

## **FRUIT-FREE DIETS FOR PRIMATES**

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### **Abstract**

Paignton Zoo has been working towards fruit-free diets for primates since about 2003, when severe dental health issues in our colobus monkeys (*Colobus guereza*) triggered us to investigate sugar levels in their diet. In common with most of our primates at the time their diet consisted of a commercial primate pellet and included a high proportion of fresh and dried fruit, along with vegetables, bread and seeds. From our investigations it became apparent that orchard grown fruit, selected to be palatable to humans, contains significantly more non-structural carbohydrate (sugars) and less fibre than wild fruits consumed by free-living primates. The difference is even more extreme when comparing orchard fruits with the leaves typically consumed by folivorous primates. So we took the decision to remove fruit completely from the diets of the colobus and other Cercopithecids on the same section in order to reduce the overall sugar levels and increase fibre levels of their diets. We use the lay meaning of fruit, rather than the botanical one, as this is more readily understandable to those involved in primate feeding. However, we have also reduced the amount of some vegetables that have high sugar levels or removed them completely for the more folivorous species.

Dental health issues declined drastically and stopped completely within a year of the diet change for colobus monkeys. In other groups we saw gradual and sustained weight loss in overweight individuals whilst others in the group maintained healthy weights and we recorded improved faecal consistency and reduced incidences of diarrhoea. This encouraged us to implement fruit free diets across all primates including lorises, lemurs, callitrichids, cebids, gibbons and great apes. We have seen similar physical effects in all these other primate groups. In addition for the lemurs and callitrichids we were able to collect behavioural data. Remarkably consistent results showed reduced aggression and self-directed behaviour (used as indicator of social anxiety) when given fruit-free diets.

### **Introduction**

Although primates are traditionally regarded as relatively easy to feed, there has been growing recognition that inappropriate diets contribute to several common health problems mostly commonly obesity and GIT issues. Traditionally, many primates tend to be regarded as fruit eaters, at least to some extent, and are therefore fed fruit in captivity. This is even the case for some highly folivorous species. Unfortunately, fruit cultivated for human consumption is very different in terms of nutrient composition to leaves and wild fruits eaten by free-living primates. Selective breeding and modern cultivation methods produce fruit that is high in sugars and low in fibre, and therefore high in readily digestible energy. Cultivated fruit also tends to be lower in protein, minerals and vitamins than most foodstuffs consumed by primates in the wild. In addition to contributing to obesity, captive primate diets containing large amounts of cultivated fruit may cause gastrointestinal problems due to low fibre content and poor dental health due to high sugar levels.

Between 2003-2013 we underwent a continual process of review and improvement of diets fed to primates at Paignton Zoo Environmental Park and Newquay Zoo. These were initiated as a result of a number of different issues of concern that could be related to diet, although most of the individuals were generally healthy. The first of these, and the main trigger for diet review, was the poor dental health of several of the Abyssinian *Colobus guereza* and king *C. polykomos* colobus monkeys. Following reviews of these diets, increased awareness of potential nutritional problems, particularly obesity, stimulated keepers to instigate similar reviews of the diets for the rest of the primates across the zoos. Anecdotal reports of behavioural changes following removal of fruit also led us to investigate this in some of the species that were subject to diet reviews later in the process.

## **Methods**

All primates at Paignton Zoo Environmental Park and many at Newquay Zoo have now been included in these diet change investigations. All remained in their usual enclosures with normal husbandry with the only change being diet ingredients (Table 1). All primates are now fed a standard diet of a commercial primate pellet with vegetables (which types varies depending on natural diet) and if appropriate browse, live feeds and/or gum. Cooked wholegrain rice is provided in small quantities to encourage foraging for many species.

## **Results**

The full results related to health and behavioural effects of fruit removal from diets are detailed in published papers (Plowman, 2013; Cabana and Plowman, 2014; Britt *et al.*, 2015) but brief results are included for each species in Table 1.

Improved faecal consistency has been reported in most species, even for some species where keepers had not raised it as an issue until they saw improvements and realized what the consistency should really be in those species. For the spider monkeys (*Ateles hybridus*) faecal consistency is still looser than we would like so further review is underway.

Many overweight individuals have lost weight whilst others in the same group have maintained healthy weights without separate feeding. We assume that this is because dominant individuals are no longer motivated to eat more than their “fair share” of the diet since there are no longer any particularly sugary and highly desirable items. Two obese female orang utans have lost considerable weight since 2010 and we had two baby orang utans in 2013 – the first to be born in the zoo since 1998.

The behavioural effects of reduced aggression and self-directed behaviour are remarkably consistent across all species in which we have studied them i.e. all the lemurs and most of the callitrichids. We did not collect formal data on the behaviour of the capuchins (*Cebus xanthosternus*) but keeper notes indicate that one individual performed a pacing/head twisting stereotypy very frequently before the diet was changed. Since fruit was removed from their diets this behaviour has not been noted by keepers.

