

# **Sensory barriers and facilitators of children's vegetable consumption**

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Project Number: VG08049

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## Media Summary

The Australian Guide to Healthy Eating recommends two serves of vegetables per day for young children, whereas they were found to consume only a little over 1 serve per day. In order to gain some insight into the barriers to greater vegetable consumption in children, taste and sensory tests were conducted to identify the key sensory characteristics of vegetables which children like or don't like. Specifically, we wished to determine if and how children's acceptance for vegetables could be influenced by the preparation method or the way they are presented.

Sweet potato, cauliflower and beans were selected as examples of common vegetable categories and prepared and presented in four different ways:

1. Boiled vegetable of typical colour (i.e. orange sweet potato, white cauliflower and green beans)
2. Mashed or short boiled vegetable of typical colour
3. Baked or stir fried vegetable of typical colour
4. Boiled vegetable of atypical colour (i.e. white sweet potato, green cauliflower and yellow beans).

Children's acceptance was measured among a group of 104 five and six year olds. An adult trained sensory panel separately determined the sensory characteristics in terms of appearance, odour, taste/flavour and texture/mouthfeel for the three vegetable types prepared according to the different methods.

The results showed that:

- Before tasting, children expected to prefer vegetables that did not have the typical colour
- Overall, sweet potato, cauliflower and beans were accepted equally
- The sweet potato samples were equally accepted regardless of how they were prepared
- Boiled cauliflower samples of different colours were more accepted than baked ones
- Boiled beans samples of different colours were more accepted than stir fried ones
- Vegetable acceptance was higher for children who reportedly liked the target vegetables in the study and who liked many vegetables; acceptance was also higher when the home preparation method was similar to that tasted for this study
- Preparation method was most important for acceptance for children who liked fewer vegetables and children who were less willing to try new foods
- Most parents (72%) used strategies to make vegetables more attractive to their children; mostly hiding, masking or mixing with other ingredients.

- A strong smell and the presence of a *browned flavour* as a result of baking or frying processes were found to be barriers to consumption. Differences in texture and flavour characteristics imparted by different boiling times, as well as small differences in sweetness or bitterness, were neither a barrier nor a facilitator to consumption. Atypical colour was a facilitator to increase children's vegetable consumption.

Atypically coloured vegetables may be promising facilitators and may provide opportunities to increase consumption in this age category, since they encouraged "trying" in children and were equally acceptable in taste to typically coloured varieties. A key recommendation to the Vegetable Industry is to consider exploiting novel or atypical vegetable colour in the marketing and/or development of these varieties for children. Furthermore, where taste can also be improved compared to typically coloured varieties, additional success should be achieved.

Health professionals and other agencies who give advice to parents are recommended to consider how something as simple as preparation may positively influence acceptance, in particular among children who do not consume the recommended amount of vegetables. Atypically coloured varieties could be used to overcome established negative expectations. Boiling results in vegetables with sensory properties that are more acceptable, whereas baked or stir fried vegetables are more often disliked. Acceptance was higher when children were familiar with the cooking method through exposure at home. Cause and effect are not known in this case, but other evidence suggests that repeated exposure has a positive effect on acceptance (Corsini et al, 2009).

Acceptance was lower for children that liked few vegetables. Children with these background characteristics would need particular encouragement and intervention may be particularly targeted towards them.

It is clear from this study that general recommendations cannot be made for all vegetables. The Vegetable Industry would be encouraged to adopt a systematic vegetable by vegetable approach to identify the optimal preparation and presentation methods. Such approaches will be useful in particular for children who are currently not meeting recommended intakes.

## Technical Summary

The Australian Guide to Healthy Eating recommends two serves of vegetables per day for children aged between 4 and 7 years, but analysis of the 2007 National Children's Nutrition and Physical Activity Survey found these children consumed only a little over 1 vegetable serve (Bowen, Klose, Syrette & Noakes, 2009).

To potentially gain insight into some of the barriers to vegetable consumption, taste and sensory tests were conducted to identify the sensory characteristics of vegetables that children particularly like or dislike. The aim was to determine if and how preparation or presentation of vegetables could influence children's acceptance for them.

### Experimental Design

Sweet potato (*Ipomoea batatas*), cauliflower (*Brassica oleracea botrytis*) and (green) beans (*Phaseolus vulgaris*) were selected by members of the Vegetables Industry Advisory Committee Industry as examples of various vegetables categories. Four preparation and presentation methods were carefully selected for each:

- 1) Boiled vegetable of typical colour (i.e. orange sweet potato, white cauliflower and green beans)
- 2) Short boiled or mashed vegetable of typical colour (i.e. mashed for sweet potato and short boiled for cauliflower and beans)
- 3) Baked or stir fried vegetable of typical colour
- 4) Boiled vegetable of atypical colour (i.e. white sweet potato, green cauliflower and yellow beans).

Children's acceptance and preference was measured amongst a sample of 104 five and six-year-olds using a three-point hedonic scale and a ranking procedure. Data regarding vegetable consumption and preparation practices at home were collected from parents. Descriptive sensory evaluation was conducted to objectively measure the sensory characteristics of vegetables prepared in a particular manner.

### Experimental Findings

Before tasting, hence based purely on appearance, children expected to prefer the atypically coloured vegetables, compared to typically coloured ones.

Although there were significant sensory differences between the three vegetable types, including differences in *sweet taste*, *crunchiness* and *firmness*, these differences did not translate into differences in overall acceptance. Hence no category was preferred over another.



There were no significant differences in acceptance between the sweet potato samples prepared in different ways, although they differed significantly in odour, colour, taste, flavour and texture.

There were significant differences in acceptance between the four cauliflower samples, depending on the cooking method; boiled cauliflower of both typical and atypical colour was preferred to baked cauliflower. Differences in acceptance were related to *odour impact*, *browned flavour*, *oily flavour* or *oily mouthcoating*, present for the baked sample. At the same time, short boiled cauliflower was more *crunchy* and *firm*, required more *mastication effort* and *released* less *moisture* than longer boiled cauliflower, however these samples were liked the same.

Green cauliflower had a slightly more intense *bitter taste* than white cauliflower prepared in the same way, but was equally liked.

There were significant differences in acceptance between the four beans samples; short boiled and atypically coloured beans were preferred to stir fried beans. Differences in acceptance could be related to the *browned flavour*, *odour impact*, *oily flavour* or *oily mouthcoating* present for the stir fried sample.

Parental responses indicated that vegetables studied were neither amongst their children's most liked nor most disliked vegetables. The preparation methods and cooking times used in this study reflected those commonly used in the household. Children were unfamiliar with the atypically coloured varieties. According to our survey, most parents (72%) used strategies to make vegetables more attractive to their children, such as combining with other ingredients or mixing in a meal. Flavour, texture and appearance attributes were frequently reported reasons for children liking or disliking a vegetable; smell was often reported as reason for dislike.

Vegetable acceptance following tasting was positively related to reported liking for the target vegetable, liking for vegetables overall and to familiarity with the preparation method. Preparation method had a greater impact on acceptance for children who liked fewer vegetables and children less willing to taste new foods. These children accepted baked cauliflower and stir fried beans less than other samples.

Baking or stir frying imparted a more intense *odour intensity* and *browned flavour* for two of three vegetables and also imparted a more intense *oily mouthfeel* and *oily flavour* than other preparation methods. The former two sensory attributes were barrier to consumption. Texture and flavour differences as a result of different boiling times did not result in differences in acceptance. Thus, they were neither a barrier nor a facilitator to consumption. Small differences in sweetness or bitterness did not affect liking. Colour may be a promising facilitator to increase children's vegetable consumption.

The atypically coloured vegetables created positive expectations about the taste and thereby encouraged "trying" of vegetables. They were also subsequently liked after tasting, although no more than typically coloured vegetables.

The Vegetable Industry is recommended to consider marketing and/or development of atypically coloured cultivars for children. Where taste of these varieties can be improved compared to typically coloured varieties, additional success should be achieved.

Health professionals and others who give advice to parents are recommended to consider how preparation may influence acceptance, in particular among children who do not consume the recommended amount of vegetables. Atypically coloured varieties can be used to overcome established negative expectations. Boiling results in vegetables with sensory properties that are more acceptable, whereas baked or stir fried vegetables are more often disliked. No specific guidelines for boiling times seem necessary from a sensory perspective. Acceptance was higher when the method of home preparation was similar to that tasted for this study.

Cause and effect are not known in this case, but other evidence suggests that repeat exposure has a positive effect on acceptance (Corsini et al, 2009).

Acceptance was lower for children that liked fewer vegetables. Children with these background characteristics would need particular encouragement and intervention may be particularly targeted towards them.

The Vegetable Industry would be encouraged to adopt a systematic vegetable by vegetable approach to identify optimal preparation and presentation methods for children, in particular for those who are currently not meeting recommended intakes.

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# 1. INTRODUCTION

The consumption of vegetables has been reported to help prevent cardiovascular disease and certain cancers. Vegetables can also play an important role in the prevention of obesity, as an increased consumption of vegetables often reduces the intake of other higher caloric foods. Obesity in later life is a significant risk factor in the development of type-2 diabetes, coronary heart disease, osteoarthritis and some cancers (St-Onge & Heymsfield, 2003).

The Australian Guide to Healthy Eating recommends two serves of vegetables a day for 4 to 7 year old children. However, the 1995 National Nutrition Survey results showed that these children consumed only 1.2 (boys) -1.3 (girls) serves a day (Magarey, Daniels & Smith, 2001). Recent data from the Australian Children's Vegetable Intake report (HAL report VG07160) analysing the 2007 National Children's Nutrition and Physical Activity Survey suggested that this situation does not appear to have changed, with younger children consuming a little over 1 vegetable serve on the survey day (Bowen, Klose, Syrette & Noakes, 2009). Consumption levels below recommendations are typical in most Western countries.

Many factors are associated with consumption of vegetables below the recommended intakes including socio-economic status and attitudes towards health (Marshall, Anderson, Lean & Foster, 1994; Anderson, Cox, McKellar, Reynolds, Lean & Mela, 1998; Blanchette & Brug, 2005; Cooke, Wardle, Gibson, Sapochnik, Sheiham & Lawson, 2004) but sensory properties are often a key barrier to consumption (Blanchette & Brug, 2005; Van Duyn, Kristal & Dodd, 2001). As a consequence, multiple studies have aimed to increase consumption of vegetables by increasing liking for sensory properties (e.g. Wardle, Cooke, Gibson, Sapochnik, Sheiham & Lawson, 2003; Wardle, Herrera, Cooke & Gibson, 2003).

Children are born with a preference for sweet and an aversion for bitter foods (Steiner, 1977). However, nearly all food preferences are learned via experiences with different foods and childhood appears to be one of the critical phases in the development of such preferences (Köster & Mojet, 2006). Several studies indicated that preparation of vegetables may influence acceptance (Baxter, Jack & Schröder, 1998; Domel, Baranowski, Davis, Leonard, Riley & Baranowski, 1993; Szczesniak, 1972) although none of these involved actual tasting of vegetables. Baxter et al (1998) and Szczesniak (1972) found that children preferred raw vegetables to cooked. Domel et al (1993) observed that children preferred vegetables served raw with a dip, or cooked with butter or a cheese sauce to vegetables prepared in other ways. A recent study (Zeinstra, de Graaf and Koelen, 2009) with actual tastings showed that children preferred boiled and steamed vegetables to those that were stir fried, mashed, fried and grilled.

Texture may be of particular relevance for children's vegetable acceptance (Blossfeld, Collins, Kiely & Delahunty, 2007; Szczesniak, 1972, 2002). Baxter et al (1998) suggested that textural properties were particularly associated with dislike of certain vegetable preparations amongst 8-11 year olds.

They also found that vegetables with hard and crunchy textures were liked, whereas soft, mushy textures were disliked.

The development of teeth and jaw movement of a child influence if textures are accepted or rejected, with the eruption of the first permanent teeth being a significant event around 5 -6 years of age (Szczesniak, 1972). Likes and dislikes for textures seem to be very dependent on the specific food type. Szczesniak (2002) found that generally, stringy, gummy or slimy foods were rejected, whereas crunchy, juicy or tender textures were preferred. In addition, Szczesniak (1972) found that children liked simple, one-dimensional textures more than textural contrast. Zeinstra, Koelen, Kok & Graaf de, (2007) found the most important determinants for liking and disliking in fruit and vegetable to shift from appearance and texture attributes in 4–5-year-olds towards taste attributes in 11–12-year-olds. However, with the exception of Zeinstra et al (2009) which focused on the effect of preparation on acceptance, most of the above described studies related to differences between and not within vegetables types and did not involve actual tastings.

Appearance may also be of particular relevance for children's acceptance of vegetables. (Zeinstra et al, 2007) . Based on comparisons between eight different vegetables, Baxter et al (1999) found size and colour to affect children's acceptance for them. Small, brightly coloured vegetables were preferred to large, dark green (and leafy) varieties. The authors point out that colour- flavour associations may play a role in shaping preferences (Baxter et al, 1999).

## 1.1 Objectives

The objectives of the current study were:

- To determine 4-6 year old children's acceptance for vegetables prepared for eating and presented in different ways
- To collect background information including children's vegetable consumption and vegetable preparation practices in the household, and to determine how this information relates to consumer acceptance
- To use a trained sensory panel to determine sensory characteristics of vegetables prepared and presented in different ways and to determine how this information relates to consumer acceptance
- To determine sensory barriers to vegetable consumption by children and identify potential facilitators in relation to preparation and presentation
- To identify opportunities and provide recommendations how this knowledge may be used by the Vegetable Industry and relevant health professionals

## 2. MATERIALS AND METHODS

### 2.1 Samples

#### 2.1.1 Vegetable selection

The first step consisted of selecting 3-4 vegetables from the available Australian vegetable supply that would be used to study children's' likes and dislikes for vegetables. These vegetables would serve as model foods with which the effect of preparation and presentation could be tested. The selection was based upon: 1) a categorisation of vegetables and 2) a set of criteria for selection of vegetables.

1) *Categorisation*: vegetables were grouped on the basis of taxonomy and sensory similarities and dissimilarities. Thus, the list was not created to be 100% taxonomically correct. The categorization was:

- Root vegetable: sweet potato, swede, carrot, parsnip, turnip, beetroot
- Brassica: broccoli, cabbage, cauliflower, Brussels sprouts
- Leafy vegetable: buck choy / paksoi, spinach, silver beet, lettuce, iceberg, celery, leek, endive
- Legume vegetable: green bean, snow pea, pea, sugar snap pea
- Cucurbit: cucumber, zucchini, squash, pumpkin / butternut
- Solanacea: capsicum, eggplant, pepper

2) *Evaluation criteria*: a set of criteria was developed on the basis of which vegetables would be selected. The selection criteria were:

- Vegetables are not highly liked nor highly disliked by children.
- The target vegetables are substantially different in their sensory properties (e.g. colour, flavour, texture).
- Similar preparation and presentation methods can be used for the vegetables so that results can be generalized across several vegetables.
- The vegetable crops have economic importance in terms of market value.
- Vegetables derive from three to four categories from the above mentioned categorisation. Proposed vegetables approved by HAL and the Vegetable Industry prior to the start of the research.

The categorisation and selection criteria were submitted for approval to the Industry Advisory Committee (IAC) Vegetables. They were approved by this committee on the 13<sup>th</sup> of August 2008 and four vegetables were proposed: green beans, cauliflower, sweet potato and eggplant. Initial sample development focused on these four vegetables.

Samples were cooked in different ways depending on the suitability of each method for the vegetable type (e.g. boiling, steaming, grilling, frying, baking) and different cooking times were used within each cooking method.

Cognitive abilities and the attention span of children of this age group are limited and it was expected they could taste a maximum of 12 samples: either three vegetables in four conditions each or four vegetables in three conditions each. Pilot testing showed that eggplant was an unsuitable target vegetable, since few children had previous experience with this vegetable and a large proportion of children did not like it. Results from Project VG08002 “Increasing children’s liking for and consumption of vegetables” also showed that eggplant was not among the list of vegetables that parents would like their child to consume more of. Therefore, the research focused on three vegetables each prepared in four ways.

The three vegetables used in sensory and consumer research were:

- Sweet potato (*Ipomoea batatas*)
- Green beans (*Phaseolus vulgaris*)
- Cauliflower (*Brassica oleracea botrytis*)

### 2.1.2 Selection of preparation and presentation methods

To select appropriate preparation and presentation methods for this study, a staged approach was followed. First, different vegetables of each category were commercially sourced including varieties with different colours.

Cooking books and internet sites were searched for different preparation methods and preparation times. A criterion was that parents should be able to prepare the vegetables easily in their own home. Therefore, no preparation methods that require specialized equipment or skills were considered.

Vegetables were prepared using a range of cooking methods and preparation times in the sensory laboratory of CSIRO. This was done for each of the target vegetables separately.

For example, the following cooking method/ cooking time combinations were trialled in initial sessions for cauliflower:

- *Boiled* – Boiled in water for 5; 8; 10; 12; 15; 20; 25 or 30min
- *Steamed* - Steamed in a small amount of water for 8; 10; 12; 15; 20; 25; 30 or 40 min
- *Boiled in microwave* – Boiled in water for 8;15 or 30 min in microwave
- *Mashed* - Mashed after being boiled for 8; 11;15 or 30min
- *Baked* – Baked in oven for 2; 5; 10; 15 min
- *Baked after boiling* – Baked in oven for 5; 7.5; 10; 15 or 20 min after boiling for 5 or 10 min
- *Fried* – Fried raw in pan for 2; 3.5 or 5 min

In addition, where anecdotal information was found about changing sensory characteristics (e.g. adding milk during boiling to reduce odour intensity), such techniques were also trialled.



The initial cooking method / cooking time trials conducted for sweet potato and beans are provided in Appendix A.

Standardised quantities of vegetable were prepared and evaluated by a team of four sensory and consumer scientists on appearance, taste, texture and other aspects. Notes were collated including details of the preparation process and a picture of the prepared sample. The information was used to narrow down the range of cooking methods and sample preparation times and to optimise preparation methods. For baked and stir fried samples, this included defining the type of oil and the method of oil application, and for baked products the temperature of the oven and turning of samples. Canola oil was chosen for its relatively neutral taste and samples were lightly brushed with oil before baking or stir frying.

The following criteria were used for the selection of the preparation and presentation methods:

- Methods using apparent hiding (e.g. in pies), masking (e.g. with sauces) or serving raw were not considered in this project.
- The samples should be acceptable to the target group of children. Information from literature was also taken into account
- Sensory characteristics – differences between samples should be large enough to potentially lead to differences in acceptance.
- The ability for parents to adopt the preparation / cooking methods in their own household to facilitate an easy uptake of recommendations deriving from this project.
- The ability to apply similar (cooking) methods to all vegetables under investigation to allow for a comparison of its effectiveness across vegetables.

An overview of the selected preparation and presentation methods is provided in Table 1.

**Table 1:** Description of the preparation and presentation methods for each of the vegetables

	Typical colour					Atypical colour
	Boiled	Short boiled	Mashed	Baked	Stir fried	Boiled
Sweet potato	√		√	√		√
Cauliflower	√	√		√		√
Beans	√	√			√	√

Two of the preparation and presentation methods were similar across the three vegetable types, which were a boiled typically coloured vegetable (i.e. orange sweet potato, white cauliflower and green beans) and a boiled atypically coloured vegetable (i.e. white sweet potato, green cauliflower and yellow beans). All vegetables also had one preparation method that included the use of oil (baked for sweet potato and cauliflower; stir fried for beans). In addition, one method differed between the vegetables; cauliflower and beans were short boiled (this was not deemed acceptable for sweet potato) and sweet potato was served mashed (not deemed acceptable for cauliflower and beans).

Details of the samples and their preparation are shown in Table 2.

