

Original Article

Types of fruits and vegetables used in commercial baby foods and their contribution to sugar content

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Abstract

Fruits and vegetables (F&V) are often featured in names of commercial baby foods (CBFs). We aimed to survey all available CBFs in the UK market with F&V included in the food name in order to describe the amount and types of F&V used in CBF and their contribution to total sugar content. Food labels were used to identify F&V and total sugar content. Fruits were more common than vegetables in names of the 329 CBFs identified. The six most common F&V in the names were all relatively sweet: apple, banana, tomato, mango, carrot and sweet potato. The percentage of F&V in the foods ranged from a median of 94% for sweet-spoonable to 13% for dry-savoury products. Fruit content of sweet foods ($n = 177$) was higher than vegetable content of savoury foods ($n = 152$) with a median (IQR) of 64.0 g/100 g (33.0–100.0) vs. 46.0 g/100 g (33–56.7). Fruit juice was added to 18% of products. The proportion of F&V in CBF correlated significantly with sugar content for all the food types except dry-savoury food (sweet-spoonable $r = 0.24$, $P = 0.006$; savoury-spoonable $r = 0.65$, $P < 0.001$; sweet-dry $r = 0.81$, $P < 0.001$; savoury-dry $r = 0.51$, $P = 0.06$) and explained up to two-thirds of the variation in sugar content. The F&V content of CBFs mainly consists of fruits and relatively sweet vegetables which are unlikely to encourage preferences for bitter-tasting vegetables or other non-sweet foods. F&V contribute significantly to the total sugar content, particularly of savoury foods.

Keywords: complementary foods, processed baby foods, fruit sugars.

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Introduction

Low vegetable consumption in children is a public health concern. The health benefits of fruit and vegetable (F&V) consumption, from childhood onwards, are well recognised (WHO/FAO 2003). However, children tend to consume few vegetables (Organisation for Economic Cooperation and Development 2012; Gubbels *et al.* 2014). One barrier to early vegetable intake may be bitter taste (Mennella 2014). Infants usually accept new foods

and tastes well (Nicklaus 2009), if vegetable tastes are introduced early they can be well accepted (Caton *et al.* 2014), and this early experience influences food preference later in childhood (Schwartz *et al.* 2011; Mennella 2014). This is one reason why complementary feeding advice encourages the use of F&V as first foods (NHS 2012; NHS Health Scotland 2014).

In Western countries, commercial baby foods (CBFs) are widely used to introduce babies to complementary food (Siega-Riz *et al.* 2010; Foterek *et al.*

2014). In the UK, the infant feeding survey in 2010 found that two-thirds of mothers gave a CBF as a first solid food (mainly baby rice and ready-made baby food) while 45% of mothers of 8–10-month-old babies use them at least once per day (McArthur *et al.* 2012). Similarly, the 2011 UK Diet and Nutrition Survey in Infants and Young Children found that 58% of 4–18-month-old children on solids had eaten a commercial baby or toddler meal over the 4-day survey period (Lennox *et al.* 2013). CBFs commonly list F&V as ingredients (Garcia *et al.* 2013), yet a recent longitudinal study found that higher use of CBF was associated with lower intake of F&V in infancy which persisted into school age for boys (Foterek *et al.* 2015). This may be because the range and amount of F&V used was low, as already described in the United States and Germany (Siega-Riz *et al.* 2010; Mesch *et al.* 2014). Still the variety and amounts of F&V used in the formulation of CBF have not been clearly explored.

In contrast to bitter tastes, infants have an innate preference for sweet foods (Cowart 1981). Current complementary feeding advice discourages the use of added sugars to baby food in order to establish lower thresholds for sweet tastes (NHS 2012). Additionally, there are strict regulations on the amounts and types of sugars used in baby food manufacturing (European Commission 2006). It has been shown that sweet products dominate the UK CBF market and that 80% of these products listed fruit in their titles (Garcia *et al.* 2013). However, that analysis did not gather information on the exact F&V content and thus the extent to which F&V contributed to the nutritional quality of the foods. We thus aimed to conduct a new survey to describe the type and amount of F&V used

in CBF in the UK and how this related to total sugars content.

