VegKIT

Report summary

New opportunities for developing vegetable products for children

VG16064 Tools and interventions for increasing children's vegetable intake
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Contents

Executive summary

This report presents the outcomes of research funded by Hort Innovation (VG16064) that has been undertaken to support the development of new vegetable-based product concepts for children in Australia. A new scientific framework is introduced, based on sensory science, that can be used to develop new vegetable-based products for children. A range of new vegetable-containing concept products (fresh and processed-vegetable containing products) designed using this framework and the qualitative evaluation of these concepts by children and parents is also presented.

The new scientific framework: CSIRO Children's Acceptance Model for Product development of Vegetables (CAMPOV) is based on a literature review focused on increasing children's acceptance for vegetables and considered intrinsic (e.g. sensory) and extrinsic (e.g. branding) product properties, as well as children's biological/physiological and psychological characteristics. The model was informed by children's sensory preferences, knowledge of vegetable acceptance and food preference development theories.

A total of 14 concepts were evaluated through qualitative research with 36 children aged 5-8 years through eight focus group sessions. Overall, children had a high interest in six of the concepts, which were Rainbow dippers, Ice cream and ice block, Fairy dust, Rainbow squeeze-mate, Crunch & Sip KIT and Children's Cooking KIT. Factors from the CAMPOV model that positively influenced children's interest in the concepts were bright colours, fun shapes, bite-sized pieces, good taste, fun eating experience, imaginative language, familiarity and role modelling.

The results can be used to further develop and evaluate prototypes into products containing vegetables for children for commercialisation. The CAMPOV Model can also be used by food manufacturers to develop further concept ideas.

1 Introduction

This report presents the outcomes from research undertaken to support businesses with the development of new vegetable-based products concepts for children.

Research has taken a sensory science approach to product development. Children's food consumption is largely driven by their own food preferences. Based on a scientific literature review into key properties that influence children's acceptance of vegetables, CSIRO has developed a sensory science model that can be used in the creation of vegetable-based products for children. Using this model, CSIRO has developed a set of new 'vegetable-based product concepts' built around the sensory properties that are regarded as 'desirable' for children. Driven by sensory science, these vegetable-based product concepts consider children's sensory preferences as well as knowledge about acceptance of vegetables. They have been evaluated by 5-8-year-old children in semi-structured focus groups as well as by parents of 5-8-year-olds.

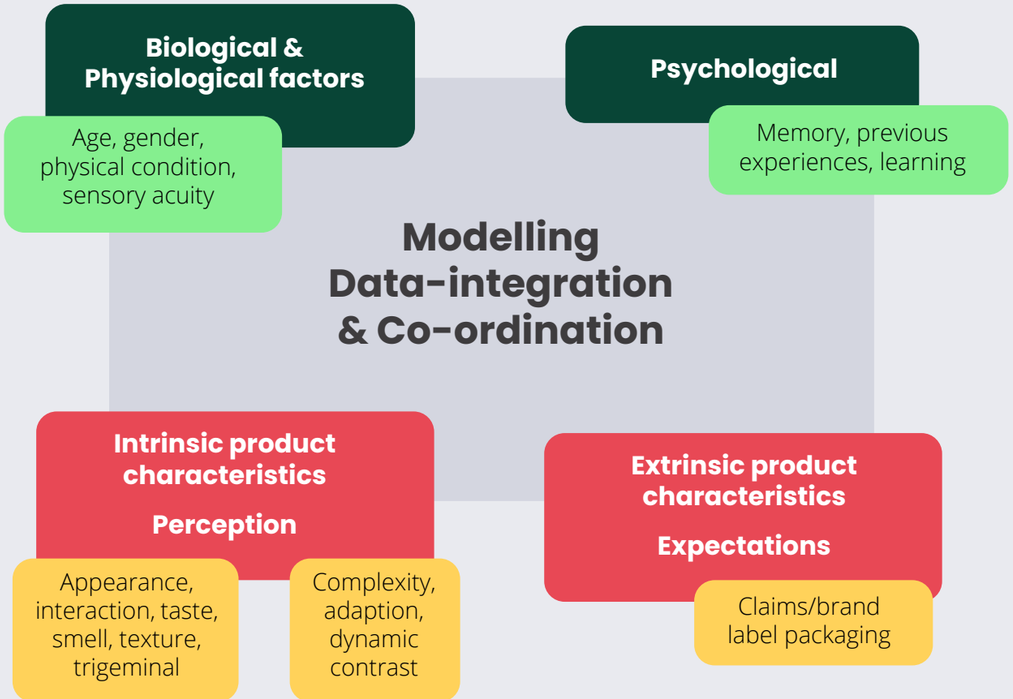
This report details the outcomes of the literature review, scientific framework and model, and concept evaluations. Recommendations for further product development as well as advice on how companies can use the learnings from this research in their own product development are provided. We hope the research presented will support the development and commercialisation of successful new vegetable-based products for children.

The research presented in this report is part of the larger VegKIT project (www.vegkit.com.au). VegKIT is a five-year project, funded by Hort Innovation using the Vegetable R&D Levy, that aims to increase the vegetable intake of Australian children.

2 Literature review & scientific framework

A review of the scientific literature identified several factors for consideration to achieve an increase in vegetable acceptance amongst children. The focus of the review was on factors that are relevant for product development. Four key factors were identified as relevant to the product development of vegetables for children (Fig 1), two of which were related to the person-the children (biological and physiological factors and psychological factors) and two of which were product related factors (intrinsic product properties and extrinsic product properties).

Figure 1: Key determinants of relevance to developing new vegetable-based products for children. Adapted from Mojet's (2001) Model of essential factors that influence eating and drinking behaviour and food choice (1)



2.1 Biological and physiological factors

- Children's perception of foods is different from adults. They are more sensitive to bitter taste and less sensitive to sweet taste, so they live in a different sensory world [2].
- Children are also born with an innate liking for sweet taste and dislike for bitter taste [3]. Together, this means they prefer higher sweetness levels and reject bitterness levels earlier than adults [2, 4].
- Children also acquire a liking for salty and energy dense foods very early in life due to positive post-ingestive feedback from fat [2].
- When comparing the key taste properties of vegetables to those of other core food groups, it is found that all core foods possess taste qualities that are either innately liked or acquired very early in life [5]. Vegetables, on the other hand, do not contain such positive drivers of liking as a whole category. Rather, they contain a driver of dislike; bitter taste. Thus, the sensory properties of many vegetables do not appeal to our innate likes and dislikes, but rather, needs to be learned (see next section) or may need some form of transformation (e.g. altering taste) to appeal to children.
- Children also differ from adults from a texture perspective. There are quite a few changes in the mouth that happen with age, with first teeth erupting, which are later lost and replaced by adult teeth. Children also gradually develop the muscles in their mouth to move food around and the force to chew down foods, thus develop a better ability to prepare a bolus in their mouth safe for swallowing [6].

