Applied Animal Behaviour Science 116 (2009) 244–249

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

# Exploiting flavour preferences of common marmosets to increase palatability of a dry pellet diet

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ARTICLE INFO

*Article history:*
Accepted 11 September 2008
Available online 1 November 2008

*Keywords:*
Marmoset
Flavour preferences
Palatability
Diet
Nutrition

ABSTRACT

Although commercially available complete diets exist for common marmosets, the animals' consumption of these diets (available in dry pellet form) is typically very low. Increasing consumption of the pellet diet could have positive consequences for the welfare of the marmosets as the pellets are designed specifically to meet their full nutritional requirements, and therefore an increase in intake should help to ensure that they take in an appropriate balance of nutrients. We carried out a series of studies targeted towards improving the palatability, and hence increasing the intake, of a complete dry pellet diet for marmosets. In Study 1 we attempted to determine which of a wide range of flavours appeared to be preferred by the marmosets. In Study 2 we tested the marmosets' preferences for a smaller number of highly preferred flavours (as determined in Study 1) when actually added to the dry pellet diet in a series of paired preference tests. Finally, in Study 3 we tested whether adding the most highly preferred flavours (as determined in Study 2) to the dry pellet diet would in fact increase consumption of these pellets in comparison with unflavoured pellets. Despite finding strong and consistent preferences for particular flavours amongst the marmosets, we found that adding these to the pellets did not significantly increase consumption. Reasons for this are discussed, along with other potential modifications which might prove more successful in increasing consumption of pellet diets for marmosets.



## 1. Introduction

The diet of wild common marmosets, *Callithrix jacchus*, consists of plant exudates (which they obtain by gouging tree trunks, branches and vines), fruit and small prey such as insects (Rylands and de Faria, 1993). The diet of captive marmosets rarely mimics this closely, with far smaller quantities of exudates and prey items in the diet. However, complete diets designed for marmosets are available commercially, and these generally contain adequate proportions of protein, fat and fibre, as well as some vitamins and minerals, and therefore virtually meet marmosets' total nutritional requirements. In the American Zoological Association's *Callitrichid Husbandry Manual*, Crissey et al. (1999) recommend three alternative diets for captive callitrichids, the major constituent of each being commercial primate diet. The three suggested diets all also contain differing proportions of fruit, vegetables, and insects.

Ensuring that marmosets are fed an adequate diet is a serious issue, as it is clear that nutritional deficiencies can impact badly upon the animals' health and welfare. Gore et al. (2001) note that diet has been suggested to play a major role in wasting marmoset syndrome, a serious medical condition that can eventually lead to death.

Our experience suggests that intake of the complete pellet diet in marmosets can be extremely low, with most other items provided in their diet being strongly preferred to the pellets. Informal reports from other marmoset

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doi:10.1016/j.applanim.2008.09.001

keepers suggest that this may be a common problem. In the *UFAW Handbook on the Care and Management of Laboratory Animals*, Poole et al. (1999) draw attention to the problem of palatability of pelleted diets for marmosets and tamarins, and note that most laboratories provide pellets on their own first thing in the morning when the animals are hungry, in order to maximise intake.

However, to our knowledge there is only one published report of an attempt to increase the consumption of complete pellet diet in marmosets (Price et al., 1999). Price et al. (1999) presented different commercially available dry primate diets to several species of marmosets and tamarins, housed at Jersey Zoo. It was found that acceptance of the diet specifically designed for New World primates was particularly low. They also attempted to increase the palatability of the diet by using different flavourings. However, the method used involved pellets soaked overnight in water, flavoured with either honey, golden syrup or Ribena. These were not compared with an unmodified pellet condition, and consequently this study reveals little about whether flavouring can increase consumption compared to standard unflavoured dry pellets. Also, all three of the additives used in this study were extremely high in sugar, and therefore far from ideal as everyday modifications to an otherwise nutritionally balanced diet.