**Table 2:** Description of the samples

Vegetable	Variant	Preparation
Sweet potato	a) Boiled	Orange sweet potato boiled for 12 min
	b) Mashed	Orange sweet potato boiled for 12 min then mashed
	c) Baked	Orange sweet potato boiled for 5 min, lightly brushed with canola-oil, and baked for 15 min (turned after 7.5 min) at 200°C
	d) Colour	White sweet potato boiled for 12min
Cauliflower	a) Boiled	White cauliflower boiled for 15 min
	b) Short boiled	White cauliflower boiled for 5 min
	c) Baked	White cauliflower boiled for 5 min, lightly brushed with canola-oil, and then baked for 10 min (turned after 5 min) at 200°C
	d) Colour	Green cauliflower boiled for 15 min
Beans	a) Boiled	Green beans boiled for 12 min
	b) Short boiled	Green beans boiled for 4 min
	c) Stir fried	Green beans boiled for 2 min, then stir fried with canola-oil for 3 min
	d) Colour	Yellow beans (butter beans) boiled for 12 min

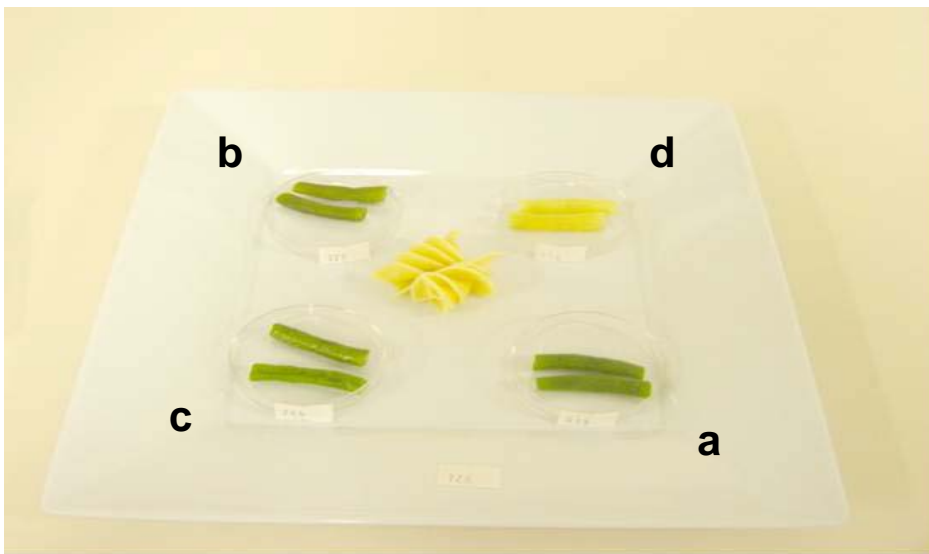
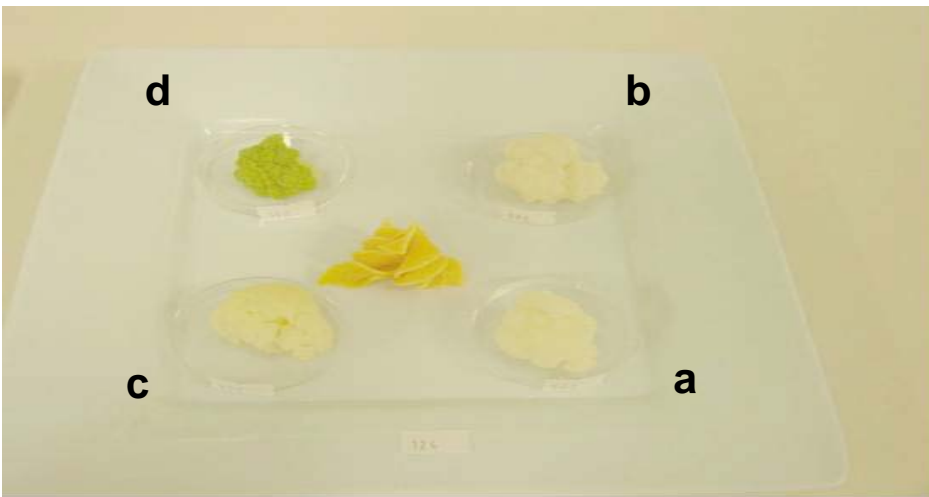
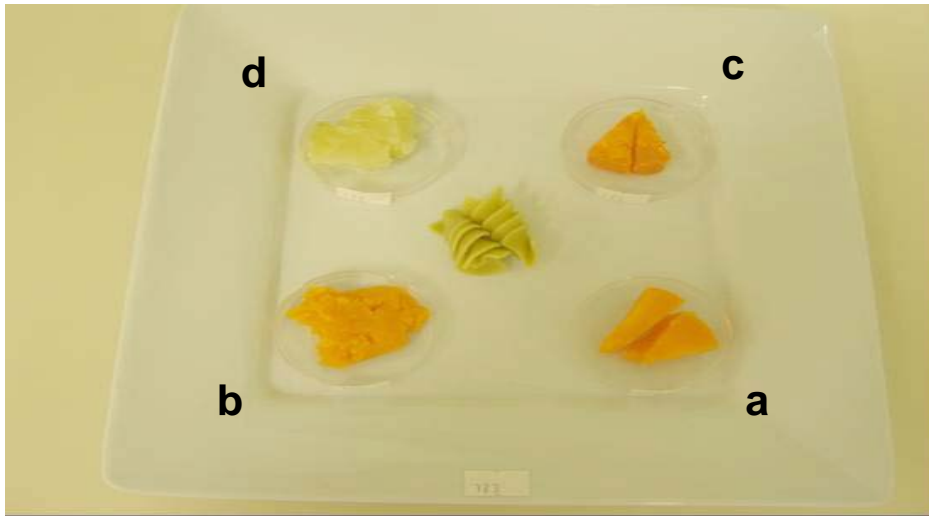
Two different boiling times were chosen (both within the range of boiling times commonly encountered in recipes) to study the effect of boiling time on acceptance). A baked / stir fried sample was chosen since it was expected to influence texture but also flavour; cooking times were based on recipes and (in case of sweet potato) adapted to the small portion size. One atypical coloured sample was included to allow for a study of appearance aspects and this sample was otherwise prepared similarly to the typically coloured boiled sample. This made the design unbalanced for colour, but enabled testing of a wider range of preparation methods in typically coloured vegetables, thereby doing justice to the larger market share of “regular” vegetables.

Vegetables were commercially sourced twice a week (Flemington markets in Sydney). Prior communication with suppliers ensured consistent supply and optimum freshness / eating quality of the vegetables. Products were stored in refrigeration (2°C) until use. Detailed preparation protocols were developed in which all preparation steps were timed by the minute, to ensure that preparations were safe, exact and consistent across sessions. Spare samples were prepared in each session and only samples that met all specifications were used (e.g. not broken, slightly browned in the case of baking and stir frying). All samples were prepared fresh for each session and immediately served. The mashed sweet potato sample required reheating in a bain-marie to be of similar temperature to the other samples. The serving temperature was generally  $55 \pm 5^{\circ}\text{C}$ , with green beans sometimes lower as their temperature decreased more quickly after cooking.

Children were presented with a plate containing the four variants of the same vegetable. The plate also contained two pasta spirals to create a meal context (Figure 1). This presentation method was chosen because it enabled a direct comparison of the samples, while not making explicit that the samples belonged to the same vegetable category (which may influence children’s expectations). Each vegetable sample was placed on a small transparent container using the following quantities:

- Sweet potato: a triangular piece of 1.5cm thick weighing around 12 grams cut in half (for the mashed sample 12 grams was served also)
- Cauliflower: one floret weighing around 12 grams
- Beans: two pieces of 4 cm length weighing around 2 grams (total weight)

**Figure 1:** Samples as they were presented in the consumer test and descriptive sensory analysis



Letters correspond with preparation methods as described in Table 2

## 2.2 Children's acceptance and preference

Ethics approval for this project was granted by the CSIRO Human Research Ethics Committee. A pilot acceptance test was carried out with four-to-six year old children in which all procedures, preparation protocols and questionnaires were tested. Important objectives of the pilot test were to:

- Determine if the procedures, tasks and number of samples were appropriate for the cognitive abilities and attention span of the age group
- Evaluate whether all aspects of the questionnaire were understood by parents
- Trouble shoot sample preparation and practical aspects of the trial
- To determine whether the test products were suitable

A total of 16 children / parent pairs participated in the pilot test. Minor modifications were subsequently made to the design of the study. The children's acceptance test itself was conducted during the April 2009 school holidays with a total of 104 eligible four-to-six year old children participating.

### 2.2.1 Recruitment

Recruitment of participants was conducted by an external recruitment agency. In order to qualify, the participants had to meet the following criteria:

#### Children:

- Aged between 4 and 6 years old
- Attending primary school (Kindergarten or Year 1)
- Willing to participate in a taste test with vegetables
- Children that strongly disliked two or more of the target vegetables were excluded from the research. Children that had never consumed two or more of the target vegetables were excluded only if they clearly disliked and/or had never consumed more than ten additional vegetables from a selected list of vegetables.
- Children with any known food allergies or dietary intolerances and children of parents with any known food allergies or dietary intolerances were excluded from the study.

#### Parent

- Parent or legal guardian of the child that will participate in the taste test
- Willing to accompany the child to the test location
- Willing to complete a questionnaire (approximately 15 minutes) while the child participated in the taste testing

A primary parent or guardian of the child was screened using a questionnaire addressing these criteria. Participants that qualified were booked into a consumer test session and received a confirmation letter with detailed information about the study.

A total of 106 children participated in the study. Two of these children were not eligible (four-year olds that did not attend primary school) and were excluded from data analysis. Hence, results are based on data from 104 children.

### 2.2.2 Procedure

Each child participated in a single session of approximately 50 minutes duration in which he / she tasted the three vegetable types in each of four variants. Sessions were held with six children / parent pairs at a time. First the group of children and parents were given oral instructions about the details of the tasting procedures. The children were familiarized with the task through the use of an example in which no actual tasting was done to avoid satiety. The parents and children were afforded the opportunity to ask questions about the test.

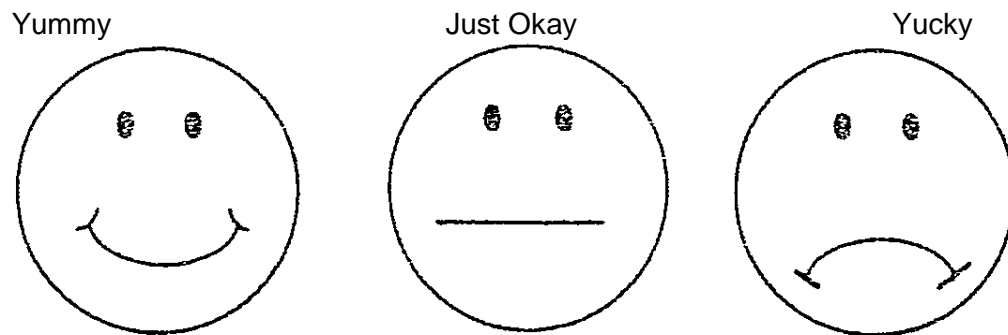
Once participants were satisfied to proceed, written consent was obtained from the parent for both the child and the parent. Respondents were free to withdraw from the taste trial at any point.

Children and parents went to the test rooms with no more than two children per room, to minimize distraction. Children were seated opposite one another with screens on the table to prevent them from interacting. Each child had one-on-one assistance from a trained test administrator throughout the entire session. A test administrator was preferred over the child's parent to ensure consistency and objectivity and to avoid unintended bias. The parent was seated in close proximity, but not in viewing distance of the child. Parents were instructed not to interact with their child during the taste testing.

Within one session of six children, all children started with the same vegetable type (e.g. in the first session all children first received the plate with sweet potato samples, then with the cauliflower samples and then with the bean samples). However, presentation order was balanced across the sessions. The tasting order of the four vegetables within a vegetable category was balanced across all children. The two pasta spirals that were served alongside the vegetable variants to create a meal context were not consumed.

Upon receiving their first plate, the child had to point out the sample they thought they would like the most. This expected preference was measured using the question: "Could you please point out the sample that you think you will like the most?" Then, the children tasted a small quantity of the first sample. The test administrator ensured that all samples were tasted in the correct order. Liking was measured using a three-point facial hedonic scale deemed to be appropriate for this age group (Wardle et al, 2003a, b) that was printed on A4-sized paper. An example of the scale is shown in Figure 2.

**Figure 2:** The three-point facial scale used to measure the children's liking for the vegetables



Children were encouraged to taste the vegetable (they did not have to eat the entire sample) and where necessary prompts were provided according to a specified procedure. Prompts included “If you don’t like it you can spit it out”. Children were allowed to spit out the sample if they really did not like it or they could refuse to taste one or more of the samples, though both were very rare. Once the child had tasted the vegetable they placed the container with the sample on the smiley face that corresponded to their response. They then continued with the same procedure until all four samples were tasted.

When the four samples were placed on the smiley faces, the children then proceeded to rank the samples in order of preference. They were allowed to re-taste in order to rank them appropriately and were particularly encouraged to do so in the case of ties. E.g. if a child had rated two samples both as “yummy”, they were asked to re-taste these two samples in order to determine which of these two was preferred. The expected preference (based on appearance only), liking, rank order preference and any sample refusals were recorded by the test administrator using a pre-coded sheet. The procedure was repeated for the remaining two vegetable types. Plates were served to the children at 15 minute intervals.

#### Background questionnaire

While the child conducted the test, their parent completed a questionnaire collecting background and vegetable consumption information. Together with the screener questionnaire, information was collected on:

1. Vegetable likes and dislikes and vegetable consumption frequency for child and parent.
2. Child’s (Pliner, 1994) and parent’s (Pliner and Hobden, 1992) food neophobia, which is a measurement to determine their willingness to try new foods.
3. Vegetable preparation and cooking methods used in the household.
4. Parents opinions on sensory properties that were liked and disliked in vegetables by their child
5. Strategies that parents had used to make vegetables more attractive to consume for their children.

6. Relevant demographic and socio-economic background information; child's age, gender, number of siblings, parent's level of education, breastfeeding history.

The HAL funded study VG08002 "Increasing children's liking for and consumption of vegetables" also measured items 1, 2 and 6 and the same questions were used in both studies. The Screening and Background Questionnaire are provided in Appendix B and C respectively. All child / parent pairs were paid an appropriate incentive for their participation.

## 2.3 Descriptive sensory analysis

In order to determine the key sensory differences between the samples (within and between each vegetable type), CSIRO's sensory panel was trained to carry out descriptive sensory analysis of the twelve samples using a standardised method of assessment. The descriptive sensory panel consisted of 9 assessors that had previously been screened for taste and smell acuity and had extensive experience in descriptive sensory analysis. A descriptive panel can provide objective perceptual information about products. This differs from consumer sensory research in that objective and unbiased information is gathered that is not influenced by preferences and previous experiences.

Training consisted of one two-hour session for overall vocabulary development and three one-hour training sessions specific to each vegetable type. The latter were held just prior to each evaluation session of the vegetable type. The training procedure ensured that comparisons could be made within and between vegetable types. During the training, a vocabulary was developed that consisted of the key sensory attributes in terms of appearance, odour, flavour and texture, and that also included basic tastes (sweet, bitter, sour and salty), regardless of whether they were perceived as key sensory attributes or not. The sensory vocabulary is provided in Table 3. Samples were prepared and presented in the same way as used for the acceptance testing, to enable a direct comparison of the data. Evaluation occurred on three consecutive days. On each day, nine assessors evaluated the four variants from one vegetable type in triplicate using the consensus vocabulary.

All samples were blind-coded with random 3-digit numbers and the order of sample assessment was balanced to account for first order and carryover effects. The experimental design was produced using the design generation package – CycDesigN (Whitaker, D. Williams, E.R. and John, J.A. (2002) *CycDesigN Version 2: A package for the computer generation of Experimental Designs*. CSIRO, Canberra, Australia). Attributes were rated on 100mm unstructured line scales anchored at 5 and 95%, respectively, with extremes for each descriptive term. The assessment took place in the sensory booths of the sensory laboratory of CSIRO, North Ryde. Data were recorded and stored using the Compusense 5 sensory data acquisition software (Version 4.6, 2004; Compusense Inc., Guelph, Ontario, Canada).



## 2.4 Data analysis

The number of refusals was low, with a total of 8 (=0.6%) refusals deriving from four children across all evaluations. Since refusal incidence rate was so low, any refused sample was recorded as a missing value and thereby excluded in the data analysis.

The categories “yummy”, “just okay” and “yucky” were assigned scores of 1, 0 and -1 respectively.

Statistical tests were carried out to determine the effect of preparation and presentation on the children’s acceptance (liking and ranking) and appearance evaluations for each vegetable type separately.

Statistical modelling was conducted to determine the relation between acceptance and sensory attributes. Analyses were also conducted to determine whether certain background characteristics of the children affected their liking for samples prepared and presented in different ways. These background variables were children’s liking of the target vegetables, liking of vegetables in general, the ways that vegetables were prepared for children for home consumption, variety in the number of vegetables consumed, and food neophobia (i.e. willingness to try new foods).

The details of the statistical analyses are provided below:

- To compare whether there were differences in the sample chosen on the basis of appearance Chi-square goodness-of-fit tests were conducted within each vegetable type
- To compare whether the sample within a vegetable type differed in liking and ranked preference, Friedman's analysis for related samples was carried out, with liking and ranked preference as dependent variables and preparation method (boiled, short boil/mash, baked, colour) as independent variables. Analysis was carried out for each vegetable separately.
- To compare whether different vegetables prepared in the same way differed in liking and ranked preference, Friedman’s analysis for related samples was carried out, with liking and ranked preference as dependent variables and vegetable (sweet potato, cauliflower, beans) as independent variables. Analysis was carried out for each preparation method (boiled, baked / stir fried, colour) separately (mashed/short boiled was excluded from this analysis as they were not comparable across vegetable types).
- To determine whether there was an overall trend for specific preparations to be liked more across vegetables Friedman's two-way analysis of ranks was carried out, with liking as the dependent variable and vegetable type (sweet potato, cauliflower and beans) and preparation type (boiled, baked, colour) as independent variables (again mashed / short boiled were excluded).
- To determine whether there were differences between groups of consumers (in terms of liking for target vegetables, liking for vegetables overall, familiarity with vegetable preparation method, overall consumption of vegetables and food neophobia), Mann-Whitney U tests were conducted, using liking / ranking

measures as the dependent variable and groups as the independent measure. To create groups for vegetable consumption and food neophobia, frequencies were graphed and two distinct groups created (low versus high) excluding children scoring “medium” on the attribute. Friedman’s analysis for related samples was conducted within each group separately to determine differences in sensitivity towards preparation methods.

- Correlations for liking of vegetables and Food Neophobia Scores between parent and child were determined using Pearson’s correlation coefficient
- For the descriptive sensory data, the quantitative measures for each sensory attribute were collated and analysed using a General Linear Model Analysis of Variance (ANOVA) with product (N = 12) and assessor (N = 9) as main fixed treatment factors. In the case of significant differences, the Least Significant Difference (LSD) was used as a post-hoc test to determine which pairs of samples differed from each other.
- The relation between consumer acceptance and sensory characteristics was determined by Partial Least Squares Regression (PLS-R) across all twelve samples, using the mean overall liking for each sample as the dependent variable and the standardised sensory attributes as the independent variables.

Analyses were carried out with the statistical software packages XLSTAT (Version 2009.3.02), SPSS (v17.0.0, 2009) and Unscrambler, (v8.0, 2003). For all analyses, a P value < 0.05 was used as a criterion for statistical significance.

**Table 3:** Sensory vocabulary used by trained sensory panel

**Vegetables - vocabulary**

<b>Odour</b>		<b>Related terms</b>
Impact	The intensity of the overall aroma of the sample from low to high	
Vegetable specific odour	The intensity of the specific vegetable odour (i.e. green bean / sweet potato / cauliflower) of the sample from low to high	
<b>Appearance</b>		<b>Related terms</b>
Colour	The visible colour intensity of the sample from light to dark	
Shiny	The degree to which the surface of the sample is shiny. The scale ranges from dull to shiny	
<b>Flavour</b>		<b>Related terms</b>
Impact	The overall flavour intensity of the sample from low to high	
Sweet taste	The perceived intensity of the sweet taste - defined by basic taste solution for sweet	
Bitter taste	The perceived intensity of the bitter taste - defined by basis taste solution for bitterness	
Salty taste	The perceived intensity of the salty taste - defined by basis taste solution for salt	
Sour taste	The perceived intensity of the sour taste - defined by basis taste solution for acid	
Vegetable specific flavour	The perceived vegetable specific flavour intensity (i.e. green bean / sweet potato / cauliflower) of the sample	
Oily flavour	The flavour associated with vegetable oil from low to high	
Browned flavour	The flavour associated with browning of vegetables. High intensity would be a burnt food.	
<b>Texture</b>		<b>Related terms</b>
Crunchiness	The noise and force with which the sample breaks. Assessed with the molars after two chews. The scale ranges from low to high	
Firmness	The force required to chew the sample. Assessed after two chews. The scale ranges from 'soft' to 'firm'.	Hard
Textural contrast	The degree to which the sample is heterogeneous in texture when biting through the sample and during chewing.	Homogeneous (opposite)
Mastication effort	The degree to which the sample needs to be masticated with the molars to prepare for swallowing. A sample low in mastication effort can be compressed between the tongue and the palate in order to prepare for swallowing (i.e. does not involve chewing with the molars).	Melting (opposite)
Moisture release	The amount of juiciness released from the sample during chewing from none to very juicy	Dry (opposite)
Oily Mouthcoating	The degree to which the samples feels oily in the mouth and coats the mouth surfaces with oil. Ranges from low to high.	
<b>AT / AF</b>		<b>Related terms</b>
Impact	The overall intensity of the residual aftertastes and afterfeel sensations that remains in the mouth after the sample has been swallowed from low to high	

### 3. RESULTS

#### 3.1 Background of participants and their parents

The parent completed a questionnaire that provided background information in relation to their child's and their own vegetable likes and dislikes and consumption, as well as other information relevant to vegetable consumption, vegetable preparation and some general background information. Comparisons with available external data (such as from the Australian Bureau of Statistics) were conducted to gain further insights into the characteristics of the consumer sample.

##### 3.1.1 Consumer group

The results are based on data of 104 children. The consumer group was well balanced with regards to gender and was close to state and national data (Australian Bureau of Statistics, 2008) (Table 4). An equal proportion of children were attending Kindergarten and Year 1 (Table 5).

An equal proportion of five- and six-year olds participated in the study, whereas the percentage of 4 year olds was very low (Table 6). The average age of the participating child was 5.9 years with a standard deviation of 0.6 years.

**Table 4:** Gender of participating child in study compared with NSW and Australian data (ABS, 2008)

<b>Gender</b>	<b>Consumer sample (%)</b>	<b>NSW (%)</b>	<b>Australia (%)</b>
Male	55	49.8	49.5
Female	45	50.2	50.5

**Table 5:** Class of participating child

<b>Class</b>	<b>%</b>
Kindergarten	52
Year 1	48

**Table 6:** Age of participating child

<b>Age</b>	<b>%</b>
4 years old	4
5 years old	45
6 years old	51

### 3.1.2 Reported vegetable liking

The most liked vegetables by the children were potato and carrot (Figure 3). Eggplant, Brussels sprouts and squash were the least liked. These vegetables were either disliked or had never been consumed by the children.