2.2 Psychological factors

- Psychological factors are very important for food acceptance. Most of our food preferences are learned, for example nearly all our odour preferences are learned [1, 2] and this determines flavour in combination with taste.
- Childhood is a very critical period in the development of food preferences, and they have been shown to track from childhood to adulthood [7, 8].
- Due to their sensory properties not aligning well to innate likes and dislikes, vegetable acceptance is largely a learned behaviour.
- There are two key mechanisms for learning to like vegetables:
    1. Repeated exposure; there is a large body of evidence that shows that repeatedly trying a vegetable increases acceptance (for a recent review see 9).
    2. Associative conditioning; simply stated, the positive value of something transfers to the vegetable when it is repeatedly offered combined. This can be a combination with a liked flavour [10] or a positive role model for the child [11, 12].

2.3 Intrinsic product characteristics

- Children are primarily driven by the sensory properties for consumption of foods.
- Relatively few studies have investigated the contribution of specific sensory aspects to children's acceptance of vegetables, meaning that findings need to be interpreted with caution and more research is needed. The lack of studies is partly because it is difficult to separate individual sensory modalities in vegetables. For example, with preparation of vegetables there are simultaneous changes to appearance, flavour and texture.

Appearance

- Appearance is the most important property for 4-5 year-olds in categorising vegetables, whereas flavour played a much larger role in 11-12 year-olds [13].
- Brightly coloured vegetables are preferred [14].
- Atypical colours, like purple cauliflower, increase children's willingness to try them [15].
- Fun shapes are preferred over slices/sticks, and these in turn are preferred over chunks [16].

Taste/flavour

- In line with our innate preferences, sweet vegetables are liked and consumed more than neutral and bitter vegetables [13, 17, 18].
- Addition of condiments or other flavours (sweet, salty) enhances acceptance, whereas sourness does not [19-23]. Part of the effect of adding condiments or tastes is that they mask or suppress the bitter taste [21, 24].

Taste/flavour: Addition of condiments or other flavours enhances acceptance.

Texture

- Several studies found a preference for raw vegetables over cooked, however this is vegetable specific [25].
- Vegetables with difficult to manipulate textures have low appeal with children [6]. Examples of this are mushrooms due to their slippery texture. Cherry tomatoes also often generate ambiguous responses amongst children due to their textural contrast.

Other (non-vegetable specific)

- The literature review identified a lack of research that explores novelty and fun through modification of sensory properties as a potential way to increase vegetable acceptance in children. However, arousal and boredom are important determinants of food choice [26]; novelty and arousal feature heavily as attributes in snack products for children and can be further explored. For example, around 1/3 of children like extreme sour tastes [26]. However, no research on these aspects have been done with vegetables yet.

2.4 Extrinsic product characteristics

Extrinsic properties are factors related to the food that are not inherent to the food, such as packaging. Not much research on vegetables is published.

- An exception is the use of cartoon characters; there is quite a bit of evidence that using cartoon characters increases acceptance and consumption of vegetables [27-30].
- Use of creative and imaginative language increases acceptance for vegetables [31, 32].
- The use of sensory claims, i.e. claims that relate to a good taste, have been shown to increase acceptance [33]. In contrast, health claims (e.g. vegetables are good for you), decreased acceptance for foods amongst children [34, 35].

Appearance: Fun shapes are preferred over slices/sticks.

3 New model for development of vegetable-based products and concepts

3.1 CSIRO CAMPOV Model

A new theoretical model is developed to support successful new product development of vegetable-containing products for children. The model, CSIRO Children's Acceptance Model for Product development Of Vegetables (CAMPOV), uses a sensory science approach for product development (Table 1). It is based on the literature review as described in the previous chapter. In addition to the literature review, product mapping of intrinsic and extrinsic properties used in snack products for children was undertaken and taken into account.

Table 1 CSIRO Children's Acceptance Model for Product development Of Vegetables (CAMPOV)

Factor	Properties to promote children's vegetable acceptance
Intrinsic properties	
Appearance	Bright colours, atypical colours of veg, colour / shape contrast, fun shapes, small sizes
Taste/flavour	Sweet taste, taste contrast (sweet/sour), suppression/absence of bitterness, flavoursome
New sensations	Novel sensations, fun sensations
Texture	Crunchiness, lack of textural contrast
Extrinsic properties	
Claims/branding	Sensory claims, imaginative language, fun characters on pack, absence of health claims
Fun	Fun eating experience
Psychological factors	
Associative learning	Pairing with liked tastes/flavours or other attributes
Previous experience	Familiarity to existing
Role modelling	Mimicking parents

You will see this icon with each of the presented concepts. It describes what characteristics of the CAMPOV model the concept has that are potentially appealing to children.

The model identifies various factors that can be considered for the development of new sensory-based concepts containing vegetables:

- Enhancing visual appeal/appearance, related to good visual appeal, novelty and fun, but also packaging (labelling, characters and claims that promote sensory appeal)
- Enhancing the sweet taste of vegetable-containing products, preferably not through sucrose addition because of health and parental concerns
- Enhancing the flavour intensity, by using condiments or other ingredients
- Reducing bitter taste, e.g. by adding a small quantity of salty ingredients or condiments
- Creating concepts with crunchiness
- Creating concepts with novelty value or with a high 'fun' factor either through visual appeal or interactive engagement 'play factor'
- Creating concepts that build onto existing, familiar products that are liked by children.

3.2 New vegetable-based concepts

Using the model, a team of experienced sensory scientists and food technologists defined a range of concepts in an iterative process consisting of the following steps:

- Brainstorming new vegetable-containing concept ideas
- Development of ideas into concepts
- Expanding the list of concepts based on key extrinsic and intrinsic properties identified
- Developing visualisation/presentation sheets for each concept.

The concepts focused on the intrinsic properties and 'fun' and not so much on other extrinsic factors. Concepts covered all eating occasions for children (main meals, snacks, at school) and also considered the Australian climate, environment and culture. The list of concepts also included ideas that draw on current food trends, such as vegan foods, meal kits and subscription models.