Methods

Data collection

A database was created using information from the food labels of CBF which were defined as food lines marketed for complementary feeding, predominantly for infants under 1 year. The baby foods surveyed were all the products of seven large baby food companies in the UK market: Organix, Hipp Organic, Heinz, Ella's Kitchen, Cow and Gate, Boots, and Plum Baby. All foods that contained individual fruits or vegetables in the name of the product (e.g. 'banana dessert') or the term 'fruit' or 'vegetable' (e.g. 'vegetable casserole') were identified and food label information obtained, mostly through the manufacturer's website. If the information was not available, supermarket websites (Tesco and Ocado) or labels in store were used. Fruit juices, smoothies and other drinks were excluded from the study. The products were packaged in jars, pouches, sachets, boxes, bags and flow wrap. All data were collected in May 2013. We did not aim in this paper to record all baby foods, because our focus was on F&B content. From a previous study, we can infer that two-thirds (~66%) of the total baby foods contained fruits, vegetables or both in their names (Garcia *et al.* 2013).

The variables entered in the database followed a similar protocol to a previous publication (Garcia *et al.* 2013). The variables entered included: brand, name of product, recommended age, food type (these were *wet*, which included spoonable, pureed foods which will be referred to as 'spoonable' foods in the

Key messages

- Fruits are featured more than vegetables in the names of commercial baby foods.
- Sweet-tasting vegetables such as carrot and sweet potato are used more frequently in the formulation of commercial baby foods, compared with those with a bitter taste.
- Total sugar content is positively correlated with fruit and vegetable content in commercial baby foods, particularly in spoonable foods (6.8 g sugar/100 g), suggesting that they may be used as sweetening agents.
- Commercial baby foods lack a variety of vegetables that will promote development of bitter tastes.

text and *dry* which included biscuits, dry breakfast cereals, rusks and dry finger food such as baby snacks) and number of ingredients.

From the food name, the first three F&V listed were recorded for each product in order of appearance. From the ingredients list, the form of the fruit or vegetable was recorded (fresh/dried/powder/oil/juice), g/100 g of each F&V, total grams of fruit and/or vegetable per 100 g, whether the food had mixed F&V content, total juice content per 100 g, number of different juices, if fruit juice was clearly labelled this was then considered as a fruit and recorded alone, but also added to a variable which included the total amount of fruits and/or vegetables g/100 g (including juice). For many ingredients, it was not possible to know individual fruit or vegetable content as it was not clearly stated; e.g. 'vegetable 35% (sweet potato 18%, butternut squash, courgette)', in this case mixed vegetables was recorded. Similarly, when a combination of fruits without exact weight contribution was found, the recorded variable was mixed fruits. Potato alone was not considered as a vegetable in this study; however, in some cases the potato content could not be discriminated from the vegetable ingredients. For example, 'vegetable 49% (potato, parsnip, carrot, swede, broccoli)', these products were listed as mixed vegetables. The products that listed potatoes in the list of vegetable ingredients were 25 (7%). Tomatoes were considered as vegetables because of their predominant use as part of savoury dishes.

Products were classified as sweet or savoury based on the product's name. Sweet products were those that only contained fruits or contained the words 'pudding', 'crumble', 'dessert' or 'cake' in the name. There were a few products that could not be easily classified due to a mix of F&V; for this we looked at the major (>50%) ingredients. If these were fruits then the product was classified as sweet. All meat, chicken, fish, cheese, vegetable and carbohydrate-based dishes (e.g. pasta, rice, potato based) were classified as savoury. If the product was meat based, but also contained a fruit in the name (e.g. 'Pork and Apple' or 'Fruity Chicken'), the product was classified as savoury.