The target vegetables in our study were not highly liked nor highly disliked; ranking 7<sup>th</sup>, 10<sup>th</sup> and 13<sup>th</sup> out of 24 vegetables for sweet potato, beans and cauliflower respectively. This was also a requirement for the study. Sweet potato was liked by 65%, disliked by 9% and never consumed by 6% of the children. Cauliflower was liked by 50%, disliked by 20% and not consumed by 7% of children, whereas green beans were liked by 56%, disliked by 19% and not consumed by 1% of children (Figure 3).

Parental liking was higher than children's liking for all vegetables (Figure 4). The vegetables most often disliked by the parent were the same as observed with the children.

There were significant correlations between the parents and their child's liking for five vegetables; cauliflower ( $r=0.27$ ), sweet potato ( $r=0.21$ ), spinach ( $r=0.21$ ), Brussels sprouts ( $r=0.51$ ) and mixed frozen vegetables ( $r=0.25$ ). With the exception of Brussels sprouts, although significant, the correlations were relatively weak.

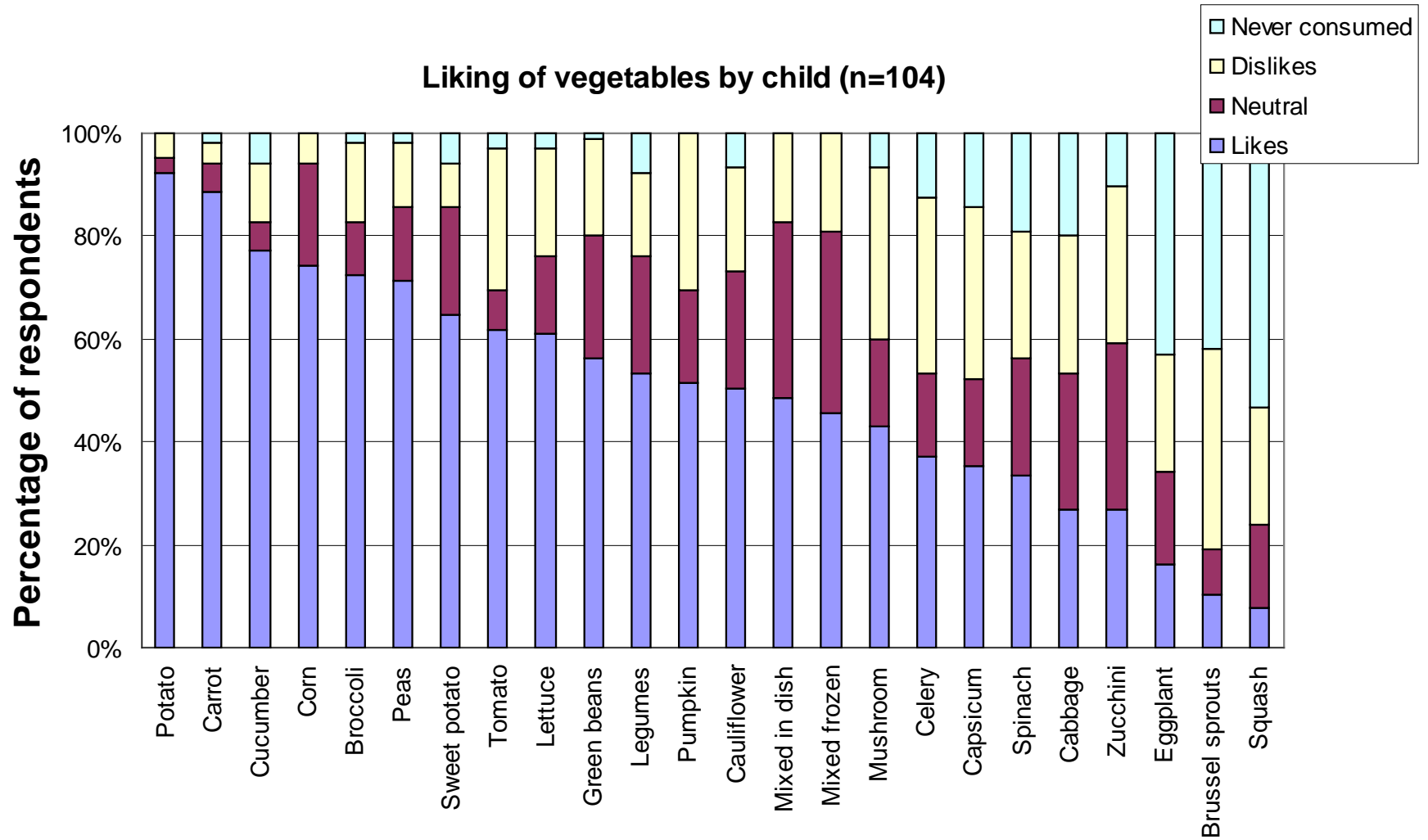


Figure 3: Parent ratings of their children's liking of a range of vegetables

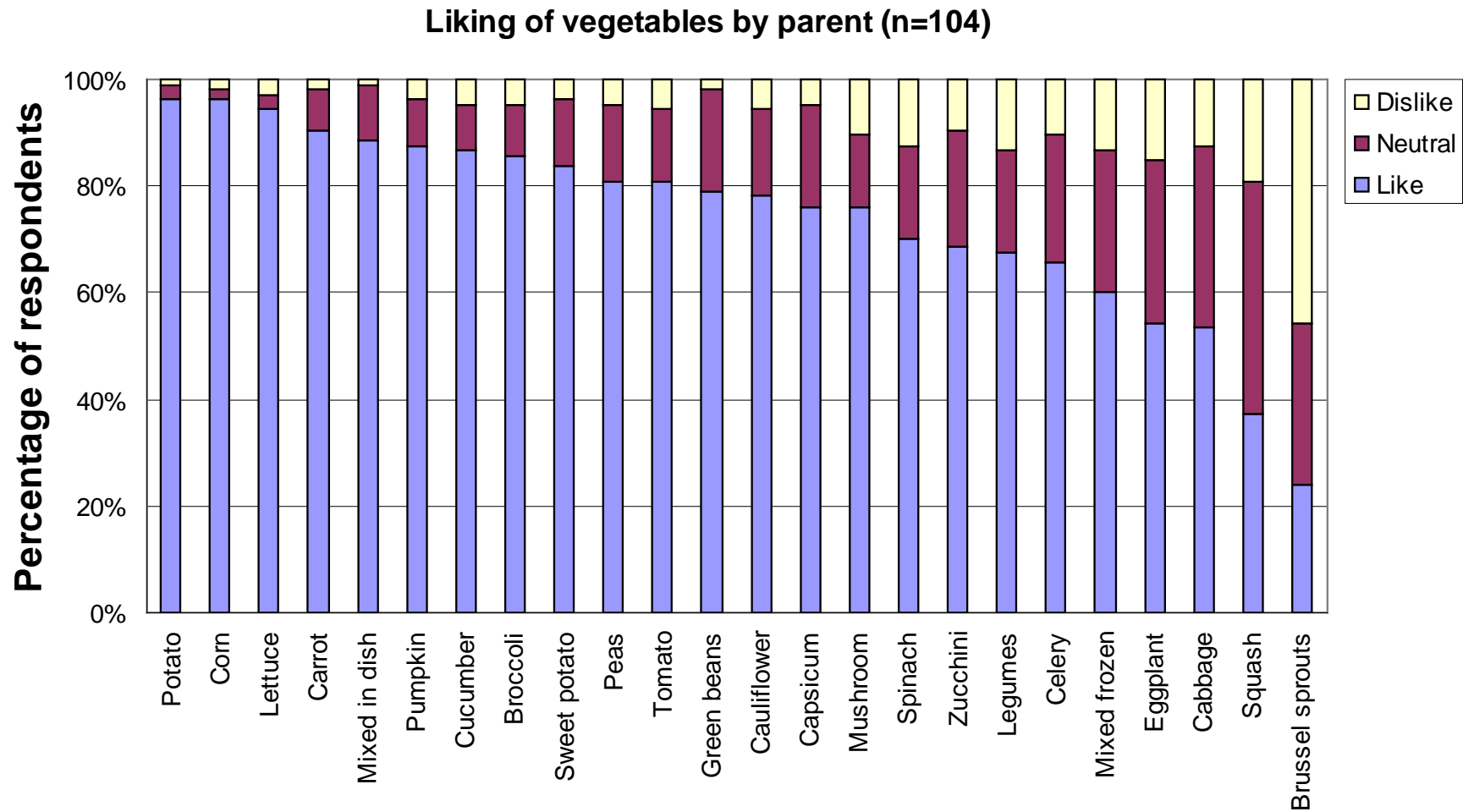


Figure 4: Parents' liking of a range of vegetables

### 3.1.3 Vegetable consumption

Several questions were asked to gain insights into vegetable consumption habits.

One question related to the number of occasions that vegetables were consumed the previous day (in any form). Table 7 shows that most parents had consumed vegetables on two different occasions the previous day, whereas the children had consumed vegetables either on one or on two occasions.

**Table 7:** Number of occasions on which vegetables were consumed the previous day by parents and children (for example salad in a sandwich and vegetable with evening meal is twice)

	<b>Parent (in %)</b>	<b>Child (in %)</b>
Nil	2	0
Once	12	39
Twice	66	41
Three times	14	16
Four times	6	4
Total	100	100

Parents were also asked about the amount of different vegetables they usually consumed per day. Over half of the parents responded that they consumed either 3 or 4 vegetables each day (Table 8).

**Table 8:** The number of different vegetables usually consumed by the parent per day (includes fresh, frozen and tinned)

	<b>Parent (in %)</b>
Less than 1 vegetable per day	1
One vegetable per day	4
Two vegetables per day	12
Three vegetables per day	29
Four vegetables per day	25
Five vegetables per day	19
Six or more vegetables per day	10
Total	100

A third question related to how often the parent and their child had consumed a range of vegetables in the three months preceding the test. The vegetable consumption by the parents is shown in Table 9. Beans, cauliflower and sweet potato were in the middle range of vegetables in terms of consumption frequency (neither among the most nor the least consumed vegetables) with green beans being consumed more often than sweet potato and cauliflower.



**Table 9:** Consumption frequency of a range of vegetables by parents

<b>Vegetable</b>	<b>Average times per week</b>	<b>SD</b>	<b>Range</b>	<b>Not consumed by</b>
Tomato	4.23	3.19	0 - 14	5%
Carrot	3.94	2.38	0 - 14	1%
Lettuce	3.62	2.67	0 - 14	2%
Cucumber	3.30	2.61	0 - 14	5%
Potato	2.99	1.60	0 - 7	0%
Corn	2.75	3.09	0 - 27	2%
Broccoli	2.62	1.95	0 - 14	3%
Mixed dishes	2.57	2.94	0 - 21	3%
Mushroom	2.17	1.96	0 - 10	12%
Peas	2.12	1.60	0 - 7	4%
Capsicum	2.05	2.22	0 - 14	7%
<b>Green beans</b>	1.67	1.77	0 - 14	4%
Zucchini	1.56	1.93	0 - 14	14%
Spinach	1.54	3.41	0 - 32	20%
Celery	1.53	2.25	0 - 14	14%
Pumpkin	1.42	1.28	0 - 7	5%
Mixed frozen	1.36	1.44	0 - 6	17%
<b>Sweet potato</b>	1.30	1.16	0 - 7	8%
Legumes	1.25	1.45	0 - 7	16%
<b>Cauliflower</b>	1.15	1.27	0 - 7	8%
Cabbage	0.58	0.73	0 - 4	22%
Eggplant	0.49	0.81	0 - 5	32%
Squash	0.39	0.88	0 - 7	54%
Brussels sprouts	0.24	0.52	0 - 3	64%

Carrot, cucumber, potato and tomato were amongst the vegetables consumed most frequently by children. Similar to what was observed with the parents, the target vegetables of the study were in the middle range of consumption frequency, ranking 11<sup>th</sup> (green beans), 16<sup>th</sup> (cauliflower) and 17<sup>th</sup> (sweet potato) respectively out of the 24 listed vegetables and had been consumed by the large majority of children (by 96%, 92% and 92% of children respectively).

**Table 10:** Consumption frequency of a range of vegetables by children

<b>Vegetable</b>	<b>Average times per week</b>	<b>SD</b>	<b>Range</b>	<b>Not consumed by</b>
Carrot	3.42	1.90	0 - 7	2%
Cucumber	2.67	2.46	0 - 10	17%
Potato	2.53	1.56	0 - 7	3%
Tomato	2.32	2.11	0 - 7	22%
Broccoli	2.00	1.57	0 - 7	14%
Lettuce	1.98	1.90	0 - 7	23%
Peas	1.91	1.48	0 - 7	8%
Corn	1.87	1.32	0 - 7	2%
Mixed dishes	1.84	1.50	0 - 7	4%
Mushroom	1.26	2.41	0 - 14	34%
<b>Green beans</b>	1.23	1.08	0 - 5	10%
Mixed frozen	1.09	1.09	0 - 5	23%
Capsicum	1.05	1.52	0 - 7	44%
Legume	1.03	1.23	0 - 7	25%
Celery	0.98	1.54	0 - 7	40%
<b>Cauliflower</b>	0.96	1.01	0 - 6	13%
<b>Sweet potato</b>	0.95	1.08	0 - 7	12%
Pumpkin	0.92	0.91	0 - 6	11%
Zucchini	0.85	1.12	0 - 5	38%
Spinach	0.67	1.20	0 - 7	44%
Cabbage	0.34	0.55	0 - 4	44%
Eggplant	0.26	0.57	0 - 4	67%
Squash	0.19	0.67	0 - 5	83%
Brussels sprouts	0.15	0.44	0 - 3	80%

The measures used for our study are markers of vegetable consumption only. Higher scores on the measures such as the Vegetable Food Frequency Questionnaire (Table 10) and questions such as 'How many different vegetable do you [the parent] normally consume?' (Table 8) are likely to be markers of higher vegetable consumption but they do not measure consumption in a way that allows to compare them to actual validated vegetable intake. The use of validated intake measurements (such as the 2007 Australian Children's National Nutrition and Physical Activity Survey which used 24-hour dietary recalls (Bowen et al, 2009)) fell outside the scope of this project and thus data can be compared only indirectly.

The 2007 Australian Children's National Nutrition and Physical Activity Survey found that on the day of the survey, as many as one in 4 children within the 4-7 age group ate no major source of vegetable and one in 7 children had no vegetable whatsoever (Bowen et al, 2009). In contrast, all children in our study group had consumed vegetables on the day prior to the test (Table 7). Thus, vegetable consumption was higher in our consumer sample compared to national intake of children in the same age group.

### 3.1.4 Preparation practices at home of target vegetables

Parents were asked how they commonly prepared vegetables for their children at home. They were asked to provide details about cooking method and cooking times.

#### Sweet potato

Most commonly sweet potatoes were baked before consumption, followed by serving as a mash (Table 11). Twenty-eight percent of the parents typically prepared sweet potato in more than one way, most commonly a combination of baking and preparing a mash, or baking and preparing in an “other way” (examples are a mixed dish, mixed mash). Preparation times are shown in Table 12. Baking was most commonly done for 25-35 minutes, whereas boiling of sweet potatoes was most commonly done for 10-20 minutes.

The preparation methods used in our study (baking, boiling, mash) were amongst the most commonly used preparation methods for sweet potato. The preparation time for boiling fell within the range most commonly used. For baking we used smaller pieces than would normally be used in a household. In order to obtain a similar degree of “bakedness”, baking times had to be adapted accordingly and are therefore lower than were reported by parents.

**Table 11:** Commonly used preparation method for sweet potato (multiple answers possible)

Preparation method	%
Bake	62%
Boil	11%
Bake/boil then mash	30%
Other	16%
Never prepare sweet potato	9%

**Table 12:** Commonly used preparation time for sweet potato

Baked	%	Boiled	%
10 min	2	2 min	8
15-20 min	20	10 min	25
25-35 min	42	15 min	33
40-45 min	25	20 min	25
60 min or more	12	30 min	8
Total	100	Total	100

#### Cauliflower

Cauliflower was most often either steamed, boiled or baked (Table 13). Thirty-one percent of the parents typically prepared cauliflower in more than one way, most commonly a combination of two of the above. Steamed was done either short (3-5 min) or long (10-15 min), whereas boiling was generally for 5 – 10 min (Table 14). Preparation times for baking ranged from 1 to 10 minutes (Table 14).

**Table 13:** Commonly used preparation method for cauliflower (multiple answers possible)

<b>Preparation method</b>	<b>%</b>
Steam or boil	56%
Boil	19%
Bake	28%
Raw / fresh	3%
Other	19%
Never prepare cauliflower	9%

**Table 14:** Commonly used preparation times for cauliflower

<b>Steamed</b>	<b>%</b>	<b>Boiled</b>	<b>%</b>	<b>Baked</b>	<b>%</b>
1-2 min	5	1-3 min	10	1-3 min	24
3-5 min	46	5-7 min	45	4-5 min	34
6-9 min	14	10 min	40	6-8 min	14
10 min	24	15 min or more	5	10 min	24
15 min or more	12			15 min or more	3
<b>Total</b>	<b>100</b>	<b>Total</b>	<b>100</b>	<b>Total</b>	<b>100</b>

The preparation methods used in our study (boiling, baking) were amongst the most commonly used preparation methods. We used two preparation times for boiling (5 and 15 min). The shorter boiling time was common amongst parents whereas the longer boiling times were seldom used. The baking time we applied (10 min) fell within the wide range of preparation times used by parents.

### Beans

The most common preparation methods for beans were steaming, boiling and stir frying (Table 15). Forty percent of the parents typically prepared green beans in more than one way for their child, most commonly a combination of two of the above.

Steaming and stir frying mostly used short cooking times (mostly 3-5 min) whereas boiling was done short (4-5 min) by 41% of parents and longer (10-12min) by 30% of parents (Table 16).

**Table 15:** Commonly used preparation method for green beans (multiple answers possible)

<b>Preparation method</b>	<b>%</b>
Canned and reheated	2%
Steam	52%
Boil	32%
Stir fry	39%
Raw / fresh	10%
Other	9%
Never prepare green beans	4%

**Table 16:** Commonly used preparation times for green beans

<b>Steamed</b>	<b>%</b>	<b>Boiled</b>	<b>%</b>	<b>Stir fried</b>	<b>%</b>
1-2 min	15	1-3 min	18	1-3 min	27
3-5 min	55	4-5 min	41	4-5 min	49
6-9 min	13	6-8 min	12	6-8 min	7
10 min	9	10 min	21	10 min	7
12 min or more	9	12 min or more	9	12 min or more	10
Total	100	Total	100	Total	100

The preparation methods used in our study (boiling, stir-frying) were amongst the most commonly used preparation methods for green beans. We used two preparation times for boiling (4 and 12 min). Similar to what was observed for cauliflower, the shorter boiling time was much more often applied in the household than the longer boiling time.

### 3.1.5 Consumption of coloured varieties

Most children had never consumed and were therefore unfamiliar with the atypically coloured varieties of the target vegetables used in this study (Table 17):

- 86% had never consumed yellow beans
- 90% had never consumed green cauliflower
- 79% had never consumed purple/white sweet potato

**Table 17:** Previous consumption of coloured varieties (multiple answers possible)

Variety	n	%
Yellow beans	15	14%
Green cauliflower	11	10%
Purple sweet potato	22	21%

### 3.1.6 Use of strategies to increase vegetable acceptance

The majority of the parents (72%) had used a strategy to make vegetables more acceptable to their children (Table 18).

Strategies used to make green beans more acceptable predominantly were used by 31% of parents and consisted most often of mixing the beans with other ingredients to change the flavour (e.g. butter, garlic, cooked with onion, steamed with peas). Also mentioned were hiding or masking (cut up finely, mix with lots of other ingredients or serve with sauce) and changing the appearance (serve in different shapes, as part of a face, in combination with vegetables of different colours).

Strategies used to make cauliflower more attractive were used by 38% of parents and predominantly consisted of serving with cheese or white sauce. Other strategies mentioned were pureeing in soup, mixing in dishes or serving in different shapes/sizes.

Strategies used to make sweet potato more attractive were used by 30% of parents and predominantly consisted of preparing them in a specific way to create a crunchy texture (chips, fried, on barbeque, roasted) or as a mash. Less frequently, they were served together with other vegetables (e.g. potato, pumpkin) in a mash or bake. Adding other ingredients (e.g. butter, milk or herbs) were also mentioned by some parents.

**Table 18:** Percentage of consumers that used strategy to make vegetables more attractive

<b>Vegetable</b>	<b>%</b>
Green beans	31
Cauliflower	38
Sweet potato	30
Other	46
None	28

### 3.1.7 Sensory attributes reported as children’s likes and dislikes for vegetables

In an open-ended question parents were asked to list the vegetables that their child liked as well as the reasons for this liking. They were asked to be as specific as possible. The same question was asked with regards to dislikes of vegetables. It is important to understand these answers are only the opinion of the parent, and they may not actually truly know why their child likes or dislikes certain vegetables.