Each potential concept was mapped against the agreed framework as well as its potential to provide meaningful increases in the vegetable intake of children. Through this process, several concept ideas were deemed not viable, for example due to low vegetable content in the end-product (e.g. a babyccino with vegetable powders) or due to being too similar to already existing vegetable products available for children (e.g. vegetable chips). A list of 22 concepts was evaluated with parents, and a total of 14 of those were adapted and selected for research with children.

4 Qualitative research methodology

4.1 Evaluation of concepts by parents

Although the main focus of this research was on children's acceptance of the new vegetable-based concepts, understanding the attitudes of parents/caregivers towards the developed concepts was deemed relevant as they are the decision makers that purchase foods that children consume. A qualitative study was undertaken by conducting fifteen one-on-one semi-structured interviews with parents of 5 to 8-year-old children. Parents from different socio-economic areas in the Greater Sydney Area were recruited and 60-minute interviews were held between August and October 2019.

During these interviews, 22 product concepts were discussed using a written interview guide. Parents were provided with the concept's A4 presentation design and were required to read the concept information themselves and were asked to provide their spontaneous reactions to the concept, including their opinions on the positives and negatives of several intrinsic and extrinsic aspects, as well as the most appropriate setting(s) (home, school, etc.) and eating occasion(s) for the concepts.

Results were used to select 14 concepts to evaluate with children. Based on parent feedback, changes to some concepts were made before evaluation with children.

The concepts that were evaluated by parents but not by children are described in Appendix A.

4.2 Evaluation of concepts by children

A qualitative study was undertaken by conducting semi-structured focus groups with children. Children were between 5 and 8 years of age and lived in the Greater Sydney area. Children were excluded when they had known food allergies or when their parent/caregiver indicated that they found it very difficult to get their child to consume vegetables. CSIRO's Low Risk Review Panel approved this study.

Each focus group was conducted with 4-6 children and to ensure that everyone felt comfortable in the discussion (being among their peers), children were grouped by age (5 and 6-year-olds together and 7 and 8-year-olds together) and split between vegetable-likers and non-likers. It was aimed to have an equal number of girls and boys in each focus group.

In total, eight focus groups of 45 minutes each were conducted and in total, 38 children participated in the focus groups; 20 (52.6%) were boys and 18 were (47.4%) girls. There was a good distribution of age: 10 (26.3%) were 5 years old, 9 (23.7%) were 6 years old, 9 (23.7%) were 7 years old and 10 (26.3%) were 8 years old.

Focus groups followed a structure outlined in an interview guide and the 14 concepts were presented and discussed one-by-one in the order as presented in the results section. The concepts were presented on A3 sheets and only showed the product/ concept name with pictures.

When discussing the concepts, the researchers briefly explained what the concept entailed and then asked the group for their thoughts.

For each concept the same questions were asked:

- What do you think about this product?
- What do you like about this?
- What don't you like about it?
- What part of it do you like the most? Why?
- Where would you like to eat it? Why there [location mentioned]?
- And when would you like to eat it? As breakfast, or as lunch, or as dinner? Or maybe a snack? Why then [meal moment mentioned]?
- Did you want to add anything else about this one before we go to the next product?

For some concepts, extra questions focused on specific concept properties and were used to prompt children when needed. Each focus group was led by two moderators and video recorded for analysis.

5 Evaluations for each of the concepts

Concept 1: Rainbow dippers

Presentation to and evaluation by children

Product description

Combination of colourful dippers and vegetable dips

Potential appealing characteristics for children

Bright colours, atypical colours, contrasts (colour, flavour), bite-sized, flavoursome, imaginative language, fun eating experience.

Evaluation

+ Most children were familiar with cheese dippers and liked the dipping way of eating (fun)
+ Overall, most children were interested in the Rainbow dippers as a concept
+ Bread and carrot sticks were indicated as most interesting as dippers. Different coloured bread sticks were liked more than plain bread sticks. Children didn't recognise the rice cakes well
+ The multi-coloured (rainbow) dip was liked more from a visual perspective than the single colour dip. However, children were unsure about whether they would like multiple flavours of dip at the same time. The cheese dip was not as well liked as the rainbow or the avocado dip
+ Flavours proposed for the dips were avocado, carrot, capsicum, hummus and tomato
+ School breaks were seen as a suitable eating occasion.

Presentation to and evaluation by parents

Product description

Mini sticks with a dip.
They are perfect as a snack for in the lunchbox or on the go!

Dip: vegetable enriched dip (e.g. cheese) or a combo "Rainbow" dip.

Dippers: breadsticks (35% vegetable) or fresh vegetables (e.g. carrot) or rice cakes (35% vegetable).

Evaluation

+ Overall positive
+ Fun way of eating
+ Bright colours of both dips and dippers are appreciated
± Need to ensure colourants are not artificial.

Recommendations

Overall positive evaluation by children and parents. Dippers can be freshly cut up vegetable sticks (carrots, capsicum, parsnip…) or breadsticks with or without added natural vegetable powders for colours and extra flavours. The dip components (e.g. different colours and different flavours versus just different colours) need further investigation. Natural vegetable colours need to be communicated on-pack. Parents had concerns about single-use plastics, therefore alternatives should be considered. Bulk packaging opportunities for school canteens or childcare can also be considered.

Concept 2: Yoghurt with vegetables

Presentation to and evaluation by children

Product description

Smooth colourful yoghurt containing vegetables

Potential appealing characteristics for children

Bright colours, flavoursome, taste contrast, sourness.

Evaluation

- ± Most children like yoghurt but associated it with flavours like vanilla, strawberry and mango
- ± Children were unsure about this concept as it was hard to comprehend what a vegetable flavoured yoghurt would taste like
- \+ Children liked idea to combine fruit and vegetable flavours, as the fruit flavour would mask the vegetable flavour
- ± Pink coloured yoghurt was interesting, particularly for girls, but flavour was more important; it should taste good and not too much like vegetables
- ± Mixed reviews about other colours presented; some children liked the bright colours, however, some children had issues with the green and orange coloured yoghurts
- ± Carrot and cucumber were mentioned as acceptable flavours
- ± Children were divided on pouch packaging; sometimes mentioned as being for babies (across all age groups), while others mentioned it was convenient because they could eat and play at the same time during the lunch break at school
- ± No clear age split for preference of eating yoghurt from a pouch or with a spoon.
- ± Children were divided whether they would consume it at home or at school indicating that it would also depend on whether it was in a pouch or not.

