

# NUTS! WHAT TO FEED A LIPID LOVING SAKI MONKEY (*PITHECIA PITHECIA*)

*Elvira Di Nuzzo, MSc\*, Sarra Gourlie, MSc, and Beth McGregor, MSc*

<sup>1</sup>*Nutrition Science, Toronto Zoo, 361A Old Finch Ave, Toronto, ON, M1B 5K7, CAN.*

## **Abstract**

Two white-faced saki (*Pithecia pithecia*) housed at Toronto Zoo were found to not readily consume concentrate feeds. Various commercially available products and feeding approaches (soaking, hand-feeding) had been trialed over a 2-year period with limited success. The original diet as offered to the 1.1 saki was a combination of common commercial fruits and vegetables, egg, various nuts, Toronto Zoo Softbill Gelatin Diet, Mazuri Leaf-eater Primate Biscuit (5M02), and ZuPreem Primate Diet (canned). An intake analysis revealed that the diet as consumed provided 301 kcal and was below the recommended levels of iron, zinc, and Vitamin E for generic non-human primates. The intake assessment also revealed a shift in energy source from the offered carbohydrates (offered at 46.0% and consumed at 28.0%) to the available fat (offered at 39.0% and consumed at 60.0%). Thus, a trial of modified concentrate biscuits was undertaken to have the 1.1 saki consume a balanced diet by developing a readily accepted concentrate biscuit. Three versions of modified biscuits were prepared (Biscuit, A, B, and C), which consisted of ground Mazuri Leaf-eater Biscuit (5M02), almond flour, almond butter, and water. Of the 3 versions of trial biscuits, Biscuit B, including almond butter at 10%, was the most consumed by the 1.1 saki. Consumption of trial biscuits ranged from 21.7% to 44.2%. The increased consumption of biscuit B (47.0% of energy from fat as offered) compared to biscuit A (37.0% energy from fat as offered) also demonstrated a preference to source energy from fat. Additional iterations of the biscuits should be trialed to discover a more readily accepted concentrate and to determine if the shift in energy source consumption is consistent.

## **Introduction**

White-faced saki (*Pithecia pithecia*) are New World monkeys found in the northern countries of South America (Marsh *et al.*, 2021) that primarily consume seeds, nuts, capsules, and drupes, or stone fruit (Norconk, 1996). Two white-faced saki (1 male, dob: 08/31/2005 and 1 female: dob 02/03/2017, collectively referred to as 1.1 saki) housed at Toronto Zoo were found to not readily consume concentrate feeds. Various commercially available products and feeding approaches (soaking, hand-feeding) had been trialed over a 2-year period with limited success. An intake analysis in February 2023 revealed that only 56% of the offered calories (kcal) were being consumed. The diet as consumed provided 301 kcal and was below the recommended levels of iron, zinc, and Vitamin E for generic non-human primates. Thus, a trial of new Saki concentrate biscuits was undertaken to have the 1.1 saki consume a balanced diet by developing a readily accepted concentrate biscuit.

## **Materials & Methods**

The original diet as offered to the 1.1 saki was a combination of common commercial fruits and vegetables, egg, various nuts, Toronto Zoo Softbill Gelatin Diet, Mazuri Leaf-eater Primate Biscuit (5M02), and ZuPreem Primate Diet (canned; Table 1). Three versions of trial biscuits were prepared, which consisted of ground Mazuri Leaf-eater Biscuit (5M02), almond flour, almond butter, and water (Table 2). Almond butter was made by adding unroasted almonds and olive oil,

88% and 12% respectively by weight, to a Robot-Coupe mixer (Model: R702v.v.) with an “S” blade attachment and running at a high speed until the almonds achieved a creamy consistency. The resulting almond butter was stored in a labeled container at 4-5°C and used as needed. The trial biscuits were made in batches, weighing each ingredient separately, then added to the Robot-Coupe and run at a moderate speed until the resulting mixture was of a uniform consistency that was soft, solid, and easily formed into a biscuit shape. The mixture was divided into daily amounts and frozen at -16°C. The required amount was subsequently thawed between 4-5°C and offered to the 1.1 saki the following day. Diet analysis was carried out on the various forms of the diet as a whole and for each biscuit.

Each modified biscuit version was trialed for 6 to 7 consecutive days with a 7-day break between versions. The original diet was offered throughout the trial period, as noted in Table 2. Almond butter was included to make the biscuits more palatable to the 1.1 saki. Approximately 100g of biscuits were offered by hand each morning before other food items were provided. Any uneaten portion of the biscuits was left in the habitat along with the other food items and the weight of the refused biscuits was recorded the following day. Throughout the trials, unaltered Mazuri Leaf-eater Biscuit (5M02) remained part of the 1.1 saki’s diet.

## **Results**

Of the 3 versions of trial biscuits, Biscuit B, including almond butter at 10%, was the most consumed by the 1.1 saki (Table 3). Consumption of trial biscuits ranged from 21.7% to 44.2%. (Table 3). In contrast, the Mazuri Leaf-eater Biscuit (5M02) had a 100% refusal rate. Biscuit A, B, and C were 86, 117, and 148 kcal per 50g, respectively (Tables 4 and 5).

