

# Nutrient Profiles, Palatability, and Intake of Various Blood Sources Fed to Vampire Bats

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## Introduction

Vampire Bats have been stereotyped centuries ago. People have been scared and frightened about these misunderstood creatures, especially when it came to their diet. The Common Vampire Bat's, *Desmodus rotundus*, diet is blood taken from other mammals. Vampire Bats, in the wild, usually inject their two incisors into a larger animal and consume that animal's blood by lapping rather than sucking. They have an anticoagulant in their saliva that prevents blood clots while feeding. Vampire Bats will drink about 40 millimeters (8 teaspoons) of blood a night, which corresponds to about 132% of its body weight (Richarz, 1993). However, captive vampire bats, like the ones at the Henry Doorly Zoo, digest blood that came from local meat packing facilities. When blood is processed, the amount of dangerous bacteria is may be high as a result of mishandling. Chaverri (2006) identified thirty different bacteria species in the stomach and intestines of wild vampire bats. In theory, this may affect the young juvenile vampire bat's life span. Unfortunately, there isn't much existing data regarding to the microbial profiles, preferences, and the nutrition of blood to captive vampire bats.

In order to determine if the captive bats would consume blood processed differently, we fed twelve common vampire bats blood that was either Freeze-Dried, after being collected from live cattle, frozen after being collected from live cattle or blood that was collected from slaughtered cattle from local meat packing facility. These blood treatments were all compared and contrasted between nutrient profiles, palatability, and their intake among the vampire bats. All three blood treatments were analyzed on dry matter, organic matter, protein and energy at Henry Doorly Zoo nutrition lab. The microbial plates and minerals were all analyzed from the local Midwest Laboratory.

## Objectives

- Determine the nutrient profiles of the blood treatments
- Determine the Palatability and intake of the blood treatments
- Determine the bacteria amount of the blood treatments



## Methods and Materials

This study was done at the Henry Doorly Zoo in the nutrition laboratory analyzing data for three different blood treatments. The Vampire Bats were cared for, monitored and fed by the Henry Doorly Zoo Jungle keeper staff with the supervision of the principal investigator.

- The study was a complete block design consisting of a six 5-day blocks for a total of 30 days
- Two diets were fed out randomly among four ice trays. (One type of blood treatment was in two ice trays, while the other blood treatment was in the other two ice trays)
- The amount of blood fed daily, was split into half. Half of the blood would be fed in the morning, and the other half would be fed in the afternoon.
- The ice trays were rotated and randomized so that the diets weren't fed in the same location
- There was an evaporative tray that determined any evaporative loss based on light, temperature, and humidity of the exhibit. Intake of blood from each tray was determined and recorded by accurate weighing of blood offered and refused daily
- The Dry Matter percentage for all of the blood treatments were achieved by the Freeze-Dried percentage 19.4%
- Crucible contained wet samples that were placed into the muffle furnace at 500°C for 24 hours. The organic matter was combusted so that the ash could be weighed back.
- Organic Material's percentage in the sample could be calculated after the ashing procedure.
- The LECO FP-528 was a machine that determined the percentage of nitrogen in a sample.
- The percentage of protein was calculated by multiplying the percentage of nitrogen by a factor of 6.25.
- Data was entered in a statistical software program called SAS (SAS Institute) in which the data was analyzed using the GLM (General Linear Models) procedure of SAS (SAS Institute).
- Microbial plating and minerals were all analyzed at the Midwest laboratory located in Omaha, NE.