Presentation to and evaluation by parents

Product description

Unicorn slime/Dragon spit

A yoghurt containing vegetables.
A tasty product feeding your imagination.

10-40% vegetables. Tasty flavour combinations (e.g. rhubard/apple, carrot/ginger). Contains diverse bacteria from yoghurt.

Evaluation

- \+ Fun names were appealing to children
- \+ Parents thought it had a high chance of rejection if taste was not perfect. Seen as more product for adults than children
- \+ Pouch packaging raised environmental concerns.

Recommendations

Overall relatively low interest because of doubts that the product would have sufficient good taste. Recommended to combine fruit and vegetable flavours, particularly fruit with sweet or sweet/sour taste, to ensure good taste profile. Fruit and vegetable best puréed to ensure smooth texture and avoid textural contrast.

Concept 3: Ice cream & Ice block

Presentation to and evaluation by children

Product description

Ice cream and ice block containing vegetables

Potential appealing characteristics for children

Bright colours, atypical colours, colour contrast, sweet taste, taste contrast (sweet/sour), flavoursome, novel sensation (sour taste), fun eating experience, familiarity with existing products

Evaluation

+ Overall, ice cream and ice blocks are very familiar to, and liked by children
+ Vegetable only flavours were not well received, but most children were open to the idea of a fruit and vegetable combination, specifically for ice blocks. E.g. beetroot and berry ice blocks were mentioned by several children
+ An extreme sour taste in ice blocks gave mixed responses; some children liked sourness, but others strongly disliked the idea – this matches scientific literature findings
+ Children liked the presented carrot ice cream, both in terms of colour and expected flavour
+ All children liked the bright colours in both ice blocks and ice cream, especially green and pink
+ Children mentioned that the following vegetable flavours could work for ice blocks: beetroot, tomato, carrot and cucumber. Most children were more likely to eat them at home, though canteens might be a viable option given children already ate ice blocks there.

Presentation to and evaluation by parents

Product description

Frozen Fruit & Veg smoothie on a stick.
A refreshing nutritious treat counting towards 5 veg a day.

Creamy texture from milk and cream. Min. 20% Vegetables (e.g. rhubarb & apple, pumpkin & banana)

Frozen Fruit & Veg on a stick.

Tangy and sweet, dairy-free. Min. 20% vegetables. E.g. spinach & lemon, carrot & ginger.

Evaluation

Note: smoothie (ice cream) and ice block concepts were presented as separate concepts to parents

+ Both were very popular products
+ Bright colours appealing in both concepts
± Taste profile needs to be good
± Fun way of eating vegetables
± Ice block seen as healthier than frozen smoothie.

Recommendations

This concept had high interest from children and parents. Ice cream and ice blocks are treats and therefore a high sensory appeal is even more important than in other foods. A 100% vegetable ice cream (frozen smoothie) will likely not be sweet enough to be successful. Pairing fruits and vegetables is recommended to achieve the sensory stimulation that children look for in such products. In addition, a 'Splice'-style product (creamy ice cream core with sour ice block outside) could be considered. Potential to sell such products in school canteens could be explored by taking the Health Star rating into account.

Concept 4: Vegetable sheets

Presentation to and evaluation by children



Product description

Flat, crispy vegetable snacking sheets

Potential appealing characteristics for children

Bright colours, atypical colours, colour contrast, flavoursome, novel sensation, crunchiness (crispy and light texture), fun eating experience, familiarity with existing products.

Evaluation

- ± Not all children were familiar with seaweed sheets (nori) and they were polarising; children either liked or disliked them. When children liked them, they mentioned the saltiness. The texture in mouth, turning from crispy to gooey, was also found to be polarising; everyone liked the crispiness but only a couple liked the gooeyness in mouth
- ± Thin crispy sheets with vegetable flavour(s) received a mixed response; children that already liked the seaweed flavour were not really open to the idea of adding a vegetable flavour, while children that didn't like the seaweed flavour were more open to vegetable flavoured sheets
- ± The following potential flavours for vegetable sheets were mentioned: carrot, capsicum, tomato, cucumber, beetroot, broccoli and salty corn
- \+ Most children liked the different colours of the vegetable sheets
- ± The idea of sushi with different coloured outsides got mixed response: some children preferred a brightly coloured sushi roll, but others preferred plain looking sushi rolls.

Presentation to and evaluation by parents

Product description

A crispy, light and tasty snack made of real vegetable fibres. *Easy on the go; alternative to nori sheets or potato chips.*

Nutrient dense (min. 85% vegetables). Natural vegetable colours and flavours. Bite-sized pieces.


Evaluation

- ± Parents were slightly positive about this idea
- ± They were concerned if this was a highly 'processed' product.

Recommendations

Vegetable sheets had a mixed response by children, with quite polarised views, partly depending on their appreciation of seaweed sheets. High fibre vegetables such as carrot, pumpkin and beetroot could be used to make crispy vegetable sheets and the sheets will be naturally coloured by the vegetable (orange for carrot, purple for beetroot, etc.). Product development needs to determine how high the vegetable content of the product would be and how vegetable textures would react after going through a drying and sheeting process and therefore, what the final texture of products would be. Potential as snack or lunchbox item.

Concept 5: Poppables / VegOPop

Presentation to and evaluation by children

Product description

Colourful crunchy pops made from naturally coloured corn or vegetable puffs.

Potential appealing characteristics for children

Bright colours, atypical colours, colour contrast, bite-sized, fun shape, flavoursome, crunchiness, imaginative language

Evaluation by children

- \+ Almost all children liked popcorn
- ± Children were hesitant about the idea of multi coloured corn based on the picture in the concept. When it was explained how multi coloured corn could be grown on a farm, most children were excited about the idea
- ± Most children liked the concept of a popped texture but felt it should taste like popcorn and not another vegetable. A popped broccoli or kale wasn't found appealing because of the green colour and the strong vegetable flavours
- \+ Concept names (made up by research team): 'Poppables' was not liked much, 'VegOPop' was slightly better accepted. Vegetable non-likers more often indicated they liked a name that tells them which vegetable flavour it is because they want to know what they are getting and choose if they still want it, while vegetable likers were not that fussed about not knowing what flavour they were getting.

Note: This concept was newly developed for children after input from the parent interviews and review of earlier concepts. It makes use of the extruded vegetable pellets that were part of the Veggie snack bar concept presented to parents (Appendix A).