*Liked vegetables* – The vegetables that parents mentioned most often as being liked by their children were carrot, potatoes, corn, cucumber and peas (Table 19) and are therefore consistent with the results shown in Figure 3. Texture attributes were most frequently mentioned as reasons for liking, followed by flavour attributes (Table 19). For carrots, potato and cucumber the texture attributes were mentioned more often than the flavour attributes, whereas for corn the opposite was the case. Appendix D provides further details about the aspects the parents mentioned. Liked sensory attributes were:

- Flavour - sweetness and overall flavour
- Texture - crunchy (e.g. in carrot, cucumber) and soft (e.g. in mashed potato)
- Appearance – colour, shape (broccoli was liked for its “tree-like” appearance) and “fun” (e.g. corn on the cob, beans)

**Table 19:** Vegetables that parents spontaneously mentioned their child liked as well as the sensory attributes liked of these vegetables

	Number of consumers	Taste in general	Smell	Flavour	Texture	Appearance	Other
Carrot	59	10		18	37	8	
Potatoes	50						
- mashed potato	26			3	12		3
- baked / chips	12			2	5		
- unspecified	14	3		3	7		
Corn	39		1	19	11	3	18
Cucumber	31	4		11	21		
Peas	25		1	7	7	3	11
Broccoli	23	3		5	5	12	3
Tomatoes	20			7	4	5	3
Beans	14	1	1	3	6		4
Cauliflower	11			2	2	4	1
Lettuce	8	1		2	7		
Capsicum	7			3	4	2	
Pumpkin	7			6	3		1
Sweet potato	6	2		3	3		
Mushroom	5			4			2
Spinach	4			2			2
Avocado	3			1	1		2
Beet root	3			3	1	1	
Celery	3				3		
Snow peas	3			1	2		
Zucchini	3			3			1
Cabbage	2			1			1
Asparagus	1	1					
Baked beans	1						1
Bean sprouts	1						1
Eggplant	1	1					
Kumera	1			1	1		
Lentils	1	1					
Parsnip	1			1	1		
Squash	1			1			
Swede	1						1
<b>Total</b>		<b>27</b>	<b>3</b>	<b>112</b>	<b>143</b>	<b>38</b>	<b>55</b>

*Disliked vegetables* - The vegetables that parents mentioned most often as being disliked by their children were Brussels sprouts, tomato, mushroom, eggplant and zucchini (Table 20). With the exception of tomato (which interestingly is frequently mentioned both as a liked and a disliked vegetable), these results show a close match with the results from Figure 3. Texture attributes were most frequently mentioned as reason for this dislike followed by taste in general and flavour attributes. Smell was also frequently mentioned as a reason for dislike (but not for liking). Appendix E provides further details about the attributes the parents mentioned.

Disliked sensory attributes were:

- Flavour – bitterness, lack of flavour, lack of sweetness.
- Texture - too soft, too hard or mushy.
- Odour – overall smell
- Appearance - “look”

**Table 20:** Vegetables that parents spontaneously mentioned their child disliked as well as the sensory attributes disliked of these vegetables

Vegetable	Number of consumers	Taste in general	Smell	Flavour	Texture	Appearance	Other
Brussels sprouts	20	1	8		2	2	
Tomato	18	4		7	5		
Mushroom	16	2	2	2	6	5	
Eggplant	15	2	1	3	4	4	2
Zucchini	15	4	1	3	4	1	
Pumpkin	14	3	2	5	6		
Beans	9	5			3	1	
Broccoli	9	4	4	1	2	1	
Cauliflower	9	1	3	2		2	1
Cabbage	8	1	4	1		2	
Capsicum	8	3	1	3	2	1	
Lettuce	8			5	5	1	1
Peas	7	2		1	4	1	
Squash	7	2	1	1	3	2	
Onion	6	1	1	1	2		1
Spinach	5			2	1	4	
Sweet potato	5	2	1	1	3		
Beetroot	4	1		2	1	1	
Celery	4	2		1	4		
Cucumber	3	3				1	
Potato	2				2		
Asparagus	1			1			
Avocado	1				1	1	
Bitter melon	1			1			
Carrot	1				1		
Choko	1	1					
<b>Total</b>		<b>44</b>	<b>29</b>	<b>43</b>	<b>61</b>	<b>30</b>	<b>5</b>



### 3.1.8 Background of the participants

Over 80% of the children were accompanied to the test site by their mother. The age of the accompanying parent ranged from 23 to 50 years, with an average age of 37.3 years and a standard deviation of 5.5 years. Parents were from a range of educational backgrounds, generally having completed high school, a technical qualification or university (Table 21).

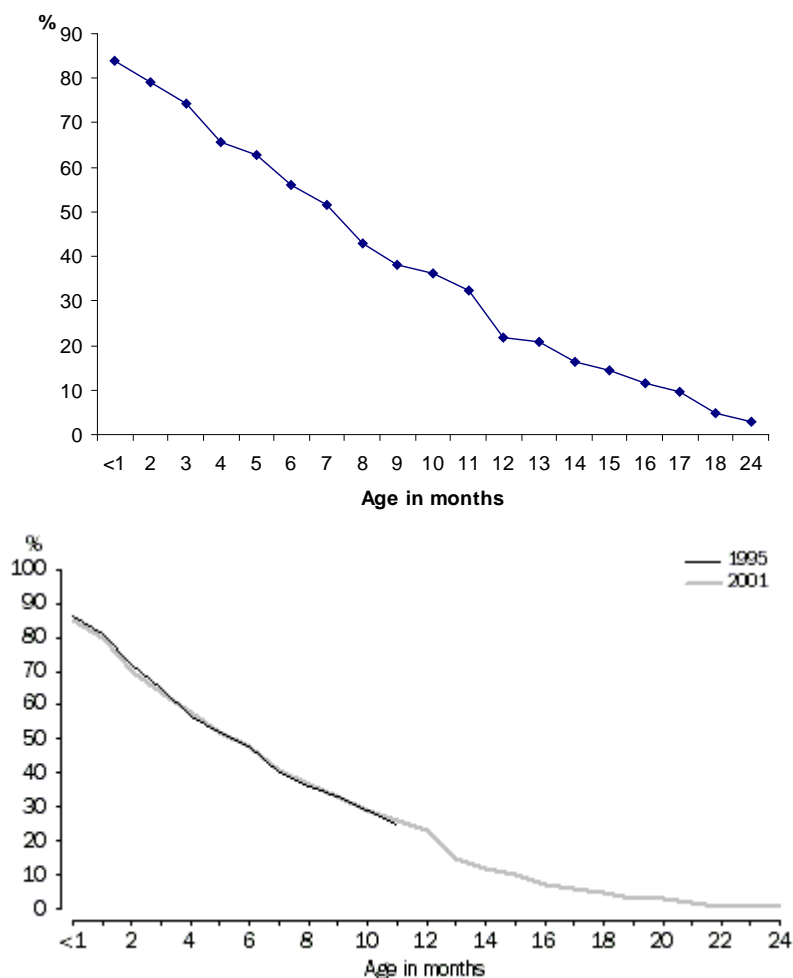
Compared to state and national data (Australian Bureau of Statistics, 2009), the consumer sample seemed to have a slight overrepresentation of parents with a relatively high education level (Table 21).

**Table 21:** Highest level of education completed by parent accompanying the child compared with state and national data (ABS, 2009)

<b>Level of education</b>	<b>Consumer sample (%)</b>	<b>NSW (%)</b>	<b>Australia (%)</b>
Some high school	3	-	-
Completed high school	26	44.0	46.1
Tech, Trade or TAFE qualification	35	35.0	34.2
University	24	16.8	15.8
Post-graduate studies	12	4.2	3.9

The majority of the children that participated in the study were breast fed (Figure 5). Our consumer sample seems to be fairly similar to the national statistics in breastfeeding duration with a slightly higher percentage of children being breastfed at six months (56% in our sample compared to 48% in Australia) and a similar percentage being breastfed at one year (22% in our sample compared to 23% in Australia) (Australian Bureau of Statistics, 2001) (Figure 5a and b).

**Figure 5:** Proportion of children breastfed by age in months in a) the current study and b) Australia (ABS, 2001)



The majority of the children had one or more siblings (Table 22) and they were about equally often the youngest as the oldest child in the family (Table 23). The Australian Bureau of Statistics does not provide a breakdown of number of children per family. On average, couple families with dependent children of which the eldest child is over 5 years old have 2.2 children (ABS, 2007-08), and therefore our sample is well represented in terms of number of children (Table 22).

**Table 22:** Number of siblings of participating child

Siblings	%
Only child	12
One sibling	50
Two or more siblings	38

**Table 23:** Order of the child within the family

Order	%
Youngest child	39
Middle child	12
Oldest child	36
Only child	12

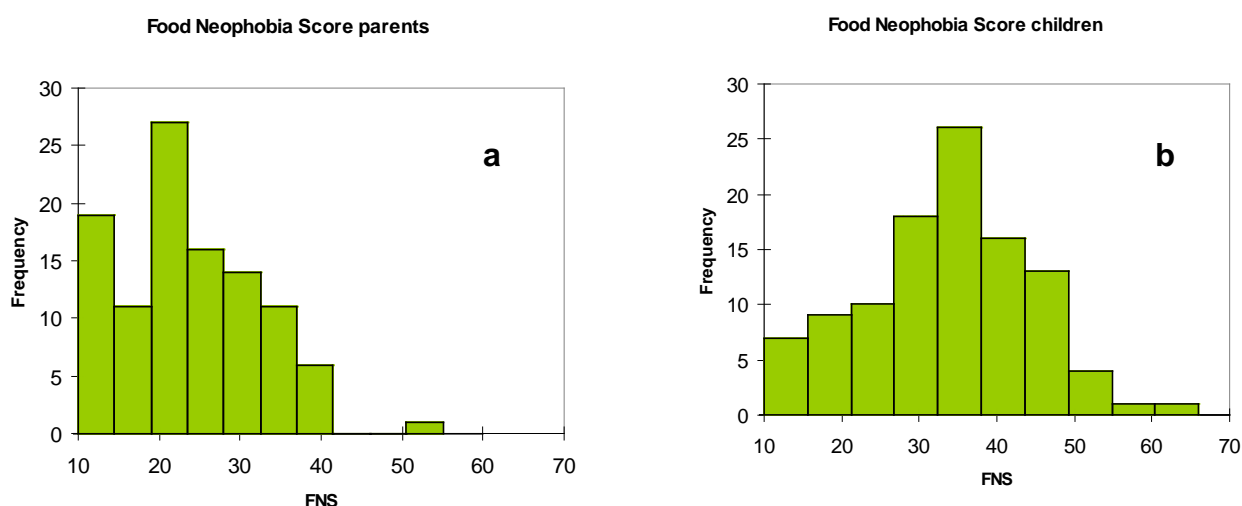
### Food Neophobia

Food neophobia refers to the willingness to try new foods. It was measured using a Food Neophobia Scale (FNS) that ranges from 10 to 70, and which is validated for adults (Pliner and Hobden, 1992) and children (Pliner, 1994). The parent completed the FNS for their child and themselves. A person scoring high on the FNS is neophobic, i.e. very reluctant to try new foods. A person with a low score on the FNS is neophilic, i.e. very willing to try new foods.

Results for parents and children are provided in Figure 6. The results show that parents were rather neophilic (Figure 10a), their average FNS was 22.3 (SD of 8.6). The children were less neophilic than the parents (Figure 10b), their average FNS was 33.7 (SD of 10.6). The correlation of Food Neophobia between parent and child was significant ( $r_{104} = 0.28, p=0.004$ ).

The children in our sample were slightly more willing to taste new foods than found by Pliner (1994), with a mean average FNS score of 40.6 in her study compared to 33.7 in the current study. The strength of the correlation of Food Neophobia between parent and child in our study was similar to what was observed in the literature (Pliner, 1994).

**Figure 6:** Food Neophobia scores by a) parents and b) children



## 3.2 Children's evaluations of the target vegetables

### 3.2.1 Evaluations on the basis of appearance

Before tasting, and thus based on appearance only, each child indicated which sample he / she thought they would prefer. Significant differences were obtained within each of the three vegetable types (sweet potato:  $\chi^2(3) = 14.3$ ,  $p=0.003$ ; cauliflower  $\chi^2(3) = 44.8$ ,  $p < 0.0001$ ; beans  $\chi^2(3) = 56.0$ ,  $p < 0.0001$ ). The results were comparable for the three vegetable types (Table 24). The atypically coloured sample was chosen relatively more often than the other samples; this was most pronounced for cauliflower and beans. The baked or stir fried sample was chosen relatively less often than the other samples. The children were asked to indicate one sample only, so the data do not imply that the baked or stir fried samples looked unacceptable, but rather that others were preferred to these samples more often on the basis of appearance.

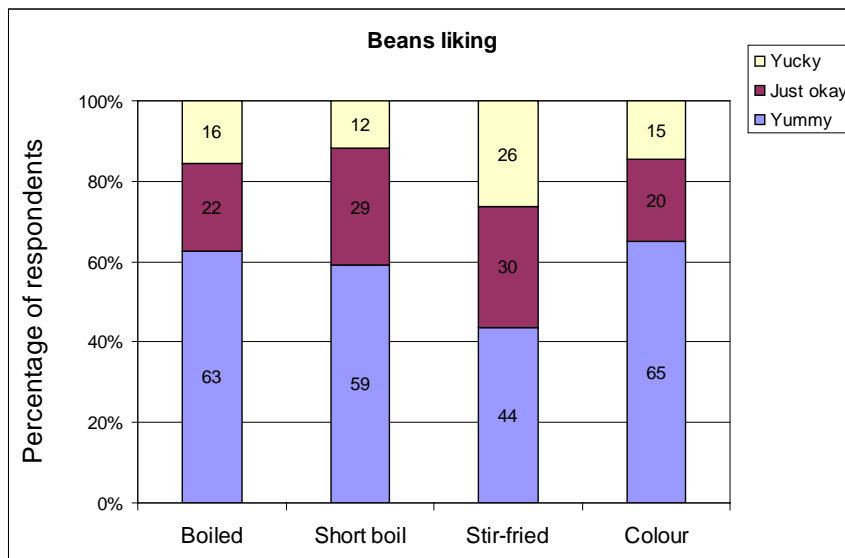
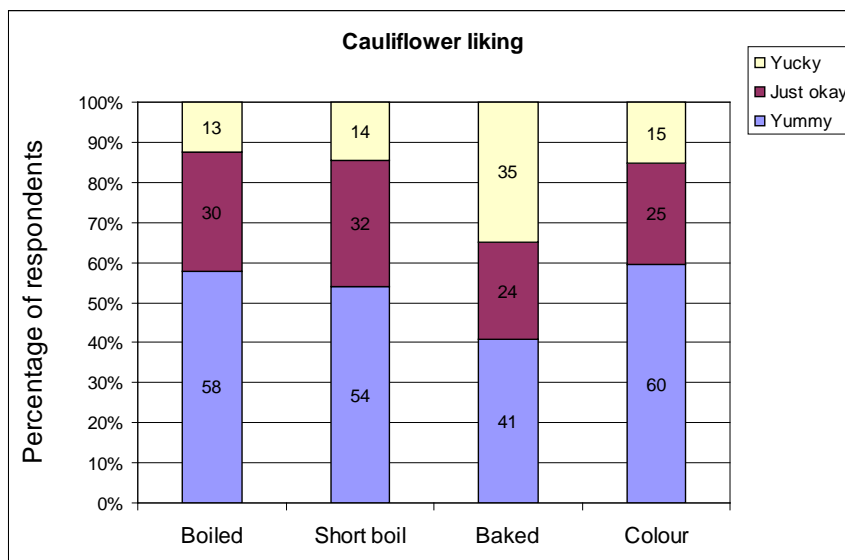
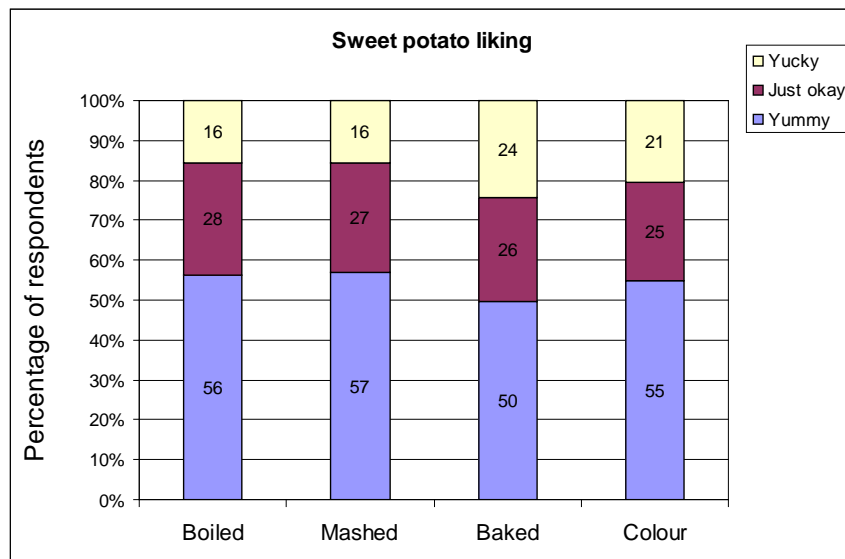
**Table 24:** Sample chosen on basis of appearance (n=104)

Vegetable type	Sample	Number of times chosen	Percentage chosen within vegetable type (in %)
<b>Sweet Potato</b>	Boiled	29	27.9
	Mashed	24	23.1
	Baked	14	13.5
	Colour	37	35.6
<b>Cauliflower</b>	Boiled	18	17.3
	Short boil	22	21.2
	Baked	13	12.5
	Colour	51	49.0
<b>Beans</b>	Boiled	18	17.3
	Short boil	18	17.3
	Stir fried	13	12.5
	Colour	54	51.9

### 3.2.2 Acceptance of samples

Figure 7 shows the percentage of children that gave a “yummy”, “just okay” and “yucky” response to the vegetables prepared in different ways. The children were allowed to use each response category as often as they wished. Overall, samples were relatively well accepted, since most samples were categorised as “yummy” by more than half of the children. Baked cauliflower and stir fried beans were rated as “yummy” by less than half of the participants and they were also the most often disliked (i.e. rated as “yucky”).

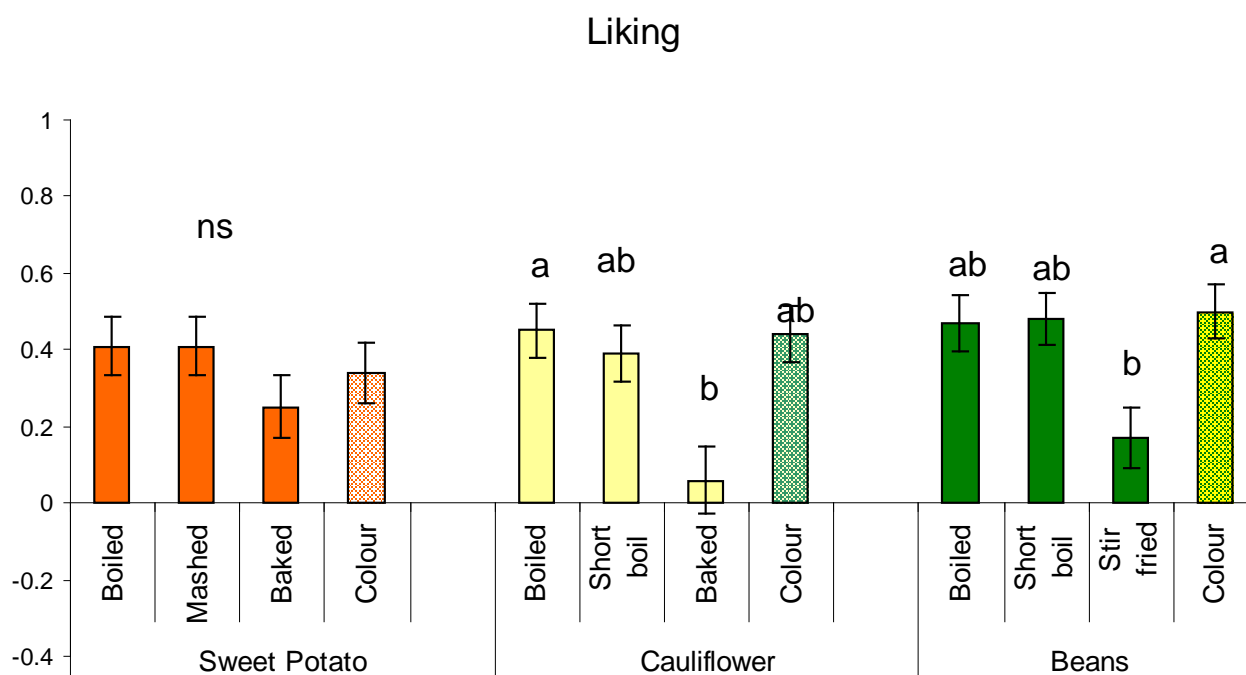
**Figure 7:** Children’s liking for the three vegetable types each prepared in four different ways – percentage of response categories “yummy”, “just okay” and “yucky”



Mean liking ratings and statistical differences are shown in Figure 8. Statistical analysis within each of the three vegetable types separately showed:

- The sweet potato samples were all liked the same, regardless of the way they were prepared ( $X^2(3) = 2.5$ ;  $p > 0.05$ ).
- There were significant differences in liking between the cauliflower samples prepared in different ways ( $X^2(3) = 15.4$ ;  $p = 0.002$ ). White cauliflower was liked more when it was boiled than when it was baked, but the differences in liking between the other samples were not significant.
- There were significant differences in liking between the beans samples prepared in different ways ( $X^2(3) = 13.9$ ;  $p = 0.003$ ). The boiled yellow beans were liked more than the stir fried green beans, whereas there were no significant differences between the other samples.