For nutritional information energy, protein, fat and carbohydrate contents were recorded. In addition, total sugar content (independent from total carbohydrate content) was also recorded exactly as reported in the label. According to the European Safe Authority, total sugars are 'both indigenous (sugars naturally present in foods such as fruit, vegetables, cereals and lactose in milk products) and added sugars' (European Food Safety Authority 2009). 'Added sugars' refers to sucrose, fructose, glucose, starch hydrolysates (glucose syrup, high-fructose syrup, isoglucose) and other isolated sugar preparations used as such, or added during food preparation and manufacturing (European Food Safety Authority 2010). 'Relatively sweet' vegetables were those which contained >4 g of sugar/100 g such as tomatoes (4.4 g), carrots (4.7 g), parsnips (4.8 g), peas (5.6 g) and sweet potato (6.5 g), while non-sweet vegetables were those containing <4 g of sugar such as broccoli (1.7 g), cauliflower (3.1 g) and spinach (0.42 g) (USDA 2015).

Statistical analysis

All statistical analyses were done using SPSS data software (version 19, SPSS, Chicago, IL, USA). The association between F&V and sugar content was explored using linear regression separately for sweet-spoonable, savoury-spoonable, sweet-dry and savoury-dry foods because of widely varying average sugar contents in each group.

Results

General characteristics and nutritional content

There were 329 baby food products labelled as containing fruits or vegetables or both in the name. The majority of products were wet, spoonable foods (83.4%) followed by dry finger foods (10.6%) and dry baby breakfast cereals/powdered food (5.8%). The amount of foods recommended at age 4+ months was 157 (47.7%), followed by 97 foods at age 6–7+ months (29.5%), 29 foods at age 9–10+ months (8.8%) and 46 foods at age 12+ months (14%). Overall, just over half of the food names suggested a sweet taste ($n = 177$,

53.8%; Table 1). Sweet foods were commonest in the age group 4+ months. Dry finger foods were mainly sweet ($n = 40$, 74%) and, as expected, targeted mainly to age 6–7 months (33%) and 12+ months (40%). The nutritional content of CBF is shown in Table 2.

F&V content and association with sugar content

Fruits were more commonly featured in the names of CBF than vegetables ($n = 198$, 60% vs. $n = 155$, 47%), while 7% ($n = 24$) featured both. Foods targeted to age group 4+ months were mostly fruit based ($n = 118$, 75%). The types of F&V most used in names of CBF are shown in Table 3 and were relatively sweet. The most common first named F&V single ingredient was apple followed by banana, tomato, mango, carrot and sweet potato. Mixed vegetables usually labelled as ‘vegetables’ and mixed fruits labelled as ‘fruit or fruity’ were reported in a large number of products. The median number of F&V (including juice) described in the ingredient list was 3 (minimum of 1 and a maximum of 11).

The F&V contents of the most common F&V used in the names and reported in the ingredient list are

shown in Table 4. Apple was the most frequent fruit used as an ingredient and also had the highest median content. Carrot was the most frequently used vegetable but was second in median content contribution after tomato. Mixed vegetables were widely used in CBF and represent the highest median content. Mixed fruits were also a common ingredient with a median content in the top four ingredients. There was also a median of 15 g/100 g added fruit juice in 59 (18%) products. The proportion of F&V in each food varied from as low as 3% up to 100%, and because of these large variations the median values are shown according to types of foods (Fig. 1A,B). F&V content of spoonable foods was high for sweet foods, with F&V making up a median of 94% for sweet-spoonable and 50% for savoury-spoonable. Sweet-dry products had a lower median content of 34%, with 13% for savoury-dry. The proportion of F&V in the food correlated significantly with sugar content for all the food types except savoury solid food (sweet-spoonable $r = 0.24$, $P = 0.006$; savoury-spoonable $r = 0.65$, $P < 0.001$; sweet-dry $r = 0.81$, $P < 0.001$; savoury-dry $r = 0.51$, $P = 0.06$) and explained up to two-thirds of the variation in sugar content (Fig. 2A,B).