Table 1. Nutrient Profile and Mineral Analysis

Sample	CB 1 (Block 1 & 2)	CB 2 (Block 1 & 2)	CB 3 (Block 3 & 4)	CB 4 (Block 3 & 4)	CB 5 (Block 5 & 6)	CB 6 (Block 3 & 6)	FB 1	FB 2	FDB 1	FDB 2
% DM (105° C)	19.84	19.75	19.15	19.04	20.02	20.08	22.58	18.28	19.4	19.4
% OM (DMB)	94.54	94.62	93.74	93.98						
% CP (DMB)	79.95	89.15	92.65	93.11	90.39	94.73	93.35	92.49	93.35	95.21
Gross Energy (cal/g) (DMB)	6,045.88	5,868.38	5,772.58	5,223.07	6,257.24	6,264.33	5,560.9	5,522.88	5,556.29	5,456.53
Sulfur (%) (DMB)	0.77	0.77	0.62	0.72	0.72	0.72	0.72	0.72	0.71	0.76
Phosphorus (%) (DMB)	0.1	0.1	0.05	0.1	0.1	0.1	0.1	0.1	0.11	0.11
Potassium (%) (DMB)	0.31	0.25	0.31	0.31	0.21	0.21	0.31	0.31	0.3	0.27
Magnesium (%) (DMB)	<1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.013	0.027
Calcium (%) (DMB)	0.26	0.05	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	0.04	0.07
Sodium (%) (DMB)	1.8	1.75	1.75	1.86	1.6	1.65	1.8	1.65	1.42	1.41
Iron (ppm) (DMB)	2,423	2,392	2,046	2,155	2,474	2,562	2,495	2,170	2,388	2,101
Manganese (ppm) (DMB)	<10	<1	<1	<1	<1	<1	5	<1	<1	7
Copper (ppm) (DMB)	5	5	5	5	5	5	10	10	5	13
Zinc (ppm) (DMB)	15	10	10	15	15	15	21	15	18	20

Table 1 presents nutrient profiles and the mineral concentrations of the three blood treatments. There was six different current blood samples, two fresh blood samples, and two freeze – dried samples during this study. The nutrient profiles that were analyzed were dry matter, organic matter, proteins, and energies. Numerically my results conclude that the nutrient profiles were similar between the blood treatments. The minerals that were analyzed in this study were: Sulfur, Phosphorus, Potassium, Magnesium, Calcium, Sodium, Iron, Manganese, Copper, and Zinc. Numerically, all these minerals are similar throughout the samples.



## Results

Table 2. Microbial Plating Analysis

Sample	CB 1 (Block 1 & 2)	CB 2 (Block 1 & 2)	CB 3 (Block 4 & 5)	CB 4 (Block 4 & 5)	CB 5 (Block 7 & 8)	CB 6 (Block 7 & 8)	FB 1	FB 2	FDB 1	FDB 2
Aerobic plate count (cfu/g) (DMB)	463.9	360.8	103.1	<10	619	928	928	206	180	3,000
E. coli (cfu/g) (DMB)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Mold Count (cfu/g) (DMB)	<10	<10	<10	<10	<10	<10	<10	<10	190	6,800
Salmonella (org/25g) (DMB)	negative	negative	negative	negative	negative	negative	negative	negative	negative	negative
Staphylococcus aureus (cfu/g) (DMB)	<10	<10	<10	<10	<10	<10	<10	<10	<10	420
Total coliforms (cfu/g) (DMB)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Yeast (cfu/g) (DMB)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Table 2 shows the microbial plating analysis for the blood treatment samples. There was, again, six samples of current blood, two samples of fresh blood, and two samples of freeze-dried blood. Table 2 shows the first trial of microbial plating done on the blood treatments. The bacteria that was analyzed in this study were: Aerobic plate count, E. coli, Mold Count, Salmonella, Staphylococcus, Total Coli Forms, and Yeast. The Aerobic Plate count is different numerically, however, the other five bacteria's were similar between the blood treatments.

## Conclusion

Based on my results, the bats consumed significantly more blood in the afternoon compared to the morning. There was no preference among the three blood treatments. Additionally, the blood treatment nutrient profiles appeared similar to one another. Prior to the start of the study, a sample of the blood offered had very high microbial plate counts. However, that batch was ignored because the blood was considered bad. There was a new analysis on the new blood obtained the day the cattle were slaughtered, and the microbial plate counts were lower and within health ranges. Although the blood is refrigerated, it is typically stored from 7 – 10 days. It is believed that the longer the blood is stored, the more microbes would be produced, resulting in the higher plate counts observed originally. In the month of March, there was a microbial plating trial analysis performed. In this trial the results concluded that every three days, the microbial count had increased drastically. The microbial counting will be monitored for further results.