**Figure 8:** Mean liking for three different vegetable types each prepared in four different ways



Statistical analysis across the three vegetable types showed that there were no significant differences in liking between the three vegetable types, i.e. sweet potato, cauliflower and beans were liked the same. This was the case across three preparation methods (boiled, baked or stir fried, and colour) as well as within each preparation method separately (e.g. comparing liking for boiled sweet potato, boiled cauliflower and boiled beans).

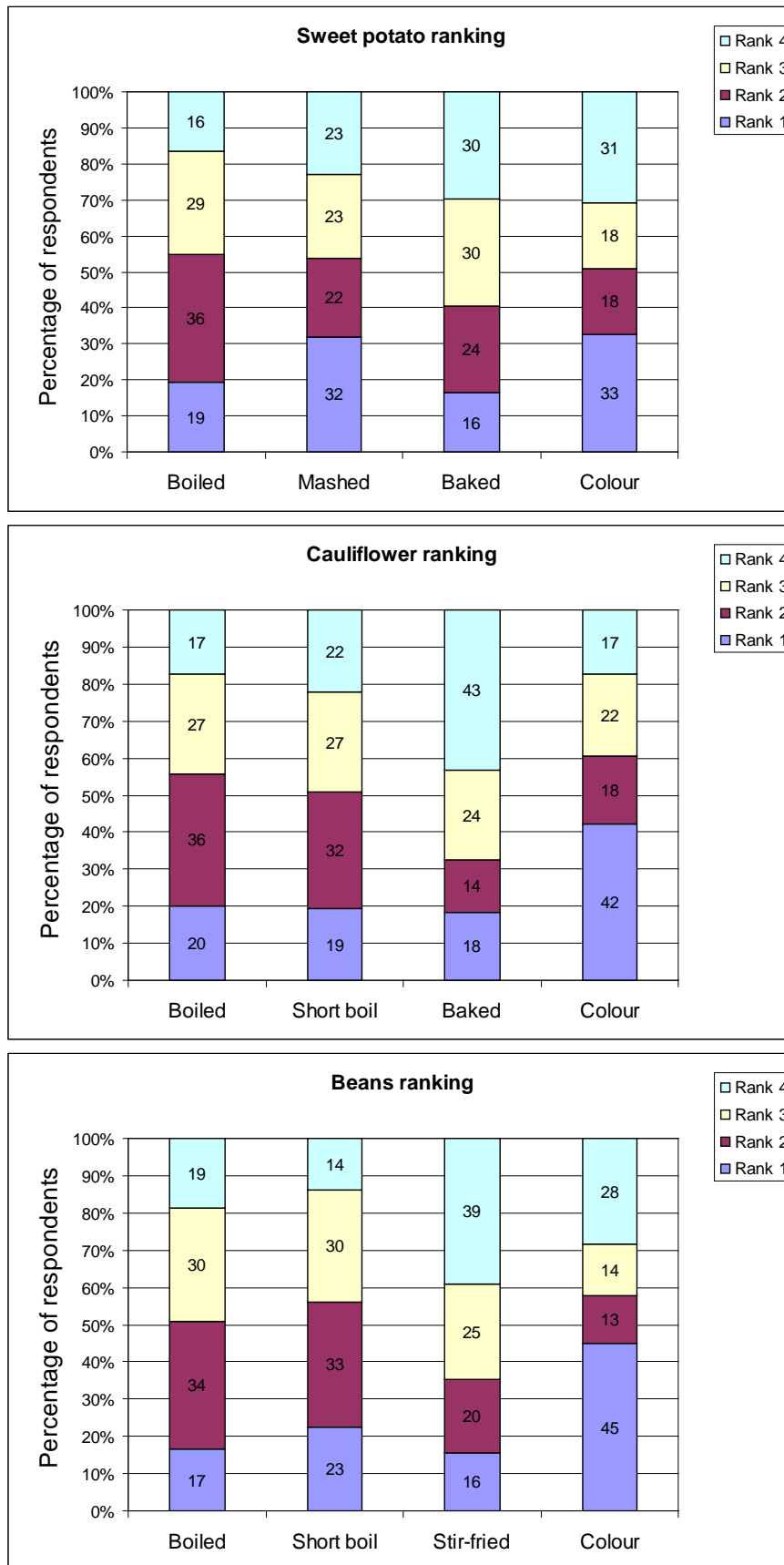
### 3.2.3 Preference for samples

Once children had indicated their liking for the samples, they were asked to rank the samples in their order of preference. Results show that the overall tendencies in ranked preference and liking data were the same but ranked preference data were more pronounced in finding differences (Figure 9). The mashed and the atypically coloured sweet potato sample were preferred the most, but the atypically coloured sweet potato was also the least preferred sample for a third of the children. The results for cauliflower and beans showed that the atypically coloured sample was preferred the most whereas the baked or stir fried sample was the least preferred.

Mean ranked preference data are shown in Figure 10. Statistical analysis within each of the three vegetable types separately showed:

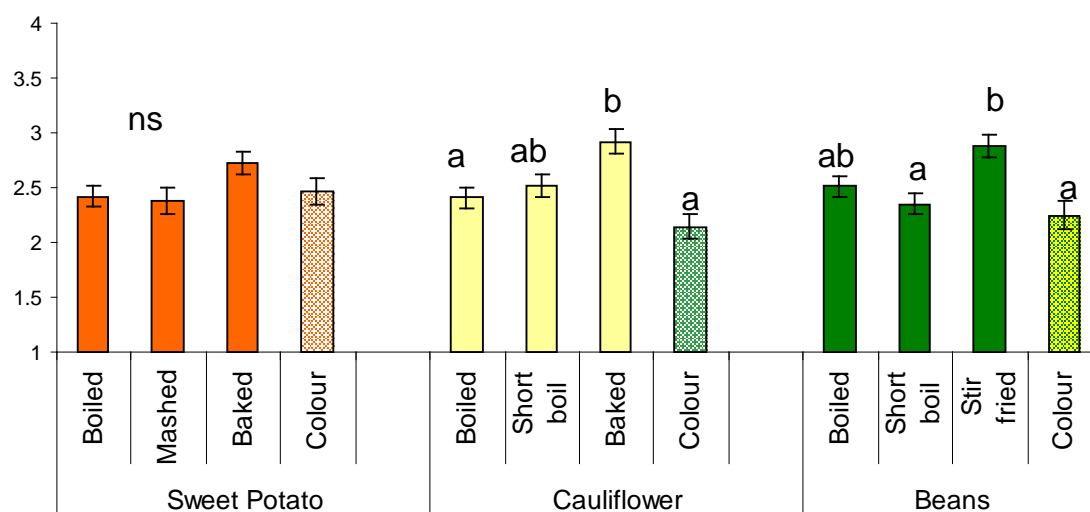
- The sweet potato samples were all ranked the same, regardless of the way they were prepared ( $X^2(3) = 4.7$ ;  $p > 0.05$ ).
- There were significant differences in ranked preference between the cauliflower samples prepared in different ways ( $X^2(3) = 19.6$ ;  $p < 0.0001$ ). White and green boiled cauliflower was preferred to baked white cauliflower. Samples boiled for the same time but with a different colour were liked the same and the difference in cooking time (boiled versus short boil) also did not affect liking for cauliflower.
- There were significant differences in ranking between the bean samples prepared in different ways ( $X^2(3) = 14.3$ ;  $p = 0.003$ ). The boiled yellow beans and the short boiled green beans were preferred to stir fried green beans. Similar to cauliflower, ranked preference was the same for samples of different colour but boiled for the same amount of time. The difference in cooking time of two green bean samples (boiled versus short boiled) also did not affect ranked preference .

**Figure 9:** Children’s ranked preference for the three vegetable types each prepared in four different ways – percentage of ranks (1=most preferred, 4 = least preferred)





**Figure 10:** Mean ranked preference\* for three different vegetable types each prepared in four different ways



Samples sharing the same letter were not significantly different from each other

\* 1 = most preferred, 4 = least preferred; thus the lower the rank, the more preferred

### 3.2.4 Relation between preference before and after tasting the sample

To explore to what degree expectations may have affected preference after tasting, evaluations on the basis of appearance alone were compared to ranked preference after tasting at an individual child level. If preference would be determined by appearance alone, the sample with the highest rank preference would always be the same as the sample chosen on the basis of appearance.

Results show that there is no one-on-one relation between expected preference and preference after tasting (Table 25). A total of 49% of the children preferred by appearance the same sample that they preferred after tasting. Thus, 51% of children did not prefer the sample they expected to prefer the most. The agreement between expected preference and preference after tasting was the strongest for the atypically coloured varieties and the mashed sweet potato, indicating that expectations were most often met for these samples. Agreement was lowest for the baked and stir fried samples, indicating that children expecting to like those samples the most in fact did not after tasting.

Although the experimental design did not allow for any causal relationship to be inferred, the results indicate that children's preferences were not driven by appearance alone.

**Table 25:** Actual preference versus expected preference - Percentage of times that the sample ranked the highest for preference was also preferred on the basis of appearance

Vegetable type	Preferred sample following tasting	Agreement actual and expected preference (in %)
<b>Sweet Potato</b>	Boiled	35
	Mashed	52
	Baked	29
	Colour	65
<b>Cauliflower</b>	Boiled	38
	Short boil	40
	Baked	11
	Colour	64
<b>Beans</b>	Boiled	35
	Short boil	39
	Stir fried	31
	Colour	78
<b>Total</b>		49

### 3.3 Descriptive sensory analysis

Nineteen sensory attributes were rated by the trained sensory panel. Two attributes related to the odour, two to appearance, eight to taste and flavour, six to mouthfeel and one attribute related to the aftertaste / afterfeel of the samples (see Table 3). Mean intensities and the results of the statistical analysis (F and P values) are summarised in Table 26. The main overall results were:

- There were significant differences between the twelve vegetable samples for all attributes with the exception of *salty taste*. Differences in *sour taste* were small and did not have practical relevance.
- The main differences between the three vegetable types were related to *colour intensity*, *shiny appearance*, *sweet taste*, *crunchiness*, *firmness*, *mastication effort* and *moisture release*<sup>1</sup>.
  - In *colour intensity* (from light to dark) and *shiny appearance*, cauliflower was the least intense and green beans the most intense.
  - Sweet potato was more intense in *sweetness* than cauliflower and beans.

<sup>1</sup> Attributes found in only one sample are not included in this, e.g. yellow colour, mashed texture

- Sweet potato was less intense in *crunchiness, firmness, mastication effort* and *moisture release*.
- The baked and stir fried samples differed from the other samples by having a higher intensity in *odour impact, oily flavour* and *oily mouthcoating*. The baked cauliflower and stir fried beans were also more intense in *browned flavour*.
- The main differences within the vegetables types were related to the texture, the colour and sensory attributes related to the baking or stir frying process. Sample differences within each of the vegetable types are described below.

#### Sweet potato

- The four samples differed significantly from each other in 13 attributes (Table 26). The largest differences between the samples were found in texture, attributes related to the use of oil (including *oily mouthcoating*) and in *odour impact, colour intensity* and *sweet taste*. Significantly discriminating sensory attribute ratings are presented in Figure 11.
- The sensory profile of the baked sweet potato was different to that of the other samples. The baked sample was significantly more intense in *odour impact, shiny appearance, crunchy, firm, textural contrast, mastication effort, oily flavour* and *oily mouthcoating* than the other three samples.
- Mashed differed from boiled orange sweet potato in four attributes: mashed orange sweet potato was less *dark in colour, less crunchy* and *firm* and required less *mastication effort* than boiled orange sweet potato
- The two sweet potatoes of different colours but boiled for the same amount of time differed in three attributes. White boiled sweet potato was less *dark in colour, sweeter* in taste and *released less moisture* (i.e. was more dry) than orange boiled sweet potato.

#### Cauliflower

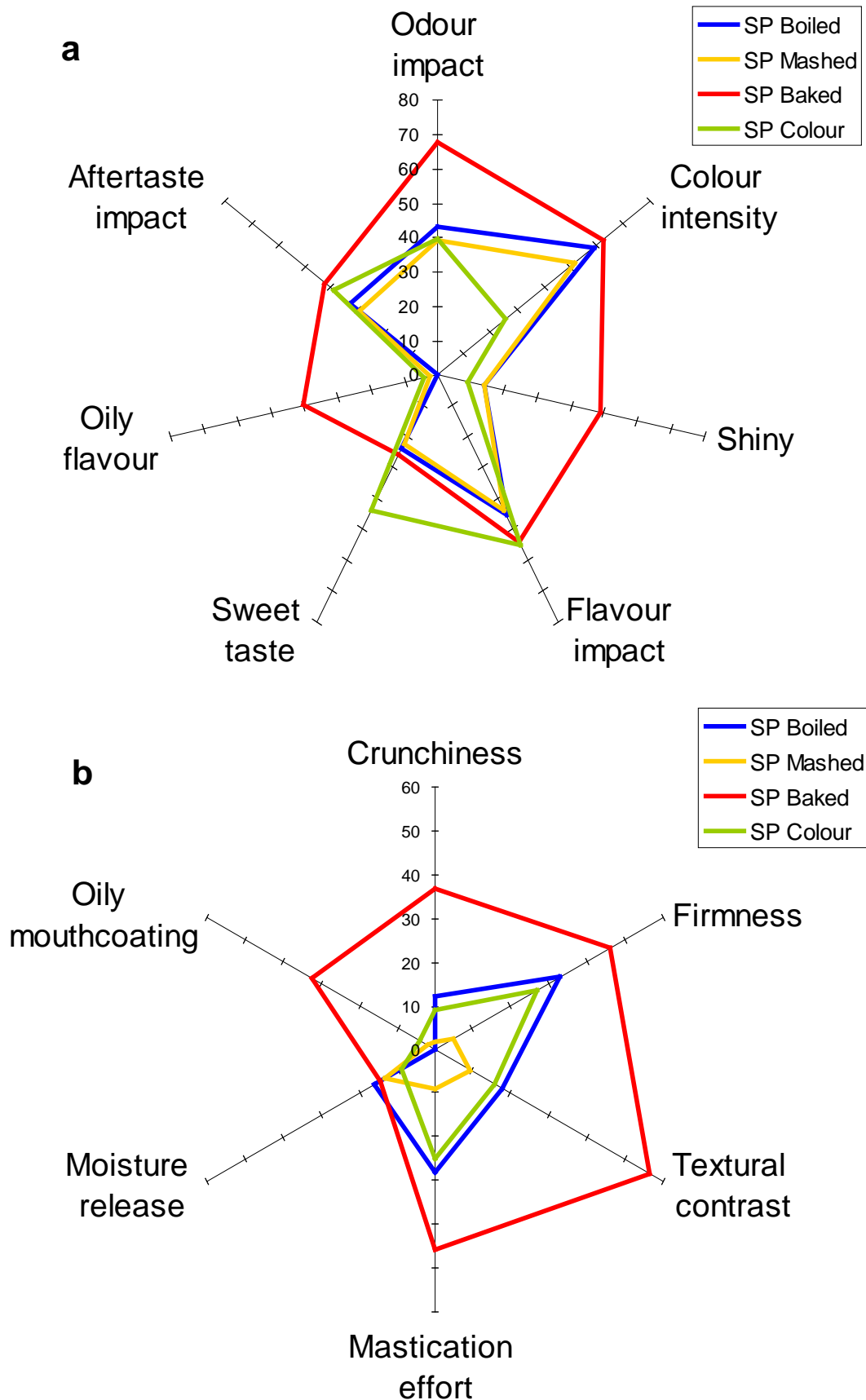
- The four samples differed significantly from each other in 13 attributes (Table 26). The largest differences between the samples were found in texture, attributes related to the use of oil (including *oily mouthcoating*) and the attributes *colour intensity, browned flavour, sweet* and *bitter*. Significantly discriminating sensory attributes are presented in Figure 12. Unlike sweet potato, there were no differences between the samples in *textural contrast*, whereas there were differences in perceived *bitterness*.
- Short boiled differed from boiled white cauliflower in texture / mouthfeel only: short boiled cauliflower was more *crunchy* and *firm*, required more *mastication effort* and *released less moisture* in the mouth.
- Baked differed from boiled white cauliflower in ten attributes that were related to “oily” (e.g. more intense in *oily mouthcoating*) and texture attributes (e.g. more *crunchy* and *firm*) but was also more intense in *odour impact, flavour impact* and *browned flavour*.

- Short boiled and baked cauliflower were similar in three texture attributes (i.e. *crunchiness*, *firmness* and *mastication effort*). At the same time, short boiled released more *moisture* whereas the baked cauliflower was more intense in attributes relating to the use of oil (*shiny appearance*, *oily mouthcoating*) and darker colour.
- Green boiled cauliflower differed from white boiled cauliflower in seven attributes (both samples had been boiled for the same amount of time): green cauliflower was more intense in *odour impact*, *colour intensity*, *bitterness*, *crunchiness* and *firmness*, *mastication effort* and less intense in *moisture release*.

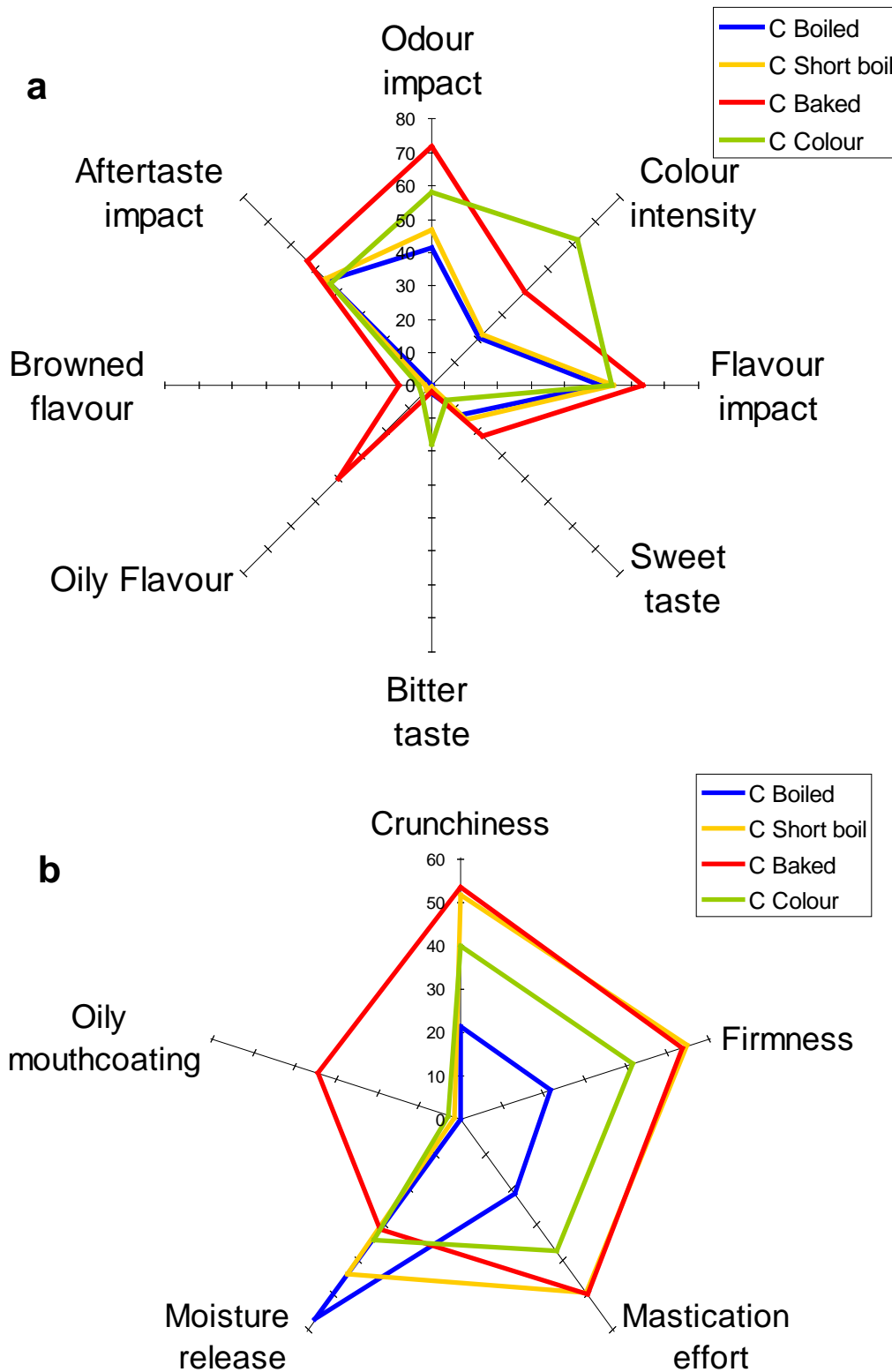
### Beans

- The four samples differed significantly from each other in 15 attributes (Table 26). The largest differences between the samples were found in the texture, attributes related to the use of oil (including *oily mouthcoating* and *browned flavour*), and *colour intensity*. Significantly discriminating sensory attributes are presented in Figure 13. Unlike sweet potato and cauliflower, there were no differences between the samples in *sweet taste*.
- Short boiled differed from boiled green beans in seven attributes: short boiled beans were less *dark in colour*, more *shiny*, more intense in *flavour impact*, were more intense in *crunchy*, *firm* and *textural contrast*, and released less *moisture* in the mouth.
- Stir fried differed from boiled green beans in thirteen attributes that were related primarily to “oily” (e.g. more intense in *oily mouthcoating* and *browned flavour*) and texture attributes (e.g. more *crunchy* and *firm*). The stir fried sample was also more intense in *odour* and *flavour impact*.
- The short boiled and stir fried green beans were similar in texture but differed in other attributes. The stir fried beans were more intense in *odour impact*, *shiny appearance*, *oily mouthfeel* and *browned flavour* whereas the short boiled beans were higher in *vegetable odour* and *flavour*.
- The yellow and green beans boiled for the same amount of time differed in two attributes. The green beans were darker and more intense in bean flavour than the yellow beans.

