
COMPOSITION OF GRAY SQUIRREL MILK^{1, 2}

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ABSTRACT

Milk was collected from eight female gray squirrels (*Sciurus carolinensis*) and pooled for analysis, in an effort to determine the best substitute for gray squirrel milk for pre-weaned young squirrels. The sample, about 2 cc, contained 9.0 percent protein, 12.1 percent fat, 3.0 percent lactose, 1.3 percent ash, 0.36 percent calcium, and 0.45 percent phosphorus. This analysis is similar to that reported for two samples from single specimens.

Infra-red spectroscopy was used for a portion of the analysis. This method provides a useful means of analyzing the small quantities (<0.5 ml) of milk obtainable from a variety of small mammals.

The gray squirrel is wholly dependent upon milk for about seven weeks post-partum and is not entirely weaned for another three to four weeks (Shorten, 1954, p. 127). If gray squirrels must be reared in the absence of their mother during the preweaning stage, a suitable substitute for squirrel milk must be provided for up to 2½ months postpartum.

This paper presents a partial analysis of a pooled sample of milk taken from eight female gray squirrels and compares the analysis with two published analyses

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of milk obtained from single females. The use of infra-red spectroscopy for the partial analysis of a small volume of milk from a wild rodent is also reported.

METHODS

Lactating female gray squirrels were livetrapped at intervals between 1966 and 1968 on the 1,250-acre Waterloo Experiment Station, Athens County, Ohio. Trapping sites were located in mature upland oak-hickory and mixed-mesophytic forests.

Each female was injected intermuscularly with $\frac{1}{4}$ cc of Oxytocin. After 20 minutes, the teats were stripped by hand and any expelled milk removed by eyedropper. Unfortunately, only 10 to 20 drops of milk could be obtained from each milking, and attempts to remilk females 12 to 18 hours later were not successful. Nearly 2 cc of milk were finally collected from eight females, with each female contributing a nearly equal amount of milk.

Because conventional methods of analysis for fat, carbohydrate, and protein would have consumed nearly all of the milk sample, analyses of these constituents were attempted by infra-red spectroscopy, using the principles of the infra-red milk analyzer initially developed in England (Goulden, 1964, p. 273). The analysis was made with a Beckman IR-5 double-beam scanning infra-red spectrophotometer. A 0.1-ml milk sample was placed in a calcium fluoride cell with a 0.100-cm light path, with double distilled water in a matching cell as the sample reference. Fat was determined by absorption at 5.73 microns and lactose by absorption at 9.6 microns. Fat and lactose from purified cow's milk were utilized to develop standard curves for the determination of concentration. It was assumed that the extinction coefficients of fat and lactose in cow's milk would be the same as the extinction coefficients of these constituents in gray squirrel milk. Five replicate analyses were made, which were in agreement with a standard deviation of less than ± 3.5 percent for both the lipid and carbohydrate. The samples were then recovered for use in other analyses.

An attempt was made to determine the protein content of squirrel milk by adsorption at 6.46 microns. Because of a lack of resolution of the instrument, the standard deviation was ± 11.7 percent. As a result of this wide variation between replicate analyses, attention was directed to other methods for deriving the protein content. A 0.1-ml sample of squirrel milk was diluted 1 to 10, 1 to 20, and 1 to 50 times, and the adsorption was determined in a Hytachi model No. 139 UV spectrophotometer. All quantities were measured in a 100-microliter syringe. Skim cow's milk, of varying dilutions, in which the protein was determined by the standard micro-kjedahl procedure, was utilized as a reference standard. Analysis was also made by the Lowry procedure and both methods were in good agreement.

The total solids present in duplicate 100-mg samples of gray squirrel milk were determined by drying them to a constant weight in a vacuum oven held at 80°C. These dried samples were then heated for one hour at 650°C in a muffle furnace for ash determination. Calcium and phosphorus analyses, using AOAC-approved micromethodology, required the largest samples of milk, 0.3 ml and 0.5 ml respectively.

RESULTS AND DISCUSSION

The analysis of the milk sample is shown in Table 1, along with two published analyses, presumably each from a single specimen. For comparative purposes, analyses of whole cow's milk and of evaporated cow's milk, both of which have been used to feed preweaned gray squirrels at the Waterloo Experiment Station, have also been included in Table 1.

All three samples of gray squirrel milk are similar in composition, with the exception of the higher fat content found in the sample reported by Jenness and Sloan (1970, p. 609). Each sample shows squirrel milk to be higher in protein and

fat, and somewhat lower in ash and carbohydrate than is whole cow's milk (Table 1). Gray squirrel milk is similar in composition to those of mouse (*Mus musculus*), rat (*Rattus norvegicus*), and hamster (*Mesocricetus auratus*) milks (Jenness and Sloan, 1970, p. 609). Young of each of these rodents and also of the gray squirrel are inclined to nurse on schedule rather than on demand, because the female is often absent for extended periods in search of food. The small volume of milk available per feeding and the often-disrupted feeding schedule require a milk particularly high in fat, known for its satiety value. The nestling squirrel, by ingesting a milk with a protein content of about nine percent, should double its weight by six to eight days postpartum (Blaxter 1961, p. 336). Shorten (1951, p. 448) reported weight gains of this magnitude for one captive litter reared by the mother.

TABLE 1

Average percent composition of two samples of gray squirrel milk compared with composition of whole cow's milk and of undiluted, evaporated cow's milk

Species	Total Solids	Water	Protein	Fat	Carbo- hydrate lactose	Ash	Calcium	Phosphorus	Source
Gray Squirrel	25.4	74.6	9.0	12.1	3.0	1.3	.36	.45	This study
Gray Squirrel	39.6	60.4	7.4	24.7	3.7	1.0	—	—	Jenness and Sloan, 1970, p. 609
Gray Squirrel	27.6	72.4	9.2	12.6	3.4	1.4	—	—	Ben Shaul, 1962, p. 336
Cow (whole milk)	13.8	86.2	3.8	4.4	4.9	.72	—	—	Wright <i>et al.</i> , 1939, p. 640
Cow (evaporated milk)	26.2	73.8	7.0	7.9	9.8	1.5	—	—	Silver, 1961, p. 60

We recognize that the composition of milks differs markedly between the early or colostrum stage and the stage of established lactation (Ling *et al.*, 1961, p. 231). The stage of lactation was not known for any of the eight females milked for this study, nor was it reported by either Jenness and Sloan (1970) or Ben Shaul (1962) for their milk samples. Therefore these analyses should be used only as a guide in formulating a milk substitute for preweaned gray squirrels.

Use of emission spectroscopy to analyze for minerals, coupled with infra-red spectroscopy for measuring the contents of protein, fat, and carbohydrate should provide a useful method for analyzing milk from a variety of small mammals. Although we were only able to analyze fat and carbohydrate by the infra-red method, an instrument with a better resolution could also be utilized for the simultaneous analysis for protein. The analytical technique is applicable to samples as small as 0.1 ml.

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