Table 3. Microbial Plating Trial Analysis

Sample	Fresh Blood Day 1	Feeder Blood Day 3	Feeder Blood Day 6	Feeder Blood Day 9	Feeder Blood Day 12	Not Fed Blood Day 3	Not Fed Blood Day 6	Not Fed Blood Day 9	Not Fed Blood Day 12
Aerobic plate count (cfu/g) (DMB)	1,340	2,423	1,288,660	1,030,928	4,278,351	773	618,557	139,175,258	515,464
Salmonella (org/25g) (DMB)	negative	negative	negative	negative	negative	negative	negative	negative	negative
Staphylococcus aureus (cfu/g) (DMB)	<10	<10	<10	<10	<10	<10	<10	<10	<10
Total coliforms (cfu/g) (DMB)	<10	<10	<10	<10	<10	<10	<10	<10	<10

Table 3 shows the results of Trial 2 on microbial plating. Since the high microbial plating was an issue with the original blood sample (Trial 1), a second study was conducted to monitor the bacteria counts over time (Trial 2). One jug was fed to the vampire bats (Feeder Blood), while another jug was never opened (Not Fed Blood). Microbial plating was analyzed on both blood jugs every third day while it was stored. In the Aerobic Plate Count there is a 68.1% difference between the Feeder Blood and the Not Fed Blood on Day 3. Between the Feeder Blood, and Not Fed Blood on Day 6, there is a 95.2% difference. On Day 9 the difference between the blood is 99.3% and on Day 12 the difference between the blood is 88.1%. The bacteria, Salmonella, was negative throughout the days of the trial. Staphylococcus aureus and the total coliforms were all less than 10 through the days also.

## Impact

Before my study, there wasn't much knowledge or research about the nutritional value of blood fed to *Desmodus rotundus* and microbial profiles. My results have shown that captive vampire bats do not have a preference between the blood treatments: Current Blood, Frozen Blood, and Freeze – Dried Blood. This is beneficial because zoos all over the world can now have the chance to house vampire bats in their domain. There aren't many zoos that can house vampire bats because they don't have a meat packing facility near them. Frozen Blood and Freeze – Dried Blood are more beneficial than the Current Blood for a variety of reasons. Freeze Dried and Frozen Blood both have the same nutritional value as the Current Blood.

Total Mean (g) Consumption per Period

Period	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Avg. P-value	Min. P-value	Max P-value
AM	230.00	238.40	223.20	214.00	210.40	171.20	0.83988	0.12042 v. 6	1.00004 v. 5
PM									

This data table shows the average blood consumed per period, the average p-value, the minimum p-value, and the maximum p-value when comparing all possible period combinations.

The average p-value was 0.8399, the minimum p-value was 0.01204, which was associated with the period 2 vs. 6 combination. Although numerically the consumption was lower during period 6 compared with period 2, this difference did not reach statistical significance of having a p-value less than 0.05. Based on the statistics,

I conclude that the bats did consume similar amounts of blood during each of the treatments regardless of the blood offered to them.

## Future Research

Since Trial 1 and Trial 2 on microbial plating was performed, there will be future monitoring on the microbial plating. The future analyzing of the microbial plating will be similar with the process of Trial 2. Another future research area would be looking at the digestibility of the bloods. In a digestibility study one would analyze the nutrients in the feces and compare them to the nutrients in the diets. The difference between the fecal amounts and diet amounts would be the digestibility amounts and would determine the amount of proteins and other minerals that the vampire bats absorbed in their body. Each blood treatment would be fed out individually instead of two blood treatments at a time. Hopefully these studies will help us reach our goal of finding a diet that promotes longevity.

Time Consumption

	Consumption	Std	P-value
AM	21.3	16.3	< .0001
PM	36.1	14.8	< .0001

This table presents that there was a difference between the morning consumption and afternoon consumption of blood treatments among the vampire bats. Obviously, the afternoon had more consumption than the morning likely for two reasons. The afternoon ice trays were left out longer than the morning ice trays. In other words, the afternoon ice trays were left out from the afternoon until the next morning. Another reason why the afternoon consumption number was greater than the morning was likely because vampire bats are nocturnal; therefore they were more active during the night.

Based upon the p-values, we are 99.99% confident that there is a difference in intake due to time.