## **Discussion**

In their test of food preferences of white-faced saki housed at the Furuviik Zoo (Sweden), Martins *et al.*, (2023) found that the saki showed a preference for food items that corresponded with the food items’ energy content, with those items having a higher content of monounsaturated fatty acids being most preferred. For the 1.1 saki housed at the Toronto Zoo, an assessment of the diet as consumed compared to the diet as offered indicated a shift in energy source from the offered carbohydrates (offered at 46.0% and consumed at 28.0%; Table 4) to the available fat (offered at 39.0% and consumed at 60.0%; Table 4). The increased consumption of biscuit B (47.0% of energy from fat as offered) compared to biscuit A (37.0% energy from fat as offered) also follows this trend (Table 4). Curiously, the intake of biscuit C, which had the highest proportion of almond butter, was higher than A, yet lower than biscuit B (Table 4).

Using [NRC] (2003) as the maintenance metabolizable energy needed for moderate activity, the minimum required energy that must be provided to maintain a body weight of 2.2-2.4 kg is 252-270 kcal per day. While the energy content of the diet as offered (535 kcal/day) and consumed (301 kcal/day) are higher than required, the diet as consumed does not meet the suggested dry matter intake level of 4-5% of body weight (Table 5) as suggested in the EAZA Best Practice Guidelines for the white-faced saki monkey (van der Heuvel *et al.*, 2021). Including a readily consumed biscuit could increase the dry matter intake to the suggested level, along with balancing other required nutrients. Additional iterations of the biscuits should be trialed to discover a more readily accepted concentrate and to determine if the shift in energy source consumption is consistent.

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**Table 1.** Average daily food items offered to the 1.1 saki as part of the regular diet (without formulated biscuit).

<b>Item</b>	<b>% of Diet</b>
Fruits	34.7
Starches	18.8
Vegetables	18.8
Complete Feeds <sup>1</sup>	16.2
Egg	6.8
Nuts	4.7

<sup>1</sup>Complete feeds include Toronto Zoo Softbill gelatin, Mazuri Leaf-eater Primate Biscuit (5M02), and ZuPreem Primate Diet (canned).

**Table 2.** Formulations of the modified biscuits offered to 1.1 white-faced saki.

<b>Item</b>	<b>Biscuit A</b>	<b>Biscuit B</b>	<b>Biscuit C</b>
Mazuri Leaf-eater Biscuit (5M02), ground, %	39.0	39.0	39.0
Almond Flour, %	11.0	11.0	11.0
Almond Butter, %	00.0	10.0	20.0
Water, %	50.0	40.0	30.0

**Table 3.** Average daily intake of trial biscuits per 1.1 white-faced saki.

<b>Biscuit</b>	<b>Offered, g</b>	<b>Consumed, g</b>	<b>Intake, %</b>
Mazuri Primate Leaf-eater (5M02)	30.0	0.0	0.0
A	99.8	21.7	21.7
B	100.7	44.6	44.2
C	100.5	31.5	31.3

**Table 4.** Nutritional analysis of energy sources of the original diets and trial biscuits offered and consumed by the 1.1 white-faced saki.

<b>Item</b>	<b>Energy</b>		<b>Protein</b>		<b>Fat</b>		<b>CHO</b>	
	<b>kcal</b>	<b>kcal</b>	<b>%</b>	<b>kcal</b>	<b>%</b>	<b>kcal</b>	<b>%</b>	
<i>Original Diet</i>								
Offered	535.0	80.0	15.0	207.0	39.0	247.0	46.0	
Consumed	301.0	37.0	12.0	181.0	60.0	83.0	28.0	
<i>Biscuit A</i>								
Offered	86.0	21.0	24.0	32.0	37.0	34.0	39.0	
Consumed	15.0	4.0	26.0	4.0	29.0	7.0	45.0	
<i>Biscuit B</i>								
Offered	117.0	24.0	21.0	55.0	47.0	38.0	32.0	
Consumed	49.0	11.0	22.0	21.0	43.0	17.0	36.0	
<i>Biscuit C</i>								
Offered	148.0	27.0	18.0	79.0	53.0	42.0	28.0	
Consumed	44.0	8.0	19.0	22.0	50.0	13.0	31.0	

**Table 5.** Analyzed vitamin and mineral content of various diets and biscuits on a dry matter basis.

<b>Item</b>	<b>DM g</b>	<b>CP g/kg</b>	<b>Ca g/kg</b>	<b>P g/kg</b>	<b>Zn mg/kg</b>	<b>Fe mg/kg</b>	<b>Vitamin E mg/kg</b>
<i>Original Diet</i>							
Offered	118.0	195.0	4.0	5.0	56.0	121.0	66.0
Consumed	61.0	176.0	2.0	4.0	39.0	50.0	35.0
<i>Biscuit A</i>							
Offered	22.0	264.0	10.0	7.0	137.0	451.0	114.0
<i>Biscuit B</i>							
Offered	27.0	252.0	9.0	7.0	118.0	378.0	139.0
<i>Biscuit C</i>							
Offered	32.0	243.0	8.0	6.0	105.0	327.0	157.0
Recommendations <sup>1</sup>		150.0-220.0	8.0	6.0	100.0	100.0	100.0

<sup>1</sup>[NRC] (2003) Table 11-2.