A more exhaustive test of the palatability of different flavours when added to a dry complete diet was carried out by Goodwin et al. (2005) with horses. A similar problem apparently exists in stabled horses, in that their intake of complete pellet diets may often be lower than is ideal. Goodwin et al. (2005) aimed, like ourselves, to increase the palatability and therefore the consumption of a complete pellet diet. This study therefore provided a useful model for our own research. They initially compared a total of 15 flavours. These were added to the pellet diet and each was presented separately to the horses. Mean consumption times were then compared in order to determine which of these was most preferred. The eight flavours with the fastest mean consumption times were then presented to the horses in a series of paired preference tests, in which a horse's relative preference for one flavour over another could be readily determined. Having found that the two most highly preferred flavours were banana and fenugreek, trials were then run during which horses were fed solely on unflavoured, banana-flavoured, or fenugreek-flavoured pellet diet for several consecutive days, and the consumption rates were compared. The addition of both banana and fenugreek flavouring to the pellet diet increased the rate of consumption. The horses took nearly four times as long to consume their unflavoured diet as they did to consume the flavoured diets.

Following Goodwin et al. (2005), we planned to first test the marmosets' consumption rates for a wide range of different flavours, all of which we believed to be acceptable to them based on our informal knowledge of their dietary choices. We could then use these preferences to design paired preference tests involving most highly preferred flavours, when added to the pellet diet. Finally, using the two most highly preferred flavours from that study, we could investigate to what extent these increased consumption of the pellet diet.

## 2. Methods

### 2.1. Study animals

Twenty-four marmosets were identified as study animals for this project. All were pair-housed (the sample therefore consists of 12 pairs). Ten were non-breeding pairs, and two were unrelated male–female pairs (and therefore potential breeders). The non-breeding pairs were either same-sex pairs (female–female $n = 7$, male–male $n = 2$), or consisted of a father and daughter ($n = 1$). One of the female–female pairs had to be separated during the project, and thus these two marmosets were individually housed for part of the time. However for the purposes of analysing results we continued to treat them as a pair. Neither of the females from the unrelated male–female pairs were pregnant when the project began, but one of the females was pregnant by the time the project ended. All were housed at the Medical Research Council Human Reproductive Sciences Unit, and none were concurrently involved in any other studies. Each pair was housed in a cage which measured 55 cm × 120 cm × 230 cm high, equipped with branches, ropes and platforms. Every stage of the study was conducted in the home cage of the respective individuals taking part in the study.

All marmosets were fed on the standard colony diet of commercially available marmoset pellets, fruit, and protein and vitamin supplements, with water available ad libitum. Pellets were provided separately, but the rest of the food was provided freshly once a day. Feeding time was usually between 12 noon and 1 p.m. on weekdays, although the timing was more variable on weekends. On Mondays, Wednesdays and Fridays, the daily feed consisted of apples, oranges, pears, tomatoes, bananas and grapes, plus a blended mixture consisting of the following ingredients: unflavoured natural yoghurt, vitamin supplements: water soluble D3 supplied by Woodstock Enterprises, commercial meal replacement designed for human consumption (''Complan'', manufactured by Complan Foods Ltd.), a high protein nutritional supplement also designed for human consumption (''Casilan 90'', manufactured by Complan Foods Ltd.), and baby rice, manufactured by Cow & Gate). On Tuesdays and Thursdays, the feed consisted of the same fresh fruit, plus (instead of the blended mixture) peanuts, raisins and dates. On Saturdays and Sundays, the feed consisted of peanuts, raisins and dates plus apples, oranges, bananas and grapes. The pellets were provided separately in a dish mounted on the bars of the cage. Around 90 g of Harlan Teklad pellets was provided, and the dish was refilled every 3 days. Prior to the start of the project we carried out pilot work to establish typical daily intake of pellets, so that we could judge how much to provide during studies involving flavoured pellets. The marmoset pairs typically consumed between 6 and 10 g of pellets per day. The average daily consumption per pair was approximately 8 g. Therefore the daily consumption per individual marmoset was approximately 4 g of pellets.

### 2.2. Study 1—determining preferred flavours

The aim of Study 1 was to determine, experimentally, which flavours are particularly preferred by the marmosets. We tested a total of 12 different flavours. In this study we tested preference using small quantities of flavoured sweets, as we expected these to be highly preferred foods for the marmosets, and therefore this would provide us with rapid measures of relative preference for the different flavours.

