	$58.2^{b,e}$
Wheat mill run	$53.0^{a,f}$	$69.8^{b,f}$
Maize	$64.3^{a,h}$	$778.7^{b,g}$
Soybean meal	$60.7^{a,g}$	$79.8^{b,c}$
Annual ryegrass straw	$21.0^{a,c}$	$48.5^{b,c}$
Ammoniated annual ryegrass straw	$28.1^{a,d}$	$51.1^{b,d}$

^{a,b} Means in the same column with different superscripts differ ($P<0.05$).

^{c,d,e,f,g} Means in the same column with different superscripts differ ($P<0.05$).

Table 3. In vitro cecal versus rumen organic matter digestibilities of the various feed ingredients.

Ingredient	In vitro cecal organic matter digestibility (IVCOMD, %)	In vitro rumen organic matter digestibility (IVROMD, %)
Alfalfa meal	$36.6^{a,d}$	$68.0^{b,e}$
Wheat mill run	$56.1^{a,e}$	$71.0^{b,f}$
Corn (yellow dent)	$66.4^{a,f}$	$84.2^{b,g}$
Soybean meal	$65.5^{a,f}$	$87.3^{b,h}$
Untreated annual ryegrass straw	$23.2^{a,c}$	$49.0^{b,c}$
Ammoniated annual ryegrass straw*	$35.4^{a,d}$	$53.9^{b,d}$

* Annual ryegrass straw was ammoniated by applying 4% urea, 1% raw soybean and 20% water (W/W) to the straw and kept in sealed plastic bag for three months.

^{a,b} Means in the same row with different superscripts differ ($P<.05$).

^{c,d,e,f,g,h} Means in the same column with different superscripts differ ($P<.05$).

Conclusion

In vitro cecal and rumen digestion studies could serve as useful measure of the nutritive value of feedstuffs for rabbits. In vitro rumen digestibility values were higher than in vitro cecal digestibility values. Cecal and rumen digestibilities of the feed ingredients were, in general, directly related to the cell contents (CC) and inversely related to the acid detergent fiber (ADF) contents. Cecal digestibility as percentage of rumen digestibility was similarly related to CC and ADF. The ADF and CC of feed ingredients could serve as indirect measure of their in vitro cecal or rumen digestibility potentials.

Table 4. In vitro cecal dry matter (IVCDMD) and organic matter (IVCOMD) digestibilities as percentages of in vitro rumen dry matter (IVDMD) and organic matter (IVROMD) digestibilities, respectively, of the various feed ingredients.

Ingredient	IVCDMD as Percentage of IVRDMD	IVCOMD as Percentage of IVROMD
Alfalfa meal	55.2	53.8
Wheat mill run	75.9	79.0
Corn (yellow dent)	81.7	78.9
Soybean meal	76.1	75.0
Untreated annual ryegrass straw	43.3	47.3
Ammoniated annual ryegrass straw*	55.0	65.7
Overall mean	64.5	66.6

* Annual ryegrass straw was ammoniated by applying 4% urea, 1% raw soybean and 20% water (W/W) to the straw and kept in sealed plastic bag for three months.

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