Table 1. Number and proportion of spoonable foods at each age that were sweet or savoury ($n = 329$)

Age group	Sweet		Savoury		Total	
	N	%	N	%	N	%
4+	109	69.4	48	30.6	157	47.7
6–7+	38	39.2	59	60.8	97	29.5
9–10+	6	20.6	23	79.3	29	8.8
12+	24	52.2	22	47.8	46	14.0
Total	177	53.8	152	46.2	329	100

Discussion

Vegetable intake in children in the UK and other Western countries remains low (Department of Health 2011, Lennox *et al.* 2013), and promoting the intake of F&V during childhood is a key public health message. The healthiness of F&V is clearly recognised by parents and manufacturers, as a majority of complementary feeding products list F&V in their names (Garcia *et al.* 2013). This survey has revealed that the

Table 2. Nutritional content* of commercial baby foods containing fruit or vegetables by food type ($n = 329$)

Food		Number	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrates (g)	Sugar (g)	Min	Max
Spoonable	Sweet	137	68.6 (19.4)	1.02 (0.8)	0.65 (0.8)	13.71(3.1)	10.74 (2.6)	5.2	23.1
	Savoury	138	64.0 (13.8)	2.77 (0.9)	1.75 (0.9)	8.51 (1.8)	2.88 (1.7)	0.1	10.8
	Total	275	66.3 (16.9)	1.9 (1.2)	1.2 (1.0)	11.1 (3.6)	6.8 (4.5)	0.1	23.1
Dry	Sweet	40	354.6 (76.9)	7.40 (3.9)	6.76 (5.2)	66.05 (15.3)	25.69 (16.9)	1.7	69.5
	Savoury	14	416.2 (32.1)	9.14 (3.0)	11.54 (5.4)	69.81 (9.0)	7.09 (3.6)	1.5	12.6
	Total	54	370.6 (73.1)	7.8 (3.7)	8.0 (5.6)	67.0 (13.9)	20.9 (16.8)	1.5	69.5

*Mean (SD)

Table 3. Most frequently named F&V in CBF (n=329)

	First F&V named in label	Second F&V named in label*	Third F&V named in label†
	Frequency (%)		
Apple	59 (17.9)	24 (7.3)	6 (1.8)
Vegetables (not specific)	44 (13.4)	1 (0.3)	
Banana	33 (10.0)	19 (5.8)	7 (2.1)
Tomato	23 (7.0)	1 (0.3)	
Fruit (no specific)	19 (5.8)	1 (0.3)	
Mango	19 (5.8)	6 (1.8)	5 (1.5)
Carrot	17 (5.2)	6 (1.8)	2 (0.6)
Sweet potato	16 (4.9)	8 (2.4)	
Butternut squash/pumpkin/courgettes	14 (4.3)	4 (1.2)	1 (0.3)
Strawberry	13 (4.0)	4 (1.2)	3 (0.9)
Raspberry/blueberry	10 (3.0)	9 (2.7)	2 (0.6)
Pear	7 (2.1)	21 (6.3)	2 (0.6)
Peach	7 (2.1)	11 (3.3)	3 (0.9)
Broccoli/cauliflower	7 (2.1)	4 (1.2)	
Sweet corn	6 (1.8)	1 (0.3)	
Spinach	6 (1.8)		1 (0.3)
Parsnips	5 (1.5)	2 (0.6)	2 (0.6)
Red pepper	4 (1.2)	3 (0.9)	
Raisin/sultana	4 (1.2)	6 (1.8)	
Plums/prunes	3 (0.9)	1 (0.3)	
Apricot	2 (0.6)	8 (2.4)	
Peas	1 (0.3)	2 (0.6)	3 (0.9)
Swede	0	0	3 (0.9)
Other‡	10 (3.0)	10 (3.0)	4 (1.2)
Total	329 (100)	151 (45.9)	44 (13.4)

*A second F&V was not included in name in 178 products (54.1%). †A third F&V was not included in name in 285 products (86.6%). ‡Other fruits were kiwi, date, orange, blackcurrant and lemon. Other vegetables were parsley, red cabbage, French bean, mushroom and aubergine.