#### 2.2.1. Study 1 materials

We used ''Jelly Belly'' jelly bean sweets, manufactured by the Jelly Belly Candy Co., which are available in 50 different flavours. The 12 flavours which we used were: vanilla, banana, orange, mango, apple, grape, lemon, watermelon, peach, peanut butter, marshmallow and pineapple. Based on our informal knowledge of the marmosets' diet choices, we expected all of these flavours to be acceptable to the marmosets. Furthermore, we knew that it was possible to source corresponding food additives in these 12 flavours which could be used to modify pellets in later stages of the project. The 12 varieties of jelly bean were different colours as well as different flavours (vanilla—white; banana—yellow and brown; orange—orange; mango—yellow and green; apple—green; grape—dark purple; lemon—yellow; watermelon—dark green; peach—orange and red; peanut butter—light brown; marshmallow—white and brown; pineapple—yellow). We will return to this point in Section 4.

#### 2.2.2. Study 1 procedure

Data collection was carried out on weekdays, for 4 days a week for a total of 3 weeks, giving a total of 12 test days. The marmosets were fed

their usual diet (detailed in Section 2.1) as normal, between 12 noon and 1 p.m. on the test days. On each of the 12 test days, each of the 12 study pairs received three presentations. Thus each pair was presented with each flavour of jelly bean on a total of three occasions throughout Study 1 (once per week). Testing was carried out throughout the day, since it took up virtually all of one working day to test all 12 pairs of marmosets three times over. Order effects were balanced using a Latin Square design. The jelly beans were first rinsed in warm water, to remove the hard outer shell. This reduced the sugar content and fully released the flavour and odour of the sweet. Each jelly bean 'inner' was then quartered, using a sterile surgical blade. Each presentation, during the study, consisted of 16 jelly bean quarters (approximately 2.6 g) evenly distributed on the base of a 100 mm diameter polystyrene tissue culture dish. The dish was secured to the base of the marmosets' home cage using velcro pads. On each presentation the experimenter (CW) introduced the dish into the home cage, and the study pair were observed for the following 7 min. The time at which the marmosets started and finished eating was noted, as was the number of jelly bean quarters remaining, if any, at the end of the observation period. This was used to calculate a rate of consumption for each presentation (weight of jelly beans consumed/elapsed time). The jelly beans were often completely consumed well before the 7 min time limit was up (sometimes under a minute) making these consumption rates extremely high.

### 2.3. Study 2—relative preference for different flavours when added to pellet diet

The six most preferred flavours, as determined in Study 1, were used to flavour Harlan Teklad pellets during the 3 weeks of Study 2. These flavoured pellets were to be fed to the marmosets in the same way that their regular pellets would be (i.e. introduced to the home cage daily, and left overnight, with any remains removed the following day). Pairs of flavours were to be presented together in this study, to provide a more sensitive measure of preference. Concentrated flavourings, designed to be used as additives in food for humans, were sourced from LorAnn Oils (http://www.lorannoils.com). Six flavours were obtained, corresponding to the six most preferred jelly bean flavours.

#### 2.3.1. Study 2 pellet flavouring technique

The technique of flavouring the pellets was refined in response to taste and odour tests by the authors. Sixty gram batches of dry pellets were sprayed with a solution of 3 ml flavouring in 10 ml water. The pellets were placed in a stainless steel dish and were shaken, between sprays, to ensure an even coating of the flavour solution. To dry the pellets off again, they were heated in an incubator (a Gallenkamp hotbox oven with fan, size 3) at 60 °C for 2 h, in 60 g batches spread over a standard sized oven tray lined with aluminium foil. Each day's pellets were prepared the preceding day and kept sealed in aluminium foil until required.