Recommendations

Overall, the concept had low interest amongst children. The concept was not well understood; the stretch between popcorn and other vegetables seemed too far for most children. A popped texture of a vegetable snack could be made, but taste should be more like popcorn than like a vegetable. An idea for further product development would be to use vegetable powder as a seasoning on popcorn itself. Weaning foods with extruded vegetables are available but these usually have a very pale colour, but children are likely to be more attracted to brighter colours (through use of natural vegetable powders to address parental concerns about use of artificial colourants).

Concept 6: Pizza base

Presentation to and evaluation by children





Product description

Pizza base with vegetable in the dough

Potential appealing characteristics for children

Bright colours, atypical colours, contrasts (colour, texture), flavour some, fun eating experience

Evaluation

- ± Most children said they like to eat pizza and were open to the idea of a pizza base with vegetables in it (vegetables mixed into dough)
- ± The different colours were found appealing, especially by the vegetable likers
- ± Vegetable likers were more open to the idea, while non-likers preferred a normal looking and normal tasting base as they know what they are getting and worried about a different taste
- ± The pink/purple coloured pizza base was said to be appealing to many children, but they were doubtful about its flavour if beetroot was in the base
- \- The image of the different coloured cauliflowers caused more negativity than curiosity; almost none seemed interested in a purple or orange cauliflower pizza base
- ± Carrot, tomato and sweet potato were suggested as most appealing (colour and flavour)
- ± Tomato in the base was seen as a 'pizza' flavour, which would pose no sensory challenges
- \- Almost no-one was interested in a 100% vegetable base because of taste concerns.

Presentation to and evaluation by parents

Product description

A pizza base like any other but with vegetables baked into the dough; an easy and tasty way to eat more vegetables! *Kids can top their own pizza with whatever they like and enjoy it during lunch or dinner.*

Min 60% vegetables (e.g. cauliflower). Cauliflower of different colours for more fun.



Evaluation

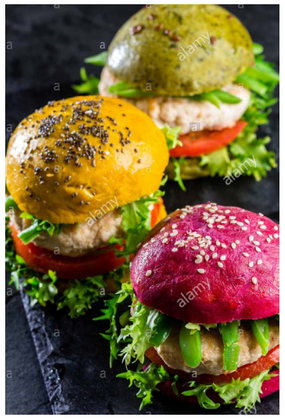
- ± Parents were positive towards the concept because their children like to eat pizza
- \- Parents warned that the vegetable flavour in the base shouldn't be too overpowering as they think it could impact negatively on their children's acceptance.

Recommendations

Pizzas are one of children's favourite foods and children were interested in this concept. However, it should mostly taste like normal pizza. For a concept so familiar to children, it seems that not too many elements should be tweaked because it becomes less what children expect of it. There was interest in other colours. Further research is needed to find a good balance between appealing colours, vegetable content and children's acceptance. Vegetable content of the end-product could be increased through vegetable topping choices. Pizza bases could be available, ready-to-top and place in the oven, at supermarkets. Ready-made pizza could be available for children at school canteens or childcare. A tomato flavoured base with garlic topping could be a substitute for garlic bread which is often part of school canteen menus.

Concept 7: Vegetable wraps & bread rolls

Presentation to and evaluation by children



Product description

Wraps and bread rolls with vegetable in the dough

Potential appealing characteristics for children

Bright colours, atypical colours, colour contrast, fun shapes, taste and texture contrast, fun eating experience, familiarity with existing products

Evaluation

- ± Most children said they like to eat burgers and/or wraps. When presented with the vegetable-containing, coloured, wraps and bread rolls, only half of the children found the colours appealing, the other half preferred them in a plain colour
- ± The children that liked the colours of the bread rolls and wraps seemed to prefer the brighter colours over the duller colours
- ± It seemed that most children preferred the bread rolls and wraps to taste like normal bread products, i.e. with not too much vegetable flavour in them.

Presentation to and evaluation by parents

Product description

Wraps and bread rolls with vegetables incorporated in the dough. *An easy way to eat more vegetables!*

35% vegetable (e.g. spinach, beetroot). Eat them for lunch or dinner. Variety of natural vegetable colours.

Evaluation

- \+ Most parents were positive about this concept
- \+ Easy way to increase vegetable consumption
- ± Mixed reviews about colours; some worried the green colour might put their child off from eating it, others thought the colours were attractive.

Recommendations

This product had low interest amongst children. Since only half of the children found the colours appealing and most children were worried about the taste of the wraps and bread rolls, there seems to be a high chance of rejection when this familiar product deviates too much from plain looking wraps and burgers. Furthermore, it might be difficult to achieve an appropriate vegetable content considering that the product would likely be rejected if vegetable flavours are too strong. Given how commonplace these types of products are, and that sandwich-style lunches are commonplace in Australia, this concept still has some potential if the challenges around acceptance can be overcome. Thus, more research and development, as well as prototyping and testing of this concept would be required to take it further.

Concept 8: VeggieStix

Presentation to and evaluation by children



Product description

A variety of single bite veggies on a skewer

Potential appealing characteristics for children

Bright colours, fun shapes, contrasts (colour, shape flavour, texture), flavour some, fun eating experience, imaginative language, familiarity with existing products

Evaluation

+ Most children have eaten from a stick before, mostly meat kebabs and some had had fruit kebabs before, only for a few it was a novel idea to eat from a stick. Most of the children said they think it's fun to eat from a stick and were interested in eating the VeggieStix
+ The sandwich-style stick was preferred over the vegetable-only sticks by most children. The reasons they preferred this concept was the inclusion of different foods such as bread, cheese and ham, as well as vegetables, and because it came with nice shapes
+ When comparing the two vegetable-only sticks, most children seemed to prefer the raw vegetables over the cooked vegetables, they couldn't provide detailed reasons for their preference except for preferring raw vegetables in general
± Some children mentioned that they might not be allowed to bring food on a stick to school for safety reasons and therefore saw themselves eating this at home and not in school.

Presentation to and evaluation by parents

Product description

A variety of single bite veggies on a skewer.
A fun and convenient way to eat a rainbow.

Comes in these forms: raw vegetables kebab, grilled vegetables kebab, sandwich kebab.



Evaluation

± Parents liked the concept but thought it might be easily overlooked by competing less healthy foods when offered in canteens
± Sandwich kebab preferred, mixed reviews for the cooked and raw vegetables.