amount of F&V used in these products is substantial, comprising an average of 60% of spoonable foods, but a majority of the foods recommended for early use (4+ months) were fruit based, and where vegetables were used they were predominantly sweet, with bitter-tasting vegetables rarely included. The proportion of F&V content varied greatly, but it was of note that the greater the proportion the sweeter the food, suggesting that their main function in the products may be as sweetening agents. Furthermore, as previously discussed (Garcia *et al.* 2013), it is a matter of concern that a large proportion of CBF are recommended from 4 months of age which adheres to EU (European Union) regulations but contradicts the current WHO (World Health Organization) recommendations on the appropriated age of weaning.

The foundation for food preferences in later childhood is laid by early food exposure, so complemen-

tary foods are an ideal opportunity to form new tastes (Maier *et al.* 2007). Introducing babies to *single* foods and repeated exposure to the same food over several days has been shown to favour acceptance (Birch *et al.* 1998), and using vegetables exclusively when starting complementary feeding has been shown to increase vegetable intake (Barends *et al.* 2013) for up to 12 months (Barends *et al.* 2014). However, the commercial foods in this study had a median number of 3 F&V per food and thus are not ideal for flavour learning. Experimental trials using flavour-flavour learning to study children's acceptance of vegetables, normally combined one vegetable with one sweet ingredient (e.g. glucose), rather than a mix of F&V (Remy *et al.* 2013; Caton *et al.* 2014). The key finding, however, was that bitter vegetables such as brassicas, spinach and chards were little used in these foods and only as a small proportion. A low variety of vegetables as key ingredients in CBF and the use of sweet vegetables

Table 4. Content of individual F&V for CBF reporting a >0.5 g/100 g of that F&V, ranked by median content

	N (%) ^a	Median (g/100 g)	First quartile (g/100 g)	Third quartile (g/100 g)	Minimum-Maximum (g/100 g)
Fruit					
Apple	116 (35.0)	45.0	15.5	45.0	2–100
Pear	34 (10.3)	37.5	17.7	65.0	4–100
Plums/prunes	5 (1.5)	33.0	14.0	43.5	12–51
Mixed fruit	5 (1.5)	33.0	20.0	45.0	13–50
Banana	79 (24.0)	20.0	13.0	20.0	3–100
Peach	23 (6.9)	20.0	15.0	30.0	3–48
Raisin/sultana	20 (6.0)	15.5	10.2	33.8	2–85
Mango	33 (10)	13.0	7.5	20.0	3–100
Apricot	15 (4.5)	11.0	9.0	22.0	3–29
Strawberry	21 (6.4)	10.0	8.5	19.0	1–25
Raspberry/blueberry	21 (6.3)	5.0	3.5	15.0	1–23
Vegetables					
Mixed vegetable	64 (19.4)	34.5	26.2	46.0	3–73
Tomato	40 (12.2)	28.5	8.3	27.0	2–70
Cauliflower	4 (1.2)	28.5	13.5	35.2	10–36
Carrot	65 (19.7)	20.0	11.0	27.5	3–78
Parsnips	11 (3.3)	19.0	13.0	30.0	10–50
Spinach	7 (2.1)	18.0	5.0	22.0	3–34
Butternut squash/pumpkin/courgettes ^b	14 (4.3)	14.0	10.0	22.0	2–43
Sweet corn	13 (3.9)	14.0	5.5	26.0	3–51
Peas	11 (3.3)	12.0	6.0	20.0	4–30
Swede	7 (2.1)	12.0	5.0	20.0	4–25
Broccoli	8 (2.4)	8.0	5.5	22.7	4–27
Red pepper	18 (5.5)	7.0	4.0	9.0	1–13

^aCalculated from the total products n = 329. ^bButternut squash, pumpkin and courgette were grouped.