#### 2.3.2. Study 2 procedure

Data collection was carried out every weekday for a 3-week period, immediately following Study 1. Every possible pair of flavours was presented to each of the 12 pairs of marmosets. There are a total of 15 paired combinations of the six flavours and each was presented on a different day over the 15 test days of Study 2. The different paired combinations were ordered such that presentations of the same flavour were separated by a minimum of 1 day. During the study, the marmosets were fed their usual diet, but instead of the unflavoured pellets, they were presented with two 20 g samples of flavoured pellets. The two samples were introduced to the marmosets' home cages at the beginning of the day and were removed and weighed the following morning. Any pellets on the floor of each cage were collected, divided into flavour by odour testing, and weighed. Flavour preferences for each presentation could therefore be calculated as ratios (following Goodwin et al., 2005): Intake A (g)/[Intake A (g) + Intake B (g)]. Flavour preference was therefore expressed as a ratio from 0 (rejection) to 1 (exclusive consumption).

### 2.4. Study 3—increasing acceptance of pellet diet

The two most preferred flavours, as determined in Study 2, were selected to be added to the Harlan Teklad pellets. The consumption of these pellets was to be compared with consumption of non-flavoured pellets, when each was fed consistently over a longer term (1 week). This would enable us to determine whether, under normal feeding conditions (where the same type of pellet would typically be fed for several days in a row), flavouring the pellets could increase regular consumption.

#### 2.4.1. Study 3 procedure

Study 3 began 3 weeks after Study 2 had ended. As in the previous studies, data collection was carried out on weekdays only. There was also a 2-week break in data collection over Christmas and New Year, between the first and second weeks of this study. Pellets were flavoured in a process identical to that used in Study 2, i.e. sprayed with a solution of 10 ml water to 3 ml flavouring and heated in an incubator for 120 min at 60 °C. Control pellets were sprayed with 13 ml water and otherwise treated in an identical way. Each pair of study marmosets was presented with banana-flavoured pellets, marshmallow-flavoured pellets and control, unflavoured, pellets for 5 days at a time. The order in which they received these pellets was counterbalanced and the starting flavour for each pair was determined randomly. A dish containing 40 g of pellets was introduced to the home cage of each pair of marmosets at the beginning of the day preceding the data collection day. On the following morning, the remaining pellets were removed and weighed. Any pellets on the floor of each cage were collected and weighed. From these data it was possible to determine how much pellet diet was being consumed by each study pair each day.

## 3. Results

### 3.1. Study 1—determining preferred flavours

Fig. 1 displays the mean consumption rate data for the marmoset pairs. A 12 × 3 two-way repeated measures ANOVA was used to determine whether the differences in consumption rate between different flavours, and between

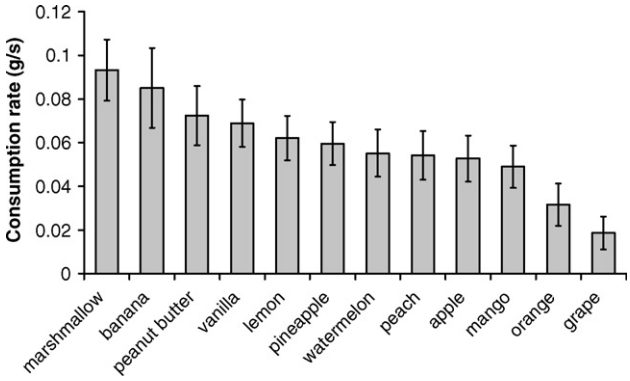


**Fig. 1.** Mean consumption rates (±S.E.) of each flavour of jelly bean for all marmoset pairs ($n$ = 12).

weeks, were statistically significant. The ANOVA showed no significant main effect of week ($F_{2,4} = 1.962$, $p = 0.255$, non-significant). There was a main effect of flavour, so some flavours were significantly more preferred than others ($F_{11,22} = 5.695$, $p < 0.001$). There was no interaction between flavour and week ($F_{22,44} = 0.921$, $p = 0.571$, non-significant). The overall order of preference can be seen in Fig. 1. Overall, the results of Study 1 showed that the marmosets displayed clear and consistent preferences for certain flavours over others. Of the flavours that we tested in this study, marshmallow was the most preferred, and grape the least preferred. The colour of the jelly beans appeared to be unrelated to their relative preference, as some very similar coloured beans were consumed at very different rates (e.g. banana, which was yellow with brown flecks, and mango, which was yellow with green flecks). This will be discussed further in Section 4.