Recommendations

This concept had mixed interest with the sandwich style stick having highest appeal as it combined different food groups and had fun, appealing shapes that the raw and cooked vegetable sticks didn't have. The idea to eat from a stick was appealing to most children. . The product would be most successful when raw vegetables and other foods, like bread and cheese, would be combined on a stick. The concept may not be suitable for school canteens due to safety concerns (the stick) but could be considered as a simple recipe for a Cooking KIT. As a commercial pre-made product by industry (e.g. for sale in supermarkets) the time-consuming assembly aspect may impose economic challenges on this concept.

Concept 9: Veggie bites

Presentation to and evaluation by children




Product description

Vegetable based bites/nuggets

Potential appealing characteristics for children

Bright colours, atypical colours, fun shapes, shape contrast, bite-sized, flavour contrast, crunchy outside, fun eating experience

Note: This concept was altered slightly from the concept 'Mini veggie burgers' presented to parents as parent interviews suggested it had more potential as nuggets filled with vegetable.

Evaluation

- ± Children liked to eat chicken nuggets; however, most children seemed to prefer 'normal' meat / chicken nuggets to vegetable-filled bites
- \- Many children had difficulties comprehending the idea of the vegetable fillings and what the Veggie bites would taste like
- ± Most children found the different shapes (upper left picture) appealing, as well as the bright coloured filling on the bottom pictures. That said, some children mentioned they would like to have the coloured filling, but it should mainly taste like meat
- ± Vegetable likers were more open to the idea of a 'surprise-filling' (i.e. not knowing what vegetable-flavoured filling was inside) than the vegetable non-likers who were opposed to not knowing what type of vegetable filling they would get
- ± The product was not really mentioned as being part of a meal, more as a stand-alone snack product like chicken nuggets, eaten at school and home.

Presentation to and evaluation by parents

Product description

Mini vegetable patties.
A fun choice for Meatless Mondays.

Meat-free, loaded with vegetables, comes in different flavours, shapes and natural colours for variety, mini size for little mouths.




Evaluation

- ± Parents thought children would like a nugget/croquette style product (with vegetable filling) more than mini veggie burgers or patties.

Recommendations

This concept had low appeal amongst children as it was too difficult to comprehend, and most children would prefer plain chicken nuggets or meat bites. Coloured fillings, shapes and bite-sized pieces were liked. Given the trends towards more plant-based diets, opportunities seem to exist for mixed meat/vegetable products, whereby partially the meat is replaced. The overall taste profile should not differ too much from the meat variant and different vegetables could be explored to achieve this (e.g. mushrooms as they have a high umami taste).

Concept 10: Sipp'a soup

Presentation to and evaluation by children

Product description

A flavoured straw to sip your soup for an exciting flavour sensation

Potential appealing characteristics for children

Flavoursome, novel flavour sensations, suppression of bitterness, fun eating experience, imaginative language, associative learning

Note: this concept was altered slightly from the concept 'Enhance your soup experience' presented to parents.

Evaluation

- ± Some children knew "Sippah straws" but most had difficulty making the connection to drinking soup through a flavoured straw. After clarification, children could imagine liking a straw with bacon, cheese or carrot flavour
- \- Soup was not consumed that often by most children, especially not in a school setting, however, children with an Asian background mentioned that they ate soup regularly, but these were mostly soups with noodles and chunks of vegetables and/or meat in them and they felt the straw could not be used when eating these type of soups.

Presentation to and evaluation by parents

Product description

Three different nutritious and tasty additions that will enhance the appeal to eat vegetable soups: toppings, savoury crackers and flavoured straws

Nutrition: Top your soup with roasted chickpeas and make it a balanced meal.

Fun: Savoury filled cracker to dip or sip your soup.

Sensation: A flavoured straw to sip your soup for an exciting flavour sensation (e.g. Coconut, Chilli, Bacon, Cheese).

Evaluation

- \- (Vegetable) soups are not very popular by children therefore limited opportunity to make this more attractive
- \+ Straw could be a fun way to eat but need to ensure it is safe (not sipping hot liquid).

Recommendations

This concept had low appeal amongst children because smooth vegetable soups are not very popular with Australian children. The value of this concept lies largely in the fact that it increases the intake of vegetable containing soup and not in the vegetable contribution of the concept itself. The inside of the straw would be layered with flavoursome powder (e.g. bacon, coconut, chilli, cumin…) adding depth to the flavours and increase children's liking of the soup. When soups become more popular amongst children a concept such as Sipp'a soup could become viable.

Concept 11: Fairy dust

Presentation to and evaluation by children

Product description

Seasoning powder made partially from vegetable to dip in or sprinkle on top of vegetables.

Potential appealing characteristics for children

Flavoursome, novel flavour sensations, suppression of bitterness, fun eating experience, imaginative language, associative learning

Note: this concept was altered slightly from the concept 'Seasoning sachet' presented to parents.

Evaluation

+ Overall, most children seemed open to this concept of either dipping their vegetables in the 'fairy dust' or sprinkling 'dust' on top of their vegetables as both are actions most children like
± Some children were concerned the 'fairy dust' would not stick on the vegetable and fall off. A few children suggested to overcome this by combining the 'dust' with a stickier component, for example served with the vegetable yoghurt or rainbow dip concepts
+ Most children found the bright colours of the Fairy dust appealing
+ Carrot flavoured dust was mentioned a few times as being a good flavour
+ Some children liked the sour taste idea; however, this was polarising
- A spicy chilli flavoured dust was not appealing to the majority as they did not like spicy food.

Presentation to and evaluation by parents

Product description

Spice up your food with these exciting seasonings. *Dip in or sprinkle on top for new flavour sensations.*

Made from vegetables. Different flavours: sweet & sour, savoury/umami (with vegetable powder).

Evaluation

Product description: Sachet containing seasoning made partially from vegetable to sprinkle on top of food and vegetables

- Parents mentioned that a 'seasoning sachet' was very processed and were not too keen.

Recommendations

Children were positive about this concept as they liked the idea of dipping or sprinkling. Raw unseasoned vegetables are relatively low in flavour intensity. This concept idea consists of freeze-dried, powdered vegetables potentially combined with other ingredients to increase appeal of taste and appearance. Additional ingredients could be added to the powder to make it an even tastier seasoning. The sprinkles can have tastes liked by children, e.g. sweet (e.g. pumpkin), sour (particularly in combination with a sour fruit like raspberry) or umami (e.g. mushroom). These tastes would enhance sensory appeal but may also partially mask slight bitter tastes from vegetables, making them more acceptable. Therefore, they can learn to like the tastes of vegetables. Particularly as an enhancer over raw vegetables as it could lead to increased intake of meaningful amounts of vegetables. The format and packaging need consideration if as a standalone powder, to address concerns on single-use materials (e.g. a 'shaker').