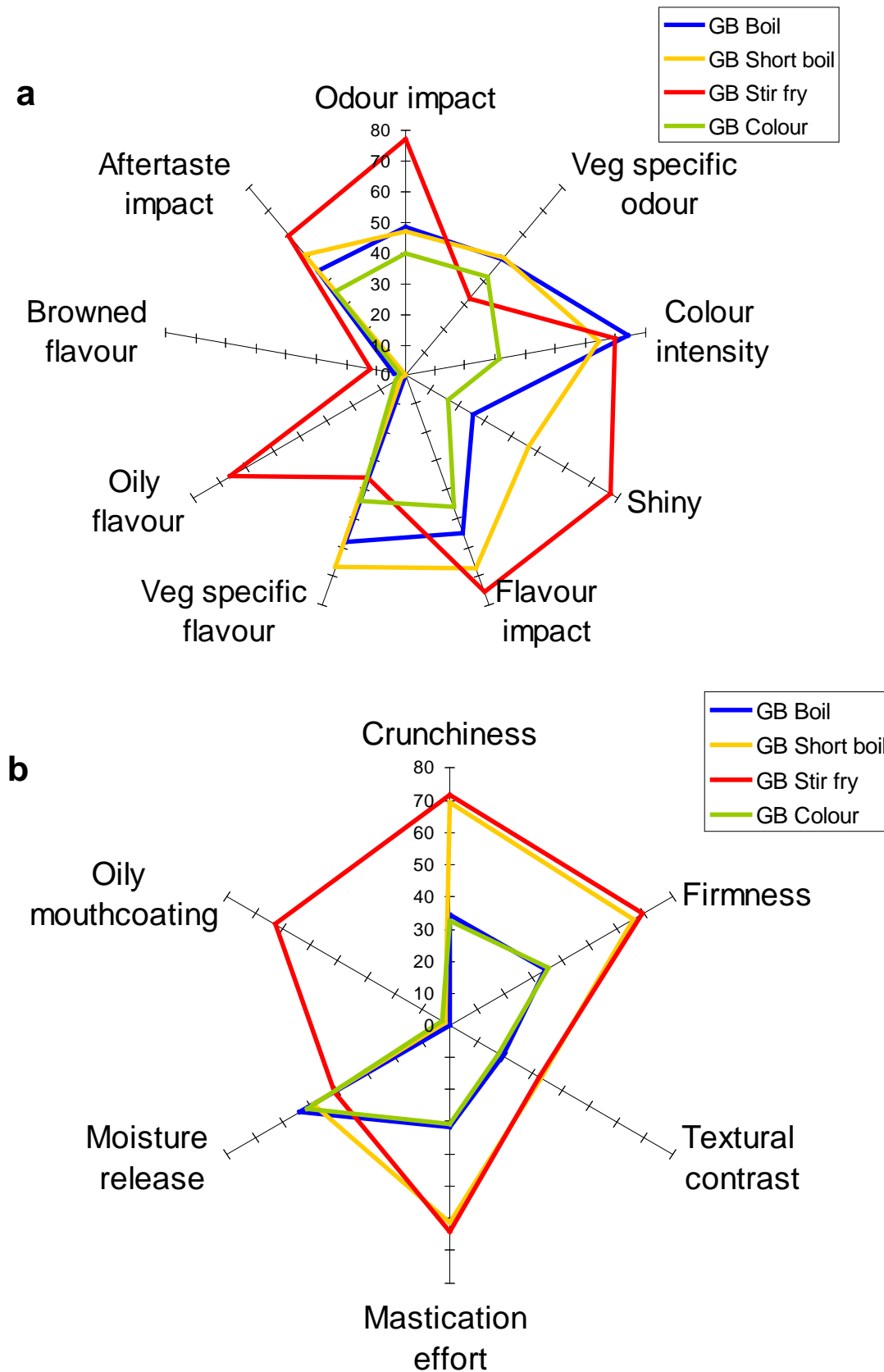
**Figure 11:** Spider plots of significant a) odour / flavour and b) texture / mouthfeel differences between the four sweet potato samples



**Figure 12:** Spider plots of significant a) odour / flavour and b) texture / mouthfeel differences between the four cauliflower samples



**Figure 13:** Spider plots of significant a) odour / flavour and b) texture / mouthfeel differences between the four beans samples



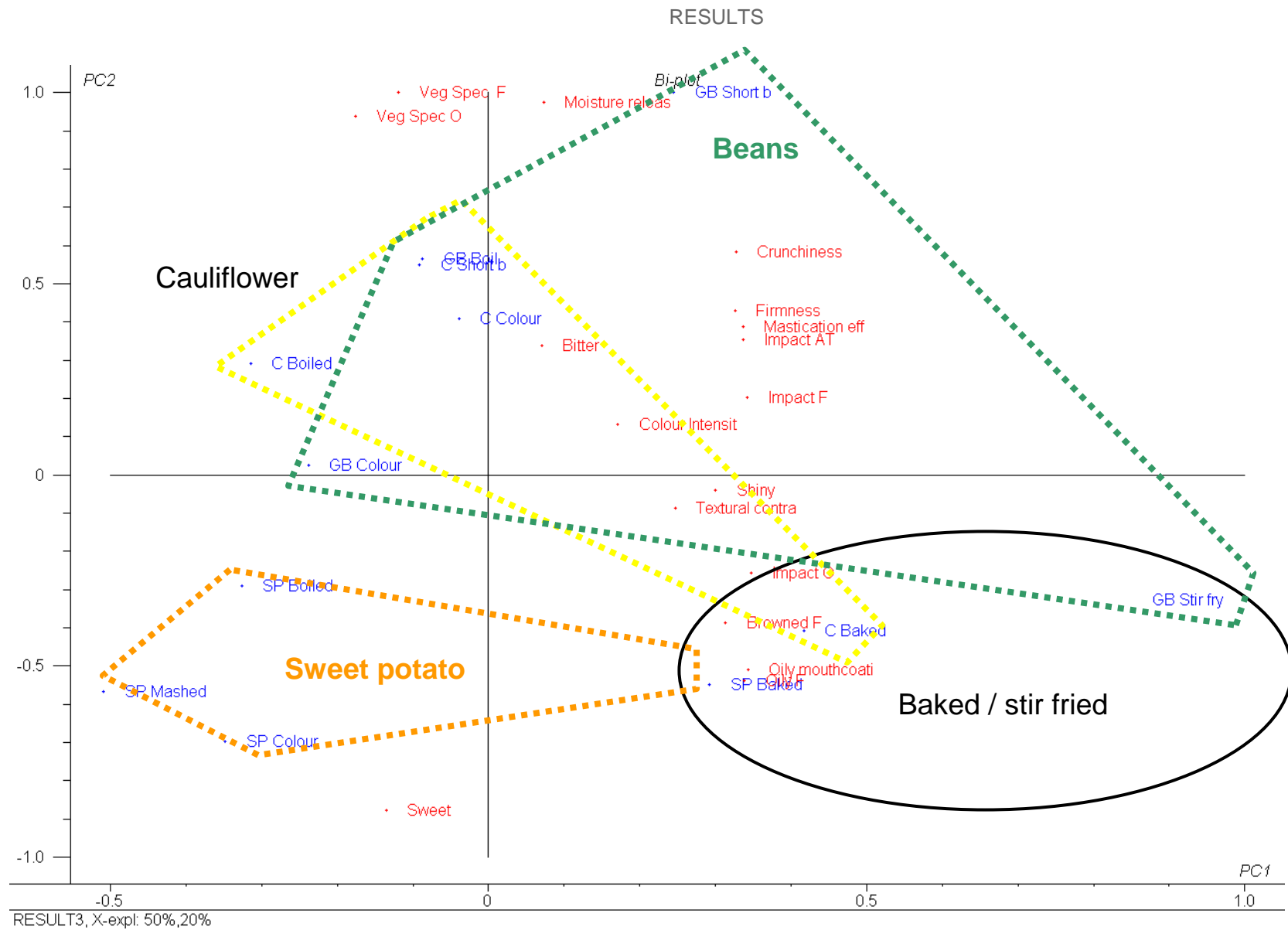
**Table 26:** Mean intensities of sensory descriptive analysis of vegetables odour, appearance, flavour/taste, texture / mouthfeel and aftertaste

Category	Odour		Appearance		Flavour / taste				
	Odour Impact	Vegetable specific O	Colour Intensity	Shiny	Flavour Impact	Sweet Taste	Bitter Taste	Salty Taste	Sour Taste
SP Boiled	43.24 d	46.41 ab	58.91 c	13.85 d	45.74 de	23.52 bc	0.76 b	1.85	2.06 ab
SP Mashed	38.94 d	43.30 ab	51.57 d	13.96 d	44.06 e	22.48 bcd	2.87 b	0.89	3.26 a
SP Baked	67.57 ab	43.41 ab	62.54 bc	48.98 b	53.93 cde	25.72 b	1.41 b	2.39	0.63 b
SP Colour	39.74 d	37.37 ab	25.52 fg	9.35 d	55.56 cd	43.80 a	0.33 b	1.37	0.52 b
C Boiled	41.22 d	46.19 ab	20.00 g	6.35 d	50.80 de	12.93 cde	2.61 b	1.76	0.30 b
C Short boil	46.74 cd	51.63 a	21.61 g	6.59 d	54.39 cde	14.93 bcde	0.61 b	1.35	0.37 b
C Baked	71.48 a	36.98 ab	39.39 e	7.61 d	63.43 bc	21.74 bcd	2.19 b	2.02	0.39 b
C Colour	58.07 bc	48.54 a	62.04 bc	6.85 d	53.76 cde	6.28 e	17.57 a	1.67	0.76 ab
GB Boiled	48.50 cd	49.44 a	73.87 a	25.58 c	55.31 cde	7.77 e	3.46 b	0.71	0.48 b
GB Short boil	47.15 cd	50.00 a	64.40 bc	46.48 b	67.08 ab	9.69 e	3.15 b	0.85	0.50 b
GB Stir-fried	77.17 a	32.52 b	69.40 ab	77.79 a	75.10 a	6.54 e	5.85 b	1.96	0.42 b
GB Colour	39.83 d	41.56 ab	31.35 f	15.83 cd	46.08 de	11.25 de	1.04 b	0.83	0.27 b
F value	27.8	3.0	150.6	103.2	12.4	19.4	14.5	1.1	2.6
P value	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	ns	0.004



RESULTS

Category	Flavour			Texture/ mouthfeel						Aftertaste
	Vegetable specific F	Oily Flavour	Browned Flavour	Crunchiness	Firmness	Textural contrast	Mastication effort	Moisture release	Oily mouth coating	Aftertaste Impact
SP Boiled	46.35 bcd	0.31 c	0.70 b	12.24 de	33.11 de	17.70 cd	28.22 def	16.07 f	0.78 c	33.13 ef
SP Mashed	44.04 cd	0.44 c	0.89 b	1.91 f	4.85 g	9.20 d	8.87 g	13.31 f	0.52 c	29.50 f
SP Baked	40.70 d	40.04 b	1.15 b	36.63 c	46.15 bc	56.44 a	45.80 bc	14.11 f	32.44 b	42.28 cde
SP Colour	49.15 bcd	0.52 c	0.59 b	9.07 ef	26.67 ef	15.46 cd	25.07 ef	8.59 g	0.96 c	39.00 def
C Boiled	55.69 abc	0.48 c	0.39 b	21.22 d	21.80 f	16.74 cd	20.91 f	56.81 a	0.31 c	44.54 bcd
C Short boil	55.91 abc	0.33 c	0.72 b	51.39 b	54.72 b	20.26 cd	49.07 b	43.89 bcd	0.74 c	45.19 bcd
C Baked	43.06 cd	39.43 b	9.94 a	53.19 b	53.35 b	24.63 c	49.57 b	31.39 e	34.33 b	53.22 ab
C Colour	46.57 bcd	0.50 c	0.57 b	39.70 c	41.48 cd	18.76 cd	37.24 cd	33.93 de	0.74 c	43.26 cd
GB Boiled	58.17 ab	0.52 c	1.25 b	34.56 c	34.31 de	18.96 cd	31.52 de	53.60 ab	1.46 c	44.38 bcd
GB Short boil	66.69 a	0.35 c	0.81 b	69.00 a	65.88 a	32.60 b	61.40 a	48.96 abc	1.29 c	51.21 abc
GB Stir-fried	35.73 d	66.08 a	11.60 a	71.69 a	69.33 a	31.88 bc	63.83 a	41.44 cde	62.81 a	59.56 a
GB Colour	43.63 cd	0.44 c	0.73 b	32.58 c	35.10 de	17.63 cd	30.46 def	51.21 abc	1.90 c	35.42 def
F value	8.6	142.5	11.0	99.0	69.0	28.1	52.1	47.8	109.3	15.4
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001



**Figure 14:** Principal Components Analysis (PC1 and PC2) of twelve vegetable samples and sensory attributes (coloured lines group samples from the same vegetable type)

Principal Components Analysis (PCA) shows that differences between the samples can be well explained by the two first dimensions, with a total explained variance of 70% (PC1: 50%; PC2 20%). Please note that the hue of the colour (thus orange, green etc) was not assessed by the panel since it was clear how samples differed in this aspect. Similarly, vegetable specific odour and flavour were rated instead of sweet potato flavour, cauliflower flavour and bean flavour separately. Thus, these obvious differences between samples are not taken into account in this PCA.

Figure 14 shows that the samples prepared with oil (baked and stir fried) were positioned in the lower right corner of the PCA and were characterised by an *oily flavour*, *oily mouthcoating*, *browned flavour* and *shiny appearance*. These samples were clearly separated from the other samples, but not very close together, indicating that there were also differences between them. The three sweet potato samples (other than the baked one) were positioned together in the lower left corner of the PCA and were characterised by a *sweet taste* relative to the other samples as well as a relatively low intensity of *crunchiness* and *firmness*. The bean and cauliflower samples (with the exception of the baked and stir fried ones) were in the upper quadrants of the PCA, and not clearly separated from one another. These samples were relatively intense in *moisture release* and *vegetable specific odour and flavour* (these terms relate to bean odour and flavour for the bean samples and to cauliflower odour and flavour for the cauliflower samples and are therefore NOT directly comparable in the odour / flavour quality). The boiled and coloured vegetables were positioned close together indicating there were relatively similar in sensory profile. The two short boiled samples were somewhat further removed from the other four samples. Table 3 shows that relative to the other boiled samples, the short boiled samples were more intense in *firmness*, *crunchiness* and *mastication effort*.

### 3.4 Relation between consumer liking and objective sensory characteristics

The relationship between children likes / dislikes and the objective sensory characteristics of the vegetables was determined quantitatively.

There were significant differences in acceptance between the cauliflower samples prepared in different ways. The boiled and the coloured cauliflower sample were preferred to the baked sample. These differences can be related to the *odour impact* or *browned flavour*, or to attributes deriving from the use of oil (i.e. *oily flavour* and *oily mouthcoating*), since all four attributes were more intense for the baked sample than the other two samples. It does not seem to be related to texture attributes related to chewing (e.g. *firmness*, *crunchiness*, *textural contrast*, *mastication effort*) since the short boiled and the baked sample were similar in these properties but were liked differently. At the same time, the samples boiled for different times were different in these texture aspects but were liked the same.

It is noteworthy that the green cauliflower had a slight *bitter taste* but was not liked less than the boiled white cauliflower.

There were also significant differences in acceptance between the beans samples prepared in different ways. The short boiled green and the yellow beans were preferred to the stir fried green beans. Similar to cauliflower, these differences were related to *browned flavour*, *odour impact* or to the use of oil (i.e. *oily flavour* and *oily mouthcoating*), since the stir fried sample was more intense in all four attributes than the other two samples. Similar to cauliflower, it does not seem to be related to texture attributes related to chewing (e.g. *firmness*, *crunchiness*, *textural contrast*, *mastication effort*).

There were no significant differences in liking between the sweet potato samples prepared in different ways, whereas they differed in odour, colour, taste, flavour and texture. Thus, these sensory differences did not translate into differences in liking. It is noteworthy that the baked sweet potato did not have a *browned flavour*, unlike the cauliflower and bean samples prepared in the same way (i.e. baked or stir fried).

There were no significant differences in liking between the vegetable types prepared in the same way, whereas they differed in *colour intensity*, *shiny appearance*, *sweet taste*, *crunchiness*, *firmness*, *mastication effort* and *moisture release*. Amongst others, sweet potato was more intense in *sweetness* and less intense in *crunchiness*, *firmness*, *mastication effort* and *moisture release* than cauliflower and beans. These sensory differences did not translate into differences in liking.

PLS-R showed that liking for the samples could be well predicted by two attributes: *odour intensity* and *browned flavour* (the model parameters were:  $R_{cal} = 0.87$ ,  $R_{val} = 0.76$ ,  $PC's = 1$ ,  $RMSEP = 0.08$ ). Both attributes were negatively correlated with liking, indicating that the more intense the *smell* and the *browned flavour*, the less the sample was liked. It is noteworthy that *browned flavour* intensities were low even in the baked or stir fried samples, but that these small differences were important for differences in liking.

### 3.5 Acceptance in relation to children's background variables

Acceptance for vegetables prepared or presented in different ways may be related to characteristics of the children, such as their current vegetable consumption. Moreover, some groups of children may be more sensitive to the way vegetables are prepared or presented than other groups of children. To determine whether this was the case, acceptance ratings were studied taking different background variables into account.

Data analyses were carried out on liking and preference ranking data. They led to similar results and only liking results are reported below.

### 3.5.1 Familiarity with methods of preparation

Familiarity with certain methods of preparation may lead to increased acceptance for this method. Parents were asked to record how the target vegetables were normally prepared at home (preparation method and preparation times; results were presented in Tables 11 to 16). These results were used to determine for each sample whether the child was familiar or unfamiliar to consuming the sample prepared in this way.

Familiarity with preparation methods increased acceptance for some vegetables. Generally acceptance was higher when the method of home preparation was similar to that tasted for this study, and the relationship was significant for baked sweet potato and (long) boiled cauliflower (i.e. 10 minutes or more) (Table 27).

**Table 27:** Acceptance for vegetables prepared in different ways depending on whether or not the child was familiar with consumed the vegetable at home prepared in this way

Sample	Child familiar with preparation method		Child unfamiliar with preparation method		P value
	Mean liking	No of children	Mean liking	No of children	
Sweet potato boiled	0.39	18	0.41	85	ns
Sweet potato mashed	0.52	31	0.37	71	ns
Sweet potato baked	0.38	66	0.03	37	0.04
Cauliflower boiled	0.70	27	0.36	77	0.03
Cauliflower short boil	0.42	45	0.37	59	ns
Cauliflower baked	0.24	33	-0.03	70	ns
Beans boiled	0.52	21	0.46	81	ns
Beans short boil	0.57	56	0.36	47	ns
Beans stir fried	0.07	43	0.25	60	ns

### 3.5.2 Reported liking for the target vegetable

Children who disliked a vegetable might be more “sensitive” to the way it is prepared than children who liked it. “Sensitive” refers to the range of differences in acceptance as a result of preparation and presentation. Thus, acceptance scores are expected to discriminate more for “sensitive” than for less “sensitive” children.

Parental responses about their child’s degree of liking for particular vegetables were used to separate the consumer sample in two groups: likers (child clearly or somewhat liked the vegetable) and dislikers (child clearly or somewhat disliked the vegetable).