We also used these data to determine whether there were consistent individual differences in preferences for particular flavours. In order to test the stability of the preferences of specific pairs of marmosets over time, and also the level of agreement (or disagreement) in preference between the different pairs, we calculated Cronbach's alpha. It was clear that there was a fairly high level of agreement between the 12 marmoset pairs in terms of their preferences. Cronbach's alpha was calculated to be 0.893 ($N = 12$), which indicates a very high level of agreement. This suggested that there was not a huge amount of variation in preference between different pairs. However, to investigate this further, we also calculated Cronbach's alpha for particular pairs over the three different presentations to determine how consistent their preferences were. The values calculated for each of the pairs were (in descending order): 0.810; 0.768; 0.737; 0.730; 0.687; 0.675; 0.596; 0.578; 0.555; 0.458; 0.353; −0.032 ($N = 3$ for all). Although these values are all (to differing degrees) lower than that for the agreement *between* the 12 pairs, this is probably accounted for by the lower number of measurements being correlated ($N$ of 3, as opposed to 12) and therefore greater error. Also, it is worth mentioning that the one pair for whom alpha was less than zero were the pair which showed most neophobia towards the jelly beans (only sampling two of the 12 flavours in the first week, despite eating all of them in the final week) so it is perhaps not surprising that their preferences by week do not show any agreement. Overall, therefore, it appeared that particular pairs' preferences were relatively stable over time. However, since the pairs' preferences were also highly correlated with one another, it seems that these stable individual preferences are probably not a major source of variation within the data.

### 3.2. Study 2—relative preference for different flavours when added to pellet diet

Due to the fact that the marmosets dropped some of the pellets onto the floor of their home cage, sometimes it was not possible to determine with absolute precision how much of each flavour had been consumed, as (unlike the pellets left in their original dishes) it was very difficult to determine the flavour of the dropped pellets. We used two methods of dealing with this. The first involved simply taking the weight remaining in the dish for both flavours (this would tend to give overestimates of the quantities consumed in terms of the absolute weight, but the preference ratios would not be inflated by this). The only potential problem with this method would have been if there was a bias towards picking up (but then discarding, rather than eating) certain flavours of pellet but not others. The other method therefore involved examining each dropped pellet and attempting to determine (usually by odour) which flavour it was. However this method was probably somewhat imprecise.

Once all of the data were collated, it was possible to look for discrepancies and irregularities in both methods. Both methods returned similar overall results. In particular the same rank order of flavour was identified, which was the most important result from the point of view of our progressing onto Study 3. The results we report here are based on the method of simply taking the weight of the pellets remaining in the dish.

The mean intake ratio was calculated for every pair of flavours, and these are reported in Table 1. It should be noted that this table contains what should be considered as duplicate data, in that the intake ratio for Flavour A when paired with Flavour B is exactly equal to one minus the intake ratio for Flavour B when paired with Flavour A. However, the results have been presented in this way so that it is possible to see, for each flavour, the mean intake ratio when compared against all five other flavours. For every pair of flavours, the intake ratio was tested against a chance ratio of 0.5 using a one-sample $t$-test. The results of

**Table 1**
Intake ratios as determined by paired preference tests (Study 2).

| | Preference for flavour (columns) | | | | | |
|---|---|---|---|---|---|---|
| | Marshmallow | Banana | Peanut butter | Vanilla | Lemon | Pineapple |
| When paired with (rows) | | | | | | |
| Marshmallow | | 0.51 | 0.51 | 0.61 | 0.32 | 0.24 |
| Banana | 0.49 | | 0.58 | 0.45 | 0.36 | 0.35 |
| Peanut butter | 0.49 | 0.42 | | 0.48 | 0.43 | 0.55 |
| Vanilla | 0.39 | 0.55 | 0.52 | | 0.60 | 0.35 |
| Lemon | 0.68 | 0.64 | 0.57 | 0.40 | | 0.55 |
| Pineapple | 0.76 | 0.65 | 0.45 | 0.65 | 0.45 | |
| Mean preference for flavour | 0.56 | 0.56 | 0.53 | 0.52 | 0.43 | 0.41 |

Ratios were calculated as: Intake A (g)/[Intake A (g) + Intake B (g)] to produce ratios ranging from 0 (rejection) to 1 (exclusive consumption).