Concept 12: Rainbow Squeeze-mate

Presentation to and evaluation by children

Product description

Vegetable dip/sauce single use dispenser

Potential appealing characteristics for children

Bright colours, atypical colours, contrast (colour, flavour), flavoursome, novel sensation, fun eating experience, imaginative language

Evaluation

- \+ All children knew commercial tomato sauce squeeze-on containers and liked using them, because they said it was fun to do. They associated them with eating pies and sausage rolls
- \+ After explaining that you could put the contents on bread or crackers, most of the children liked the idea of doing that during lunch
- \+ Most children liked the look of the rainbow spread with the different and vibrant colours
- ± Some worried the colours would mix and that the mix becomes unappealing
- ± Children were doubtful about the rainbow spread having multiple flavours, some children said they preferred multiple colours but only one vegetable flavour
- \+ Vegetable flavours that they mentioned as appealing included: avocado, tomato, beetroot, cucumber, carrot and pumpkin.

Presentation to and evaluation by parents

Product description

Vegetable spread in a 'squeeze on' package.
Squeeze it on a sandwich for lunch and avoid soggy bread.

More vegetables than regular squeeze-on sauces. Different flavours: 1 flavour or multiple flavours in 1 package.

Evaluation

- \+ Parents thought children would find this fun
- \- Some parents expressed the concern of the single-use plastic container and asked whether these packages could be made from biodegradable sources.

Recommendations

This concept had positive evaluations from both children and parents. It is a fun way for children to 'play' with their food without actually having to touch the spread. It can prevent having a soggy sandwich because the vegetable spreads are added to sandwiches just before eating (e.g. at school lunch time). Various vegetable flavours (e.g. guacamole, beetroot, pumpkin) can be available to satisfy all taste buds and the concept is high in vegetable content. The Squeeze-mate can be added in the lunchbox or sold in school canteens. Further product development recommended to investigate acceptance of the rainbow concept in different colours/ 1 flavour vs. different colours/ different flavours e.g. through use of atypically coloured vegetables, and technicalities in keeping colours separated. Environmental concerns and legality around using this type of food dispenser may also need to be considered.

Concept 13: Crunch & Sip® KIT

Presentation to and evaluation by children

Product description

Medley of vegetables for morning tea

Potential appealing characteristics for children

Bright colours, atypical colours, fun shapes, contrasts (colour, flavour), bite-sized, flavour some, crunchiness, familiarity with existing eating occasion

Evaluation

+ Most children had a Crunch & Sip® break at school
+ Most children liked the Crunch & Sip® KIT idea, and both the mini/baby vegetables, and the cut-up vegetables were liked a lot
+ For the mini/baby vegetables, several positives were mentioned including cuteness, able to grab and hold with one hand and they are easy to eat
+ However, children said they thought that cut-up vegetables were even easier to eat
+ For both ideas they liked the mix of colours and the variety of vegetables
+ Including atypically coloured vegetables was also tested and some children liked the idea of different coloured carrots and tomatoes, if they tasted as expected
+ The idea to have a subscription at school for Crunch & Sip® was also prompted and overall, children liked the idea of getting a Crunch & Sip® KIT subscription from the canteen.

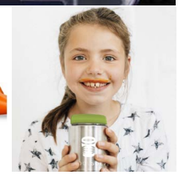
Presentation to and evaluation by parents

Product description

Vegetable based crunch & sip KIT. *Save time with a premade Crunch & Sip KIT.*

Choice of: mix of whole baby vegetables, medleys of freshly cut vegetables, freshly puréed vegetable soup (50-80% vegetables).

Also available as a subscription at school.



Evaluation

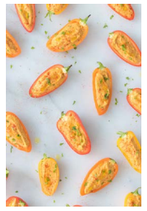
+ Parents mentioned convenience of the Crunch & Sip KIT® subscription as a major positive point for this concept; this would save them time to prepare something at home.

Recommendations

This concept was positively evaluated by both children and parents. Crunch & Sip® is a program run in primary schools across Australia to promote children to consume vegetables and/or fruits in the classroom during a set time in the day. Most children bring fruits but rarely vegetables. Building familiarity through exposure is a well-known mechanism to increase children's vegetable acceptance. By offering medleys of vegetables there is opportunity to build children's familiarity to a wide range of vegetables. Further product development needs to determine the exact content and portion sizes of vegetables, and the ratio of familiar vs unfamiliar vegetables. Kits could be available at retail, childcare or canteen or available through a canteen school subscription system.

Concept 14: Cooking KIT

Presentation to and evaluation by children



Product description

A box that contains a child-friendly recipe with all ingredients in it to get children involved in cooking

Potential appealing characteristics for children

Fun shape, taste and textural contrast, fun eating experience, role modelling (mimicking parents).

Evaluation

- \+ Instantly, all children loved the Cooking KIT idea as they said that they like to help out with cooking at home
- \+ The idea of getting a chef's hat and child friendly knife were also well liked by children
- \+ No negatives or concerns were mentioned about this concept
- \+ The children were interested in making small snacks, pizza, pasta dishes, nachos, fish & chips, fruit salad, lasagne and soup.

Presentation to and evaluation by parents

Product description

All the ingredients for a delicious dish in 1 KIT.
Easy and fun way to get your child cooking!

Lots of fresh vegetables, builds children's independence and cooking skills, fun and easy recipes specifically made for kids.

Evaluation

- \+ Parents liked the idea of this kit
- \+ Limited time and safety were mentioned by parents as barriers to let their children help in the kitchen. Providing a KIT with simple recipes that don't take much preparation time and providing an optional child-friendly knife might help them overcome these barriers.

Recommendations

Overall, this concept was very well received by the children and parents. This concept builds on to the idea of meal kits which have made a recent introduction in family homes. This concept is a meal kit tailored to children with child-friendly recipes, fun and age-appropriate recipe sheets and child-friendly cooking utensils (e.g. apron, hat, knife). The kit can be versatile and can incorporate recipes that stress important characteristics for children such as fun characters and atypical coloured vegetables or just cater for the whole family. All recipes will centre around and contain fresh vegetables that children will have to prepare themselves to assist in building familiarity around vegetables. This concept also plays into the child feeling more autonomous and this can lead to increased willingness to try new meals with vegetables. These kits could be available in supermarkets or through home delivery subscription models.