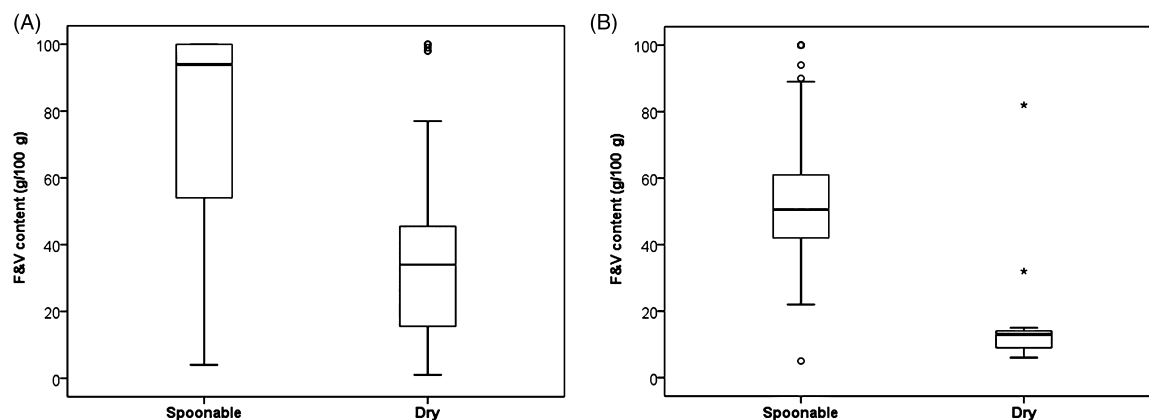


Fig. 1. Fruit and vegetable content by food type ($n=329$). (A) Sweet foods. (B) Savoury foods.

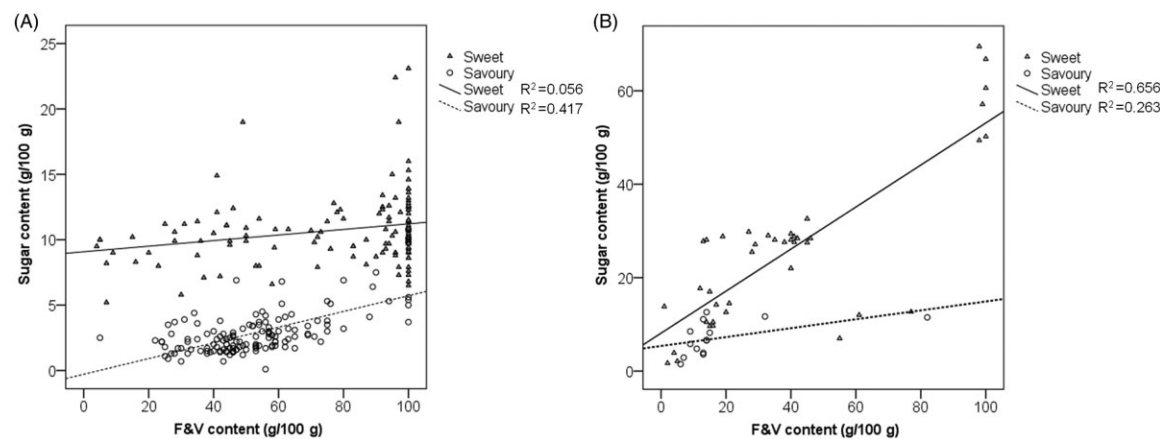


Fig. 2. Associations between sugar and fruit and vegetable content. (A) Spoonable foods ($n=275$). (B) Dry foods ($n=54$).

has also been reported for CBF in Germany, with carrots being most popular (Mesch *et al.* 2014). This probably reflects commercial pressure to produce instantly palatable foods, as infants have an innate preference for sweet flavours and to avoid bitter tastes (Beauchamp & Mennella 2009). It has also been reported that UK mothers are more likely to make weaning solids with mixed vegetables during weaning (Caton *et al.* 2011). It could be argued that combining new flavours with sweet tastes would also increase acceptance, but one randomised control trial found that repeated exposure to a novel vegetable (artichoke) was no more effective in increasing vegetable acceptance than the combination with a sweet component (Remy *et al.* 2013). Altogether, this sug-

gests that the F&V used in these foods may be used to increase the palatability of foods, but they are likely to be ineffective in promoting taste acceptance of vegetables.