**Table 2**
Results of one-sample *t*-test on the intake ratios reported in Table 1 (tested against a chance ratio of 0.5).

| | Preference for flavour (columns) | | | | |
|---|---|---|---|---|---|
| | Marshmallow | Banana | Peanut butter | Vanilla | Lemon |
| When paired with (rows) | | | | | |
| Marshmallow | | | | | |
| Banana | NS | | | | |
| Peanut butter | NS | NS | | | |
| Vanilla | NS | NS | NS | | |
| Lemon | $p = 0.001$ | Trend $p = 0.075$ | NS | NS | |
| Pineapple | $p < 0.001$ | $p = 0.004$ | NS | $p = 0.030$ | NS |

The order of preference (as determined by the number of wins and losses for a particular flavour) was: marshmallow (most preferred—two wins and no losses), banana, vanilla, peanut butter, lemon, pineapple (least preferred—three losses and no wins).

these tests are reported in Table 2 (Table 2 omits the duplicated data, so where a significant win is reported for Flavour A when compared with Flavour B, this obviously also denotes a significant loss for Flavour B). It was found that marshmallow was significantly preferred to both lemon ($t = 4.383$, d.f. = 11, $p = 0.001$) and pineapple ($t = 7.238$, d.f. = 11, $p < 0.001$). Banana was also significantly preferred to pineapple ($t = 3.581$, d.f. = 11, $p = 0.004$), with a trend towards preference over lemon ($t = 1.970$, d.f. = 11, $p = 0.075$). Vanilla was also significantly preferred over pineapple ($t = 2.495$, d.f. = 11, $p = 0.030$). Based on these wins and losses, the rank order of flavours was found to be: marshmallow (most preferred), banana, vanilla, peanut butter, lemon, pineapple (least preferred). This is identical to the order of preference as determined in Study 1 using the jelly beans, with the exception of the switch between vanilla and peanut butter in third and fourth places. Using the mean preference ratios (as reported in Table 1), rather than the wins and losses, the order of preference is in fact exactly the same as that found in Study 1. Most importantly, however, for the purposes of progressing to Study 3, the two most preferred flavours were clearly marshmallow and banana.

### 3.3. Study 3—increasing acceptance of pellet diet

For each pair, the mean daily consumption was calculated for every flavour. These means were then used for statistical analysis. Fig. 2 displays daily consumption of each pellet flavour. The mean daily consumption of the unflavoured pellets was slightly higher than that of the flavoured pellets. A one-way repeated measures ANOVA was used to determine whether certain flavours were consumed significantly more than others. This analysis revealed that the difference in the consumption of the different flavoured pellets was not statistically significant ($F_{2,22} = 2.002$, $p = 0.159$, non-significant). Overall, the results of Study 3 showed that adding the most preferred flavourings, marshmallow and banana, to the pellets, did not increase consumption.

## 4. Discussion

In Study 1 we presented the marmosets with samples of 12 differently flavoured jelly beans. We clearly showed that certain flavours were significantly and consistently preferred over others. Although the different colours of the jelly beans in Study 1 could have affected the results, the order of preference appeared to be unrelated to colour. Furthermore, the findings from Study 2 were highly consistent with those from Study 1, suggesting Study 1 had indeed provided a useful indication of flavour preferences. In Study 2 we added the most highly preferred of the 12 flavours (the top six) to primate pellets and fed them to the marmosets in place of their usual pellets in paired preference tests. Again we found clear and consistent flavour preferences. In Study 3 we took the two most highly preferred flavours, marshmallow and banana, and again added these to the primate pellets, and