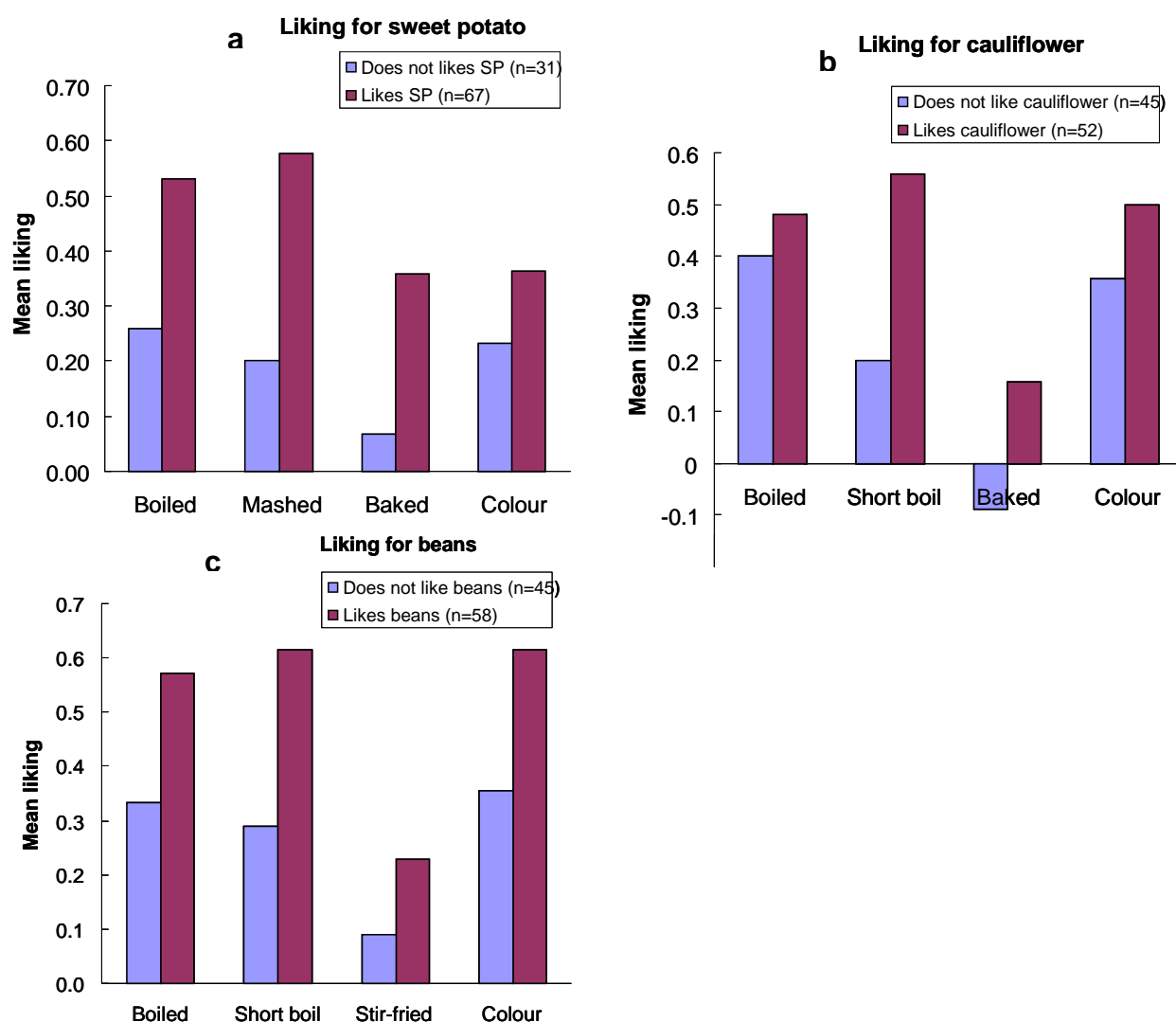
### Differences between groups

Reported likers accepted the same vegetable more than reported dislikers of the vegetable. Results were significant overall (i.e. taken over all vegetable types and preparations together) and also for mashed sweet potato, short boiled cauliflower and short boiled beans separately.

### Differences within groups

The results showed that preparation and presentation method influenced liking for cauliflower and beans for both dislikers and likers in the same way; the baked or stir fried sample was liked less than the other samples. In sweet potato, preparation and presentation did not influence liking for either the dislikers or the likers of sweet potato (Figure 15).

**Figure 15:** Acceptance for vegetables prepared in different ways by reported likers and dislikers for the vegetable: a) sweet potato, b) cauliflower and c) beans



### 3.5.3 Overall liking for vegetables

Children who like fewer vegetables may be more sensitive to the way a vegetable is prepared than children who like many vegetables.

Parents had indicated how much their child liked 24 different vegetable types and these results were used to separate the consumer sample into two groups: children who reportedly liked many vegetables (liked 13 vegetables or more, n=52) and children who reportedly liked fewer vegetables (liked 10 vegetables or less, n=37).

#### Comparison between groups

Children reportedly liking fewer vegetables accepted the vegetables tasted less than children reportedly liking many vegetables (Table 28). This result was found taken over all twelve samples and also specifically for mashed and baked sweet potato, short boiled and baked cauliflower and short boiled beans.

**Table 28:** Comparison of acceptance for vegetables by children who reported liked few versus many different vegetable types

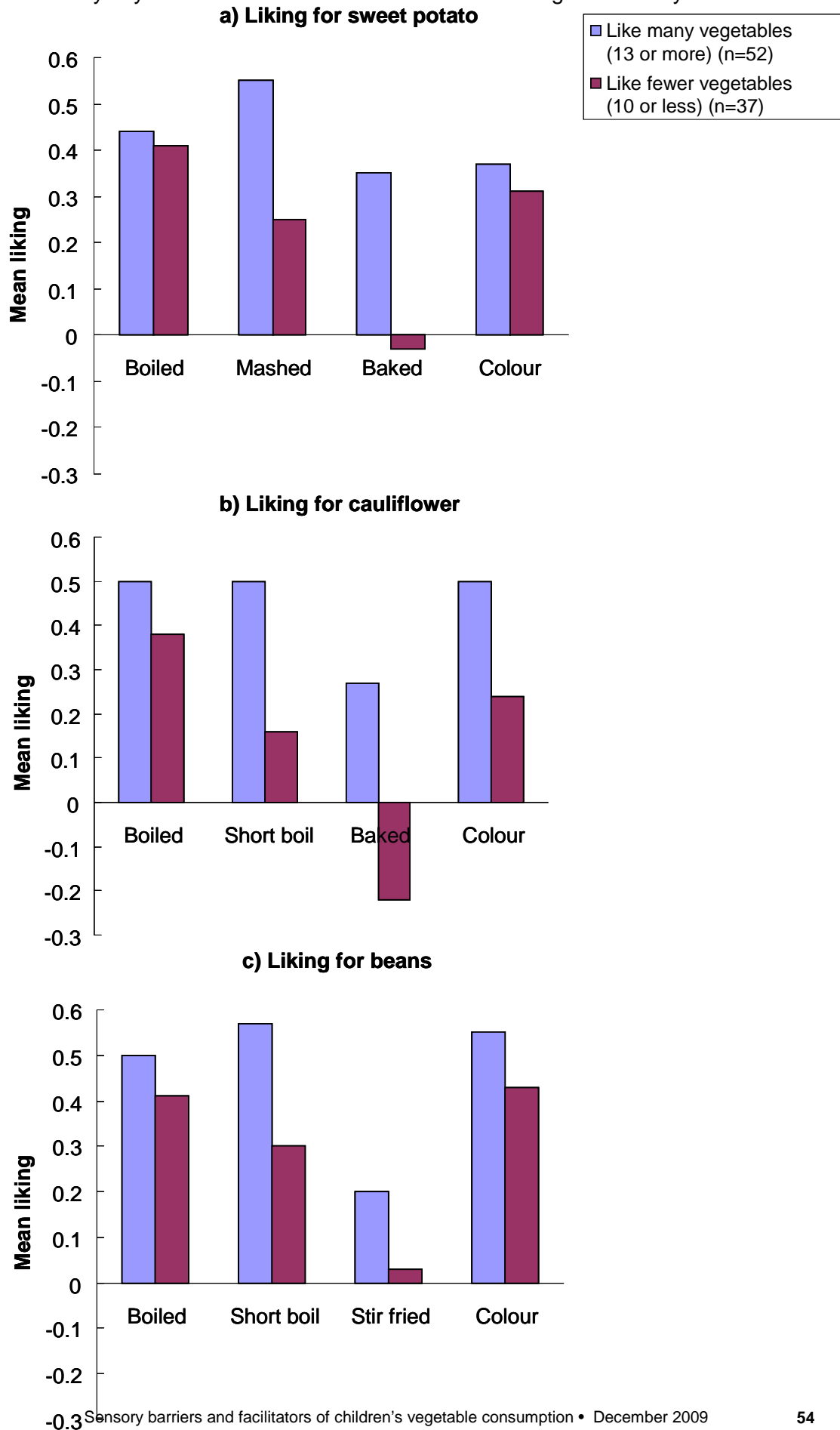
	Low (liked 10 or less vegetables) (n=37)	High (liked 13 or more vegetables) (n=52)	P value
Sweet potato boiled	0.41	0.44	ns
Sweet potato mashed	0.25	0.55	0.05
Sweet potato baked	-0.03	0.35	0.04
Sweet potato colour	0.31	0.37	ns
Cauliflower boiled	0.38	0.50	ns
Cauliflower short boil	0.16	0.50	0.03
Cauliflower baked	-0.22	0.27	0.008
Cauliflower colour	0.24	0.50	ns
Beans boiled	0.41	0.50	ns
Beans short boil	0.30	0.57	0.05
Beans stir fried	0.03	0.20	ns
Beans colour	0.43	0.55	ns
Overall	0.22	0.44	<0.0001

#### Comparisons within groups

Children who liked many vegetables accepted all vegetables equally, regardless of the way the vegetable was prepared or presented. In contrast, acceptance of cauliflower and beans depended on preparation for children who liked fewer vegetables. These children accepted the baked or stir fried sample significantly less than the other samples. The same trend was observed for sweet potato, but results were not significant (Figure 16).

In conclusion, children who liked fewer vegetables were sensitive to the way vegetables were prepared, in contrast to children that liked many vegetables.

**Figure 16:** Acceptance for a) sweet potato, b) cauliflower and c) beans prepared in different ways by children who differed in the amount of vegetables they liked





### 3.5.4 Dietary variety in vegetable consumption

Children that consume few different types of vegetables (i.e. children that have a larger dietary variety with regards to vegetables) may be more sensitive to the way vegetable are prepared than children who consume many vegetables.

Analyses were done using two different measures for dietary variety in vegetables:

1. Parents had indicated which vegetables their child had consumed in the past three months. These results were used to separate the children sample in two groups: children that had consumed few different vegetables (14 or less, n=23) and children that had consumed many different vegetables (18 or more, n=51).
2. Parents indicated how many times their child had consumed vegetables on the day preceding the test. Analysis compared children with relatively low (consumed 0 or 1 time vegetables the day preceding the test, n=41) to children with relative high (consumed vegetables 2 or more times, n=63) consumption the day preceding the test.

#### Differences between children's groups

Both measures of dietary variety in vegetable consumption provided the same result; there were no significant differences in acceptance between the groups of children, neither overall nor for any of the twelve samples.

#### Differences within children's groups

The two measures of dietary variety in vegetable consumption pointed in the same direction.

Variety in consumption the previous three months showed that both low and high variety children were sensitive to the way cauliflower was prepared (liking baked cauliflower less than the others). In addition high variety children were sensitive to how green beans were prepared (accepting stir-fried less) whereas low variety children were not.

Variety in amount of serves consumed the previous day showed that high variety children were sensitive to how cauliflower and green beans were prepared (accepting the baked and stir-fried varieties less) whereas the low variety children were not.

### 3.5.5 Food Neophobia

It may be hypothesized that neophobic children (i.e. children with a fear to taste new foods) would respond differently to the vegetables than the neophilic children, in particular with regards to the atypical coloured varieties.

Two groups of children were created on the basis of their Food Neophobia scores:

- Neophilic children (n=34, FNS lower than 29); relatively low score on fear of tasting new foods
- Neophobic children (n=30, FNS score higher than 41); relatively high score on fear of tasting new foods.

There were no significant differences in liking between the neophilic and neophobic children for any of the samples.

There were no differences in acceptance for vegetables prepared in different ways by neophilic children for any of the three vegetable types. Neophobic children liked the baked cauliflower less than the other cauliflower samples ( $X^2(3) = 13.5, p=0.004$ ) but no differences in liking were observed within the sweet potato and beans samples.

## 4. CONCLUSIONS AND DISCUSSION

### 4.1 Conclusions

#### Children's acceptance research

- The sample of children consisted of 104 five and six year olds from the Sydney metropolitan area, with an even spread in gender and age. The target vegetables of the study were not amongst the most liked nor the most disliked.
- Before tasting the samples, and thus based on visual appearance alone, children expected to prefer the atypically coloured varieties.
- There were no differences in acceptance across vegetables, i.e. sweet potato, cauliflower and beans were liked the same. There were significant differences in acceptance within two of three vegetable types.
  - Sweet potato: Samples were accepted equally regardless of the way in which they were prepared or presented
  - Cauliflower: green boiled and white boiled cauliflower were accepted more than white baked cauliflower. There were neither differences in acceptance for cauliflower samples boiled for different amounts of time nor between samples of different colours but boiled for the same amount of time.
  - Beans: yellow and short-boiled green beans were more accepted than stir fried green beans. There were no differences in acceptance for cauliflower samples boiled for different amounts of time or between samples of different colours but boiled for the same amount of time.
- Comparisons of evaluations before and after tasting showed that both appearance and sensory preferences during tasting were important for children's acceptance of vegetables.
- In the general survey, parents reported that their children liked more vegetables than they disliked. Texture attributes were most frequently mentioned as reasons for liking vegetables (such as crunchy for carrot and soft for mashed potato but also for disliking vegetables (too soft, too hard, mushy). Flavour (bitter, lack of sweetness) and smell attributes were frequently mentioned as reason for dislike. Obviously, it is hard for parents to really know why their children liked or disliked vegetables.
- 72% of parents used strategies to make vegetables more attractive to their children; most commonly this included combining with other ingredients to mask the flavour, hiding or mixing in a dish or preparing them in specific ways.
- Parents often used the preparation methods and cooking times in the current study when preparing these vegetables for their children.
- Children were largely unfamiliar with the atypically coloured varieties.

Sensory characteristics of the samples

- There were significant differences in sensory properties between and within vegetables as a result of preparation and presentation. Apart from differences in colour (hue) and vegetable specific flavour, the largest differences between the vegetables were found in *colour intensity*, *sweetness* and texture (*crunchiness*, *firmness*, *mastication effort* and *moisture release*).
- Within each vegetable type, there were large sensory differences between the baked or stir fried sample and the other samples in texture, *oily flavour*, *oily mouthfeel*, *odour intensity* and in case of cauliflower and beans of *browned flavour*. In texture the baked or stir fried sample was characterised by high *firmness*, *crunchiness* and *mastication effort* compared to long boiled samples. Texture properties of baked or stir fried and short boiled samples were similar.
- The sweet potatoes of different colours but boiled for the same amount of time were similar in sensory properties (apart from obvious colour differences). This was also the case for beans but less so for cauliflower. The green cauliflower had a “firmer” texture (expressed through several texture attributes) and was more *bitter* than the white cauliflower boiled for the same amount of time.
- Differences between samples boiled for different times were primarily observed in texture attributes as perceived during chewing. Short boiled samples were more *firm*, *crunchy* and required more mastication than long boiled samples.

Relation between liking and sensory characteristics

- Atypical colour of samples positively affected expected preference.
- The sensory differences between the three vegetable types did not result in differences in acceptance.
- The least preferred samples within each vegetable type (baked cauliflower and stir fried beans) differed primarily from the other samples in a higher intensity of *browned flavour*, *odour impact*, *oily flavour* and *oily mouthcoating*. The baked or stir fried cauliflower and bean samples had a slight *browned flavour* that was absent in the baked sweet potato.
- Samples (cauliflower and beans) boiled for shorter times were *crunchier* and *firmer* than samples boiled for longer times. Crunchiness is reported to be a reason for liking certain vegetables, both by parents in our study as well as in the scientific literature. However, the differences in *crunchiness* induced by different cooking times of the same vegetable did not affect overall acceptance.
- Quantitative modelling found that acceptance was well explained by two sensory attributes: *odour intensity* and *browned flavour*. The more intense the *smell* or *browned flavour* of a sample, the less it was liked.

Acceptance in relation to background characteristics

Vegetable acceptance was related to the children’s background in the following way:

- Vegetable acceptance was positively related to reported liking for the target vegetable, liking for vegetables overall and to familiarity with preparation method.
- Preparation method had a larger impact on children who reportedly liked fewer vegetables (they accepted baked or stir fried less than boiled cauliflower and beans) than on children who reportedly liked a broad range of vegetables (they accepted all vegetables regardless of the way they were prepared or presented)
- Preparation method had a larger impact on cauliflower acceptance for children that were less willing to taste new foods (they liked baked cauliflower less than other samples) than for children more willing to taste new foods.

## 4.2 Discussion

This study investigated the effect that preparation and presentation has on children's acceptance for three vegetables. Previous research suggested that colour may play an important role in children's acceptance for vegetables (Baxter et al, 1999; Zeinstra et al, 2007). Our study confirmed these results in expected preference. Atypically coloured varieties appear to be promising facilitators. Baxter et al (1999) found brightly coloured vegetables to be preferred to dark green vegetables. This study indicated that it was the unfamiliarity of the colour that was liked rather than specific colours. Acceptance for the atypically coloured vegetables did not seem to be related to specific flavour or texture characteristics of these vegetables. Our findings coincided with the suggestion that colour / flavour associations play a role in shaping expectations (Baxter et al, 1999), since expected preference for the atypically coloured vegetables was higher. For children with negative expectations about the taste of vegetables based on their colour, the atypically coloured varieties thus provide opportunities for reintroducing vegetables with a view to establishing positive colour / flavour associations. Further research would be required to confirm if this is effective in increasing liking for vegetables.

Previous research also suggested that preparation may play an important role in children's vegetable acceptance (Baxter et al, 1998; Domel et al, 1993; Szczesniak, 1972, 2000; Zeinstra et al, 2007, 2009). The current research confirmed that preparation method affects children's acceptance for vegetables, and larger effects are observed across children who liked fewer vegetables. The results are in direct alignment with the findings of Zeinstra et al (2009) were, upon tasting two vegetables prepared in different ways, children preferred vegetables when they were boiled and steamed to those that were stir-fried, mashed, grilled and deep-fried.

Preparation is in particular suggested to affect children's acceptance through its effect on texture properties. Firm and crunchy textures are preferred over softer, mushy textures (Baxter et al, 1999; Szczesniak, 1972). These studies have focused on comparisons between and not within vegetables and / or dealt with differences between raw and cooked vegetables (without actual tasting). Parents confirmed the importance of texture for their children's reported likes and dislikes for vegetables in our study, although knowing the real reasons is obviously difficult for parents.

The current research showed that, by actual tasting, the more moderate changes in texture (and flavour) induced by different boiling times (compared to differences between raw and boiled) did not affect children's acceptance.

The stir-fried and baked vegetables had a firmer and more crunchy texture than (long) boiled samples, but they were seemingly less accepted because of their odour / flavour properties. Baxter et al (1999) suggested that the texture of the vegetables in a (mixed dish) such as in a stir-fry may be appealing to children, with the strong flavour of the meal concealing the flavour of the vegetables being another appealing factor. In our study the prepared vegetables were presented without other ingredients and therefore "flavour-masking" did not occur. Thus, context of evaluation needs to be taken into account and it may be merely stir fried / baked vegetables presented on their own that are less acceptable.

Differences in acceptance were found within cauliflower and bean, but not within sweet potato samples. Apparently, children's acceptance of a particular preparation method differs depending on the type of vegetable. The absence of differences in acceptance for sweet potato prepared in different ways may be related to the absence of a *browned flavour* in the baked sample, but may also be caused by other as yet unknown factors. Zeinstra et al (2009) studied carrots and beans and found "brown-colouring" to be undesirable in both vegetables. A better understanding of factors underpinning differences in acceptance for vegetables is needed before generalisations to the wider category of vegetables can be made.

The study provided useful insights into the factors that influence children's vegetable acceptance. The following need to be taken into account when generalising the results:

- Consumer sample: the group of children in our study consumed more vegetables than children in the overall population and was not representative in some other aspects. The background variables that were found to influence children's acceptance for vegetables should be taken into account when generalising results to the wider population.
- Vegetables: three vegetables were selected as model foods for this study. Results were not the same across the three vegetables, and a systematic vegetable by vegetable approach would be required to identify optimal preparation for each vegetable.
- Preparation and presentation methods: preparation methods were carefully selected and optimised in extensive pre-trials. However, further insights could be gained by investigating other preparation and presentation methods, or by investigating the effect of preparation details on acceptance. The results have shown that atypically coloured varieties, although small in sales volumes, could be a promising category for children. Further research that includes several atypically coloured samples (thereby providing a more balanced design with regards to colour) may enhance the understanding of the role that colour plays in children's acceptance for vegetables.

## 5. BARRIERS, FACILITATORS AND RECOMMENDATIONS

Baking and stir frying processes imparted a more intense *odour intensity* and *browned flavour* for two of three vegetables, and also imparted a more intense *oily mouthfeel* and *oily flavour* than other preparation methods. The former two sensory attributes were barrier to consumption. Texture and flavour differences as a result of different boiling times, were neither a barrier nor a facilitator to consumption. The small differences within vegetables in sweetness or bitterness as a result of differences in preparation or variety did not affect liking either. Colour may be a promising facilitator to increase children's vegetable consumption and may provide opportunities for the Vegetable Industry. The atypically coloured vegetables created positive expectations about the taste and thereby encourage "trying" of vegetables. They were also subsequently liked after tasting, although no more than typically coloured vegetables. The Vegetable Industry is recommended to consider marketing and/or development of atypically coloured cultivars for children. Where taste of these varieties is improved compared to typically coloured varieties, additional success should be achieved.

Health professionals and others who give advice to parents are recommended to consider how preparation may influence acceptance, in particular among children who do not consume the recommended amount of vegetables. Atypically coloured varieties can be used to overcome established negative expectations. Boiling results in vegetables with sensory properties that are more acceptable, whereas baked or stir fried vegetables are more often disliked. No specific guidelines for boiling times seem necessary from a sensory perspective. Such advice could focus on boiling times that allow for optimum preservation of nutrients or that take preferences of other family members into account. Acceptance was higher when the method of home preparation was similar to that tasted for this study. Cause and effect are not known in this case, but other evidence suggests that repeat exposure has a positive effect on acceptance (Corsini et al, 2009).

Acceptance was lower for children that liked fewer vegetables and were unfamiliar with the way a vegetable was prepared. Children with these background characteristics would need particular encouragement and intervention may be particularly targeted towards them.

Similarities in results were obtained for beans and cauliflower, but no differences in acceptance were found for sweet potato. Caution should be applied in generalising the findings to the overall category of vegetables and the Vegetable Industry would be encouraged to adopt a systematic vegetable by vegetable approach to identify optimal preparation and presentation methods for children, in particular for those who are currently not meeting recommended intakes.