We have not noted any detrimental effects of fruit-free diets in any species.

## **Discussion**

The results of removing fruit completely from the diets of a range of primates clearly indicate to us that fruit-free diets are beneficial in terms of physical health and behaviour. The physical health effects are most likely due to reduced sugar and increased fibre levels in the overall diet. Other changes of dietary ingredients that have similar effects on those nutrient levels would probably also have similar affects. However, many of the effects on behaviour, particularly aggression and self-directed behaviour, may be more directly related to the absence of fruit rather than the nutrient content of the resulting diet. Removing a highly desirable resource, i.e. sugary, highly palatable food items, may in itself be enough to reduce motivation for aggression and other dominance behaviour in the group.

Removing fruit is an easy, practical method to achieve reduced sugar and higher fibre in primate diets. There are no nutritional benefits of fruit that cannot be acquired in other ingredients so there is no reason to maintain a small amount in the regular diet. Insisting on no fruit at all (using the lay, not botanic definition) rather than still allowing a small amount makes it much easier to prevent keeper drift and ensure the prescribed diets are followed. We only allow small amounts if it is the only way to successfully administer medication. Keepers were initially reluctant to exclude all fruit because they did not want to deprive their animals of their favourite food items, However, since seeing for themselves the health benefits that have resulted they have become zealous proponents of this strategy and are very willing to spread the message at other zoos.

## **Literature Cited**

- Britt, S., Cowlard, K., Baker, K. and Plowman, A. 2015. Aggression and self-directed behaviour of captive lemurs (*Lemur catta*, *Varecia variegata*, *V. rubra* and *Eulemur coronatus*) is reduced by feeding fruit-free diets. *J Zoo Aquarium Res* 3:52-58
- Cabana, F. and Plowman, A.B. 2014. Pygmy slow loris (*Nycticebus pygmaeus*) natural diet replication in captivity. *Endangered Species Res* 23:197-204
- Plowman, A. 2013 Diet review and change for monkeys at Paignton Zoo Environmental Park. *J Zoo Aquarium Res* 1:73-77

**Table 1.** Primate species at Paignton Zoo Environmental Park and Newquay Zoo that are fed fruit-free diets.

<b>Species</b>	<b>Group types</b>	<b>Prior health concerns</b>	<b>Effects of removal of fruit</b>
<i>Nycticebus pygmaeus</i>	Single animals Pairs	Dental condition Overweight Some abnormal behaviour	Improved dental health Gradual weight loss Reduced abnormal behaviour
<i>Lemur catta</i>	Mixed group Bachelor group	Weight management	Reduced aggression and self-directed behaviour
<i>Varecia rubra</i>	Pair	Weight management	Reduced aggression and self-directed behaviour
<i>Varecia variegata</i>	Pair	Weight management	Reduced aggression and self-directed behaviour
<i>Eulemur coronatus</i>	Pair plus young	Weight management	Reduced aggression and self-directed behaviour
<i>Callimico goeldii</i>	Family group		Reduced aggression Increased foraging and active behaviour
<i>Callithrix pygmaeus</i>	Family group		
<i>Saguinus bicolor</i>	Family group		
<i>Saguinus imperator</i>	Family group		Reduced aggression
<i>Saimiri sciureus</i>	Family group		
<i>Pithecia pithecia</i>	Family group		
<i>Cebus xanthosternus</i>	Bachelor pair	Frequent stereotypic behaviour	No stereotypic now seen
<i>Alouatta caraya</i>	Pair		
<i>Ateles hybridus</i>	Pair	Loose faeces Frequent diarrhoea	Improved faecal consistency, although more improvement needed
<i>Cercocebus torquatus</i>	Family group		
<i>Cercopithecus diana</i>	Family group	Dominant male overweight	Gradual weight loss in male
<i>Macaca nigra</i>	Large mixed group	Dominant male and females overweight Frequent diarrhoea	Gradual weight loss in all overweight individuals Improved faecal consistency
<i>Papio hamadryas</i>	Very large mixed group		Massive reduction in cost of diet for large group
<i>Mandrillus sphinx</i>	Family group	Weight management issues – some under, some over	Healthy weights in all individuals
<i>Colobus guereza</i>	Mixed group	Dental health	No dental issues within a year of change
<i>Colobus polykomos</i>	Mixed group	Dental health	No dental issues within a year of change
<i>Hylobates lar</i>	Mixed group		
<i>Hylobates muelleri</i>	Single female		
<i>Hylobates pileatus</i>	Pair		
<i>Gorilla gorilla</i>	Bachelor group	Weight management	Increased time to consume
<i>Pongo pygmaeus</i>	Mixed group, fed singly	Two females obese	Gradual weight loss First babies (2) in many years