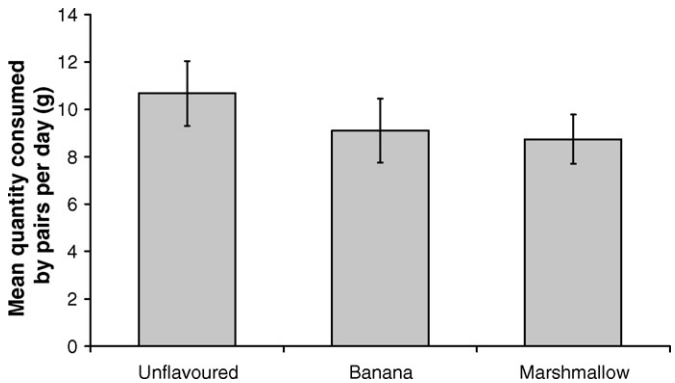


**Fig. 2.** Mean (±S.E.) daily consumption of the three different pellets – unflavoured, banana flavoured, and marshmallow flavoured – presented to the marmoset pairs ($n = 12$).

compared consumption of these (again simply given in place of the usual pellets) with consumption of unflavoured pellets. However, we found that flavouring the pellets did not significantly increase consumption.

It is surprising that, given the extensive tests of flavour preference leading up to Study 3, we did not find increased consumption of the flavoured pellets compared with the unflavoured pellets. It should be noted that the quantities of pellets consumed in Study 3 were also very much in line with the baseline data that we collected on consumption of untreated pellets prior to the beginning of the project (reported in Section 2.1). This suggests that simply adding pure flavourings to pellets is not likely to be sufficient to significantly increase consumption. We are confident that the flavours of banana and marshmallow are strongly preferred by the marmosets, based on the findings from Studies 1 and 2, and we think it is unlikely therefore that it is simply the case that we made poor choices of flavours for making the comparison with the unflavoured pellets.

It may be the case however that flavourings such as those we used (i.e. food additives which do not alter the calorific or nutritional value of the pellet) may not greatly improve the flavour of the pellet in the absence of other (nutritional) additives such as sugar. Altering the nutritional composition of the pellets is clearly undesirable as they have been specifically designed to meet a marmoset's nutritional needs. However, if pellet consumption was increased by the addition of such substances then it is conceivably something worth considering.

### 4.1. Avenues for future research

As mentioned above, it would be interesting to investigate how the addition of calorific substances, particularly sugar, affected the intake of primate pellets. The additional calories might cause marmosets to actually consume less of the pellets themselves, as the sweetened pellets would be higher in energy. This would clearly be undesirable since we would expect it to further decrease the intake of other essential nutrients, whose concentration had already been decreased by the addition of sugar. However, if the sweetening the pellets made them sufficiently palatable to increase consumption, irrespective of the extra calories contained in the sweetening substance, then this might be worth considering in revising standard recipes. It would also be possible to investigate the effects of flavouring pellets with low calorie sweeteners such as aspartame and saccharin, and comparing the consumption of these with pellets flavoured with sugar. However, it should be noted that artificial sweeteners have been linked with health problems in some animal studies, and therefore these may not be considered appropriate additives to laboratory diets (e.g. see review in Kroger et al., 2006).

There is also a possibility that altering the texture of pellets may significantly affect consumption. As noted in the introduction, marmosets' natural diet consists largely of tree exudates, and their teeth are specialised for gouging wounds in plants to access these. Furthermore, informal reports suggest that chewy foods tend to be highly preferred by these animals (e.g. from our own personal observations we find marshmallows are the most highly preferred food that we can identify). It would be interesting to carry out research into the effects of texture on pellet consumption. Many marmoset keepers soak primate pellets prior to feeding, as it is believed that this increases the consumption rate compared with the dry pellets. It would be useful to quantify this, and to compare it with other textures.

Research into topics such as these, which extend our understanding of marmosets' food preferences, may in future allow us to generate pellets which are significantly more palatable, and which can therefore improve the nutritional balance of the overall diet consumed by captive common marmosets.

## 5. Conclusion

We identified clear and consistent flavour preferences in common marmosets, based on a test of consumption rates using jelly beans (Study 1), as well as a paired preference test using flavoured primate pellets (Study 2). However, we found that adding the most highly preferred flavours to primate pellets did not significantly increase consumption compared to a control condition of unflavoured pellets (Study 3). Further study is required to identify effective methods of increasing marmosets' consumption of pellet diets.

## Acknowledgements

This research was supported by a grant from Harlan Teklad to KDM. We are grateful to Graham Tobin and Hannah Buchanan-Smith for comments on an earlier draft of this work.

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