Given the natural sugar content of fruits, it was not surprising that the F&V content of sweet-dry foods explained two-thirds of their variation in total sugar content. What was unexpected was that the F&V content of savoury-spoonable foods also correlated highly with total sugar content. This reflects the types of sweet vegetables found in these foods. EU guidelines limit the addition of non-milk extrinsic sugars ('added sugars') such as 'sucrose, fructose syrups or honey' in CBF (European Commission 2006), but using F&V increases the total sugar content without

the need to use added sugars. The risk is that while parents think that CBFs are introducing their children to healthy vegetable tastes, actually they are mainly reinforcing preferences for sweet foods. Current recommendations for total sugar intake in babies are that total sugar intake should be 'around' 40% of total energy intake, a number based on the average total lactose intake in breastfed babies (Department of Health 1991). Just as we previously found with total energy content (Garcia *et al.* 2013), the sugar content of spoonable CBF mirrors average that of breast milk: if 6–8-month-old babies ate 303 g of spoonable CBF according to the WHO recommended intake of 200 kcal/day from complementary foods (WHO 2000), they would get exactly 40% energy intake from total sugars from CBF (20.6 g total sugar/day, which amounts to a total of 82 kcal from total sugars). Thus, as long as the baby eats a mix of savoury and sweet foods and no more than the recommended amount, the amount of sugar in these foods would not exceed recommendations, although we do not know if that is a healthy pattern for complementary feeding. Thus, further research on feeding patterns with predominant use of CBF in the development of food preferences later in life is needed.

The strength of this study is that it represents a near complete survey of baby foods on the market in the UK listed as containing F&V, although it is possible that we have missed further products that may have been flavoured or sweetened with F&V if this was not specified in the label. A limitation is that we cannot know how applicable this would be in other countries, but as EU directives regulate the content of baby foods across Europe, it seems likely to be relevant to other parts of Europe. It is also by necessity a snapshot, as manufacturers change their products on a constant basis, but by examining all the then available products one gets an overview of the market approach, which is less likely to change. The applicability of our findings to American markets is less clear, but recent studies suggest a lot of similarity, in particular to low vegetable variety (Siega-Riz *et al.* 2010) and high sugar content (Cogswell *et al.* 2015). We must rely on the contents as reported by the manufacturers, but a recent study in a sample of infant foods in the UK suggests that the macronutrient

content reported by manufactures reflects the declared values (Zand *et al.* 2012). Furthermore, the nutrient content in this survey is consistent with data reported in a similar study (Garcia *et al.* 2013). It must also be born in mind that CBFs form only part of the diet of most babies (Lennox *et al.* 2013), so we cannot comment on how this would translate to an infant's total dietary intake, which is beyond the scope of this survey.

Conclusions

The types of vegetables used in CBF are predominantly sweet and non-bitter, and thus will not encourage preferences for non-sweet vegetables. F&V contribute significantly to sugar content in CBF evidencing their sweetness and suggesting that they are used as sweetening agents. There are implications from these results for practitioners and parents. Manufacturers clearly recognise commercial demand for products that appear healthy, but commercial pressure on them will be to ensure that these products are highly palatable. While taste learning requires parents to introduce their children to less palatable bitter tastes and keep offering them, it is probably unrealistic to expect that commercial products will assist in this process. Thus, practitioners need to be aware when advising parents on complementary feeding that CBFs, even if containing vegetables, are unlikely to help their children develop a taste for bitter vegetables, and parents still need to be encouraged to cook and offer home-prepared vegetables to promote taste acceptance.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

ALG: study design, data analysis and interpretation. KM: data acquisition and analysis. CW: data analysis and interpretation. All authors contributed to manuscript drafting.

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