## 6. TECHNOLOGY TRANSFER

The following activities were undertaken to ensure adoption of the results of the R&D:

- Presentation at ILSI Nutrition conference on the 12<sup>th</sup> of November 2009.

The objective of the conference, entitled “Vegetable Nutrition: Why your Mum was right when she told you to eat your vegetables!”, was to bring together the latest findings in vegetable nutrition research and insights into vegetable consumption with consumer communication strategies for health professionals, dieticians, food technologists and educators to promote the benefits of vegetables in the diet.

The findings of this study were presented jointly with the findings from a complementary HAL funded study entitled “Increasing Children’s Liking for Consumption of Vegetables” (VG08022). This study was also carried out by CSIRO Food and Nutrition Sciences, and teams from the two projects have collaborated. Both studies were presented at the ILSI conference by Dr. David Cox.

The conference was attended by around 100 people from the target audience (industry nutritionists, dieticians and members of the Nutrition Society) and the presentation was well received. The presentation was the only one that focused on behavioural and sensory approaches to increase vegetable consumption and it showed that both approaches provide valuable tools to try to increase children’s vegetable consumption.

- An article for *Vegetables Australia* is currently in preparation
- Dissemination at national and/or international scientific conferences and a peer-reviewed publication in a sensory and consumer science journal are anticipated

The following ongoing HAL funded projects may benefit from the research results of this study:

- Go For 2&5 Program
- VG09084 Health promoting vegetables that do not compromise on taste



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## APPENDIX A SAMPLE PREPARATION TRIALS FOR SWEET POTATO AND BEANS

The following cooking method / cooking time combinations were trialled in initial sessions for sweet potato:

- *Boiled* – Boiled in water for 5; 6.5; 8; 10; 15; 20min
- *Mashed* - Mashed after being boiled for 8; 10; or 15min
- *Grilled after boiling* – Grilled 2.5 or 5 min each side after boiling for 5; 10 min
- *Baked* – Baked in oven for 10; 15; 20; 25 min
- *Baked after boiling* – Baked in oven for 5; 10; 15; 20 min after boiling for 5 or 10 min

The following cooking method / cooking time combinations were trialled in initial sessions for beans:

- *Boiled* – Boiled in water for 2; 4; 5; 6; 8; 10; 12 or 14 min
- *Steamed* - Steamed in a small amount of water for 2; 4; 5; 6; 8; 10; 12 or 14 min
- *Boiled in microwave* – Boiled in water for 0.5; 1; 2 or 5 min
- *Mashed* - Mashed after being boiled for 2; 5; 8 or 12 min
- *Fried* – Fried raw in pan for 2; 3.5 or 5 min

In addition, where anecdotal information was found about changing sensory characteristics (e.g. adding milk during boiling to reduce odour intensity), such techniques were also trialled.

## APPENDIX B SCREENER QUESTIONNAIRE

On behalf of our client, Food Science Australia / CSIRO, we are looking for children and one of their parents / legal guardians to participate in a taste test on vegetables. We would like to ask you a few questions to determine whether you and your child qualify to participate in this study.

Q1	Are you the parent or legal guardian of a child that is aged between 4 and 6 years?		
		Yes	1 CONTINUE
		No	2 CLOSE

Q2	Does this child attend Kindergarten or Year 1 of a primary school?		
		Yes	1 CONTINUE
		No	2 CLOSE

Q3	Please indicate if <u>your child</u> has any known food allergies or dietary intolerances?		
		Yes	1 CLOSE
		No	2 CONTINUE

Q4	Please indicate if <u>you</u> have any known food allergies or dietary intolerances?		
		Yes	1 CLOSE
		No	2 CONTINUE

APPENDIX B SCREENER QUESTIONNAIRE

Q5	For the following vegetables, could you indicate how much your child likes these on a scale from 1 to 5? (1 is clearly dislikes, 2= dislikes, 3 = neutral, 4 = likes somewhat, 5 = clearly likes) If your child has never eaten this vegetable, please tick the appropriate box.	Liking score	Never consumed
	1. Pumpkin		
	2. Cauliflower		
	3. Potato (not hot chips)		
	4. Peas		
	5. Green beans		
	6. Lettuce		
	7. Celery		
	8. Eggplant		
	9. Carrot		
	10. Broccoli		
	11. Corn		
	12. Tomato		
	13. Capsicum		
	14. Zucchini		
	15. Cabbage		
	16. Brussels sprouts		
	17. Sweet potato		
	18. Spinach		
	19. Cucumber		
	20. Mushroom		
	21. Squash		
	22. Legumes (baked beans, chickpeas, lentils, kidney beans)		
	23. Mixed frozen vegetables		
	24. Vegetables in mixed dishes (soups, stews & stir fries)		

This question is not asked to consumers

Q5a	<b>Data base / interviewer to review responses of target vegetables (i.e. 2, 5, 8 and 17 of Q5)</b>		
	"Clearly dislikes" (response 1) two or more of the target vegetables	1	CLOSE
	"Never consumed" two or more of the target vegetables <u>AND</u> "Clearly dislikes" (response 1) and/or has never consumed more than ten additional vegetables	2	CLOSE
	Else	3	CONTINUE

APPENDIX B SCREENER QUESTIONNAIRE

Q6

We realize that food intake and food purchasing can vary from time to time, so we are trying to get an overall picture for the last 3 months. Please think about the last three months and record how often your child usually eats the listed foods.

How often **in the past 3 months** has **YOUR CHILD** eaten the following vegetables (count fresh, canned and frozen whole vegetables for 1-22)?

You can tell us as the number of times per day, week or month. Whichever is easiest.

Write in the last column how you commonly prepare this vegetable for your child (e.g. boiling / steaming /raw/ grilling).

**NOTE: SINGLE RESPONSE ONLY, ENTER DAYS OR WEEKS OR MONTHS OR NEVER**

	Times per day	Times per week	Times per month	Never	Preparation of this vegetable for my child
1. Pumpkin					
2. Cauliflower					
3. Potato (not hot chips)					
4. Peas					
5. Green beans					
6. Lettuce					
7. Celery					
8. Eggplant					
9. Carrot					
10. Broccoli					
11. Corn					
12. Tomato					
13. Capsicum					
14. Zucchini					
15. Cabbage					
16. Brussel sprouts					
17. Sweet potato					
18. Spinach					
19. Cucumber					
20. Mushroom					
21. Squash					
22. Legumes (baked beans, chickpeas, lentils, kidney beans)					
23. Mixed frozen vegetables					
24. Vegetables in mixed dishes (soups, stews & stir fries)					

Thank you for completing this screener questionnaire. A member of the [add name of recruitment agency] fieldwork staff will contact you shortly about this study.

## APPENDIX C BACKGROUND QUESTIONNAIRE FOR PARENTS

Cons.Nr. \_\_\_\_\_

## BACKGROUND QUESTIONNAIRE PARENT

- Q1.** Please indicate your agreement with the following statements. Please circle the appropriate response from 1 to 7, where 1 is *Disagree Strongly* and 7 is *Agree Strongly*

## CIRCLE ONE RESPONSE PER ROW

	Disagree strongly	Disagree moderately	Disagree slightly	Neither agree or disagree	Agree slightly	Agree moderately	Agree strongly
1. I am constantly sampling new and different foods.	1	2	3	4	5	6	7
2. I do not trust new foods.	1	2	3	4	5	6	7
3. If I do not know what a food is I won't try it.	1	2	3	4	5	6	7
4. I like foods from different countries.	1	2	3	4	5	6	7
5. Ethnic food looks too weird to eat.	1	2	3	4	5	6	7
6. At dinner parties, I will try a new food.	1	2	3	4	5	6	7
7. I am afraid to eat things I have never had before.	1	2	3	4	5	6	7
8. I am very particular about foods I will eat.	1	2	3	4	5	6	7
9. I will eat almost anything.	1	2	3	4	5	6	7
10. I like to try new ethnic restaurants.	1	2	3	4	5	6	7

- Q2.** This question is about the kinds of vegetables **YOU** eat and like to eat. Read through the following list of vegetables and record how much **YOU** like them

## CIRCLE THE APPROPRIATE RESPONSE - ONE RESPONSE PER ROW

	Dislike	Neutral	Like
1. Pumpkin	1	2	3
2. Cauliflower	1	2	3
3. Potato (not hot chips)	1	2	3
4. Peas	1	2	3
5. Green beans	1	2	3
6. Lettuce	1	2	3
7. Celery	1	2	3
8. Eggplant	1	2	3
9. Carrot	1	2	3
10. Broccoli	1	2	3
11. Corn	1	2	3
12. Tomato	1	2	3
13. Capsicum	1	2	3
14. Zucchini	1	2	3
15. Cabbage	1	2	3



APPENDIX C BACKGROUND QUESTIONNAIRE FOR PARENTS

16. Brussel sprouts	1	2	3
17. Sweet potato	1	2	3
18. Spinach	1	2	3
19. Cucumber	1	2	3
20. Mushroom	1	2	3
21. Squash	1	2	3
22. Legumes (baked beans, chickpeas, lentils, kidney beans)	1	2	3
23. Mixed frozen vegetables	1	2	3
24. Vegetables in mixed dishes (soups, stews & stir fries)	1	2	3

We realise that your food intake and food purchasing can vary from time to time, so we are trying to get an overall picture for the last 3 months. Please think about the **last 3 months** and record how often you usually eat the listed foods.

- Q3. How often in the past 3 months have YOU eaten the following vegetables?** (count fresh, canned and frozen whole vegetables for 1-22)? You can tell us as the number of times per day, week or month. Whichever is easiest.

**NOTE: SINGLE RESPONSE ONLY, ENTER DAYS OR WEEKS OR MONTHS OR NEVER**

	Times per day	Times per week	Times per month	Never
1. Pumpkin				
2. Cauliflower				
3. Potato (not hot chips)				
4. Peas				
5. Green beans				
6. Lettuce				
7. Celery				
8. Eggplant				
9. Carrot				
10. Broccoli				
11. Corn				
12. Tomato				
13. Capsicum				
14. Zucchini				
15. Cabbage				
16. Brussel sprouts				
17. Sweet potato				
18. Spinach				
19. Cucumber				
20. Mushroom				
21. Squash				
22. Legumes (baked beans, chickpeas,				
23. Mixed frozen vegetables				
24. Vegetables in mixed dishes (soups, stews & stir fries)				

APPENDIX C BACKGROUND QUESTIONNAIRE FOR PARENTS

**Q4.** Please circle how often YOU had vegetables (raw and cooked) yesterday. For example salad in a sandwich and vegetables with your evening meal = twice. TICK ONE RESPONSE ONLY.

- 1. Nil
- 2. Once
- 3. Twice
- 4. 3 times
- 5. 4 times

**Q5.** How many different vegetables do YOU usually eat per day? (include fresh, frozen or tinned)

- 1. Less than one vegetable per day
- 2. 1 vegetable per day
- 3. 2 vegetables per day
- 4. 3 vegetables per day
- 5. 4 vegetables per day
- 6. 5 vegetables per day
- 7. 6 or more vegetables per day

The next section is about YOUR CHILD.

**Q6.** Please indicate your agreement with the following statements. Please circle the appropriate response from 1 to 7, where 1 is *Disagree Strongly* and 7 is *Agree Strongly*

**CIRCLE ONE RESPONSE PER ROW**

	Disagree strongly	Disagree moderately	Disagree slightly	Neither agree or disagree	Agree slightly	Agree moderately	Agree strongly
1. My child is constantly sampling new and different foods.	1	2	3	4	5	6	7
2. My child does not trust new food:	1	2	3	4	5	6	7
3. If my child does not know what is in a food, he/she won't try it.	1	2	3	4	5	6	7
4. My child likes foods from different cultures.	1	2	3	4	5	6	7
5. For my child, food from cultures different to his/her own looks too weird for him/her to eat.	1	2	3	4	5	6	7
6. At social gatherings, my child will try a new food.	1	2	3	4	5	6	7
7. My child is afraid to eat things he/she has never had before.	1	2	3	4	5	6	7
8. My child is very particular about the foods he/she will eat.	1	2	3	4	5	6	7
9. My child will eat almost anything.	1	2	3	4	5	6	7
10. My child likes going places serving foods from cultures different to his/her own.	1	2	3	4	5	6	7

The next section is about how you typically prepare certain vegetables for your child. Add details about preparation times where appropriate.

**Q7a** How do you typically prepare **green beans** for your child?

- 1. Canned and reheated
- 2. Steam for ± \_\_\_\_\_ minutes
- 3. Boil for ± \_\_\_\_\_ minutes
- 4. Stir fry for ± \_\_\_\_\_ minutes
- 5. Raw / fresh
- 6. Other, \_\_\_\_\_
- 7. I never prepare green beans

**Q7b** How do you typically prepare **cauliflower** for your child?

- 1. Steam for ± \_\_\_\_\_ minutes,
- 2. Boil for ± \_\_\_\_\_ minutes
- 3. Stir fry for ± \_\_\_\_\_ minutes
- 4. Raw / fresh
- 5. Other, \_\_\_\_\_
- 6. I never prepare cauliflower

**Q7c** How do you typically prepare **sweet potato** for your child?

- 1. Bake for ± \_\_\_\_\_ minutes
- 2. Boil for ± \_\_\_\_\_ minutes
- 3. Bake / boil and then mash
- 4. Other, \_\_\_\_\_
- 5. I never prepare sweet potato

**Q8** Has your child ever consumed any of the following vegetables? TICK ALL THAT APPLY OR "NO" IF NONE APPLY.

- 1. Yellow beans
- 2. Green cauliflower
- 3. Purple sweet potato (white from the inside)
- 4. No

**Q9** Is there any particular strategy that you've used to make them more attractive for your child to eat? Examples may be the addition of other ingredients or the use of a shape or a pattern. If yes, provide details. TICK ALL THAT APPLY OR "NO" IF NONE APPLY.

- 1. Green beans, \_\_\_\_\_
- 2. Cauliflower, \_\_\_\_\_
- 3. Sweet potato, \_\_\_\_\_
- 4. Eggplant, \_\_\_\_\_
- 5. Any other vegetable, \_\_\_\_\_
- 6. No

APPENDIX C BACKGROUND QUESTIONNAIRE FOR PARENTS

**Q10.** Please circle how often YOUR CHILD had vegetables (raw and cooked) yesterday.  
For example salad in a sandwich  
and vegetables with the evening meal = twice. TICK ONE RESPONSE ONLY.

- 1. Nil
- 2. Once
- 3. Twice
- 4. 3 times
- 5. 4 times

The next section is about your child's likes and dislikes for vegetables.

**Q11.** Think about the vegetables that your child **likes**. What aspects of eating these vegetables makes your child like them? You can think of all aspects of eating, e.g. the smell, the flavour, the way it feels in the mouth and even the way it looks.

Be as specific as possible- e.g. *Peas - because they are sweet and soft.*

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**Q12.** Think about the vegetables that your child **does not like**. What aspects of eating these vegetables make your child not like them? You can think of all aspects of eating, e.g. the smell, the flavour, the way it feels in the mouth and even the way it looks.

Be as specific as possible, e.g. *Brussel sprouts - too big, taste too bitter and need too much chewing.*

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**Your background**

Parent 1	Parent 2
<b>Q13.</b> Gender <input type="checkbox"/> Female <input type="checkbox"/> Male	<b>Q16.</b> Gender <input type="checkbox"/> Female <input type="checkbox"/> Male
<b>Q14.</b> Age (in years) _____	<b>Q17.</b> Age (in years) _____
<b>Q15.</b> Highest level of education completed	<b>Q18.</b> Highest level of education completed
<input type="checkbox"/> 1. Some high school	<input type="checkbox"/> 1. Some high school
<input type="checkbox"/> 2. Completed high school	<input type="checkbox"/> 2. Completed high school
<input type="checkbox"/> 3. Tech, Trade or TAFE qualification	<input type="checkbox"/> 3. Tech, Trade or TAFE qualification
<input type="checkbox"/> 4. University	<input type="checkbox"/> 4. University
<input type="checkbox"/> 5. Post graduate studies	<input type="checkbox"/> 5. Post graduate studies

## APPENDIX D SENSORY ASPECTS LIKED IN VEGETABLES

Vegetable	Number of times mentioned	Flavour	Texture	Appearance	Other
Carrot	59	Sweet (17), carrot flavour (1)	Crunchy [raw] (31); soft [cooked] (2)	Colour (4), looks nice (2), shape (1), bright (1)	Raw (13), Can see in the dark (1), in dishes (1), easy to hold/eat (3)
Potatoes	50				
- mashed potato	26	Buttery (2), taste (1)	Creamy (6), mouthfeel (3), soft (3)		Easy to eat
- baked / chips	12	Flavour (1), not strong (1)	Crunchy (4), crunchy outside, soft inside (1)		
- unspecified	14	Sweet (1), flavour (2)	Soft (3), smooth (1), mouthfeel (3)		Roasted as chips
Corn	39	Sweet (16), flavour (3)	Juicy (5), crunchy (4), soft (1), burst in your mouth (1)	Colour	Off the cob (8), fun to eat off cob (5), can hold cob (2), easy to eat (3)
Cucumber	31	Sweet (2), flavour (4), mild flavour (1)	Crunchy (18), crunchy outside, soft inside (1), without seeds (1), juicy (1)		Refreshing (1), easy to eat (2)
Peas	25	Sweet (6), flavour (1)	Soft (5), burst in your mouth (1), texture (2)	Small	Frozen (6), easy to eat (4), fun to eat (1)
Broccoli	23	Mild taste, flavour	Soft (4), different textures (1)	Looks like trees (6), looks good (4), brightly coloured (1)	Easy to eat (2), with white sauce
Tomatoes	20	Sweet (4), taste (3), flavour (1)	Juicy (2), bursting feel (1), soft (1)	Small (4), appearance (1)	Raw (2), pop straight in mouth (1)
Beans	14	Flavour (3), sweet (1)	Crunchy (4), soft (2)		Finger food (1), fun to split open (1), slurp like spaghetti (1), easy to eat (1)
Cauliflower	11	Flavour, mild taste	Crunchy (1), soft (2)	Colour (2), shape (1), looks like tree (1), looks fluffy (1), way it looks (1)	As gratin
Lettuce	8	Flavour (1), taste (1)	Crunchy/crisp		
Capsicum	7	Sweet taste (2), flavour (1)	Crunchy	Colour	
Pumpkin	7	Sweet (3), taste (2), flavour (1)	Soft		Easy to eat in soup
Sweet potato	6	Sweet	Soft (2), creamy (1)		

Vegetable	Number of times mentioned	Flavour	Texture	Appearance	Other
Mushroom	5	Taste (3), flavour (1)			Raw (1), nice with gravy (1)
Spinach	4	Taste			Nice as pasties (1), in pasta easy to eat (1) Easy to digest
Avocado	3	Flavour	Soft		
Beet root	3	Sweet (2), flavour (1)	Crunchy	Strong colour	
Celery	3		Crunchy		
Snow peas	3	Sweet	Crunchy (2), easy to chew (1)		
Zucchini	3	Taste (2), flavour (1)			In dishes
Cabbage	2	(sauerkraut) flavour			Tastes good with bread
Asparagus	1				
Baked beans	1				Warm and wholesome
Bean sprouts	1				Same as noodles
Eggplant	1				
Kumera	1	Sweet	Soft		
Lentils	1				
Parsnip	1	Sweet [roasted]	Crunchy [roasted]		
Squash	1	Taste/flavour			
Swede	1				

## APPENDIX E SENSORY ASPECTS DISLIKED IN VEGETABLES

Vegetable	Number of times mentioned	Flavour	Texture	Appearance	Other
Brussels sprouts	20	Bitter (5), not sweet, sour, no flavour	Solid, too much chewing	Look	
Tomato	18	Too acidic (4), flavour (2), tasteless	Seeds (3), consistency, too juicy, too hard		
Mushroom	16	Strong flavour, bland	Slimy	Look (4), colour	
Eggplant	15	Bitter, flavour, not tasty	Chewy, slippery, mouthfeel, soft	Looks different, appearance, colour	Doesn't like skin, word "egg" puts off
Zucchini	15	Bitter, flavour, lack of flavour	Too soft and squishy	Look	
Pumpkin	14	Flavour (4), too sweet (1)	Too mushy (4), too soft (2)		
Beans	9		Not soft, mouthfeel, too stringy	Colour	
Broccoli	9	Bitter	Too hard, too soft	Look	
Cauliflower	9	Tasteless		Look	Expects to taste like broccoli
Cabbage	8	No flavour		Look	
Capsicum	8	Bitter (2), too strong	Hard to chew	Look	
Lettuce	8	Tasteless (3), bitter, boring taste	Too crunchy (3), too long to chew (2)	Look	
Peas	7	Not sweet enough	Soft and mushy	Green colour	
Squash	7	Tasteless	Squishy, too soft, texture	Look, too big	
Onion	6	Too spicy	Hard to chew, crunchy		Make you cry
Spinach	5	Flavour too strong, bitter	Too long to chew	Look	
Sweet potato	5	Flavour	Too soft		
Beetroot	4	Too strong, vinegar flavour	Too hard	Look	
Celery	4	Bitter	Stringy (2), hard, hard to chew		
Cucumber	3			Look (without skin)	
Potato	2		Too soft, mushy		
Asparagus	1	Strong taste			
Avocado	1		Too mushy	Strange colour	
Bitter melon	1	Bitter			
Carrot	1		Too hard [raw]		
Choko	1				

## APPENDIX E SENSORY ASPECTS DISLIKED IN VEGETABLES