6 Conclusion and discussion

Table 2 presents an overall summary of the results of the children's evaluation of the concepts, with concepts grouped on the basis of their relative interest. Children had a high interest in six of the concepts, which, overall, seem to be characterised by having high visual appeal, a 'fun' factor and children anticipating the product would taste good. For three concepts, children had a mixed response, indicating that this may appeal to a proportion of children only. It is likely that the lack of appeal in this portion of children was either because they were unfamiliar with, or did not like the existing product on which the concept was based anyway (e.g. nori sheets), or they had concerns about whether it would taste good. These two reasons, unfamiliarity and concerns about taste, also seemed to be the primary reasons for the concepts that children were not interested in.

Table 2: Summary of results from focus groups with children about the concepts

Overall interest in concept	Concepts
High	Rainbow dippers Ice cream & ice block Fairy dust Rainbow squeeze-mate Crunch & Sip KIT Children's cooking KIT
Mixed response	Vegetable sheets Pizza base VeggieStix
Low	Yoghurt with vegetables Poppables / VegOPop Vegetable wraps & bread rolls Veggie bites Sipp'a soup

A new model for product development was proposed, the CAMPOV model. The current qualitative evaluation provides a first evaluation of the model. Overall, most of the factors hypothesised to positively influence children's interest in vegetable-containing products were found to contribute to children's interests in the concepts. These factors were bright colours, fun shapes, bite-sized pieces, good taste, fun eating experience, imaginative language, familiarity and role modelling. The factors for which we found limited or no support were atypical colours (mixed response in part depending on the child's degree of neophobia) and some specific novel sensations (extreme sour taste had a mixed response and spiciness was not supported). There was insufficient evidence for the role of texture, particularly due to low textural awareness amongst children in combination with the fact that concepts were presented visually in this stage of concept development, and not actually tasted.

7 How to use this report

Using the results within this report, there are two main ways that product developers and industry can develop and evaluate new vegetable-based products for children or increase the vegetable-based offerings in their portfolios.

1. The concepts presented in this report can be taken by companies and put further into the new product development (NPD) cycle and developed to suit their needs; there is no Intellectual Property (IP) surrounding the ideas presented in the concepts
2. The insights from the literature review and CSIRO CAMPOV model can be applied to suit different organisations' specific needs in developing new products. Using each, or either of these aspects, companies can facilitate their own idea or concept generation, specific to their own product category.

There are several ways in which organisations can collaborate with CSIRO in order to further develop or progress any of these concepts or even their own ideas.

If companies are interested in taking one or more of the concepts forward, CSIRO can assist in the development phase of the NPD cycle through prototype development and in the testing and analysis phases through consumer and/or market research and trained panel profiling. If companies are interested in collaborating with CSIRO on their own organisation's ideas, then this can be done in the idea generation and research phases through concept testing, targeted focus groups, product mapping activities and market analysis.

CSIRO has a dedicated trained sensory panel and the ability to run consumer testing with different consumer populations, including children. In addition to the sensory and consumer science capability and facilities at CSIRO, there is also broad expertise in the Food Program, including: food formulation, processing and engineering, applied and process microbiology, food safety, fermentation expertise, flavour science and food chemistry. There are also dedicated Pilot Plant facilities at the Werribee and Coopers Plains sites, where new products can be scaled up and tested.

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Appendix A: Other concepts presented to parents

Concepts below were evaluated by parents but not by children.

Concept A1: Stuffed baby capsicum

Product description

Baby capsicums stuffed with any kind of filling.
Perfect as a snack or in the lunchbox.
Variety of fillings e.g. coleslaw, beetroot, humus, couscous.
Consumed raw or baked in the oven.

Potential appealing characteristics for children

Bright colours, atypical colours, fun shapes, contrasts (colour, flavour), flavour some, good taste through suppression of bitterness, fun eating experience.

Evaluation by parents

Parents found it visually appealing and some parents commented it was a novelty to use the capsicum as a container for the filling. However, some parents were worried that it might become messy when eating. It was also mentioned that some children really don't like raw capsicum. Other barriers included that it might be overlooked in the canteen and when bought in supermarkets, parents worried about preservatives and price.

Concept A2: Vegetable Pasta and Noodles

Product description

100% vegetable pasta or noodles to use in your regular recipes: more vegetables in 1 meal.

Simply steam in the microwave and serve with a sauce and extra veggies!

Natural vegetable colours. Replace carbs with vegetables.

Potential appealing characteristics for children

Bright colours, atypical colours, contrasts (colour, flavour), flavour some, familiarity with existing products

Evaluation by parents

Most parents knew this product already, however, they mentioned barriers to use including not knowing enough recipes to use it in and that it looked dry when sold in supermarkets. Some parents said their child would like it, others said their child prefers regular pasta due to the taste and texture. Many parents said they think their child needs carbohydrates to grow and therefore wouldn't want to replace regular pasta or noodles with vegetables.

Concept A3: Vegetable Sushi

Product description

Ready-to-eat sushi with veggie rice (e.g. broccoli or cauliflower); an easy and tasty way to eat more vegetables!

Perfect for lunch or as a snack. Min. 80% vegetables. Variety of regular sushi fillings, like seafood and/or vegetables.

Potential appealing characteristics for children

Bright colours, atypical colours, fun shapes, shape contrast, bite-sized, fun eating experience

Evaluation by parents

Parents said their children like sushi but would prefer the normal rice or maybe a substitution of half of the rice at most, as taste and texture would otherwise differ too much from what the children are used to.

Concept A4: Vegetable Steamed buns

Product description

Ready-to-eat steamed buns with vegetable incorporated in the dough and a vegetarian filling.

Steam in the microwave and serve with a sauce for lunch. Variety of natural vegetable colours. Variety of fillings. Balanced meal on the go.

Potential appealing characteristics for children

Bright colours, atypical colours, fun shapes, bite-sized, flavour contrast, fun eating experience

Evaluation by parents

Most parents said their child wasn't familiar with steamed buns and not all parents were sure their child would like it. Some children who had tried them before didn't like the texture of steamed buns, according to the parents. The colours were said to be appealing and parents were positive about the vegetables in the dough. It was also mentioned it was probably easy to eat and not messy.

Concept A5: Sweet treats with hidden vegetables

Product description

A range of sweet treats with added vegetables. Healthier alternative than regular treats.

Min. 20% vegetables. E.g. pumpkin/sweet potato brownie, avocado mousse, zucchini-carrot cake. High in fibre, low in sugar.

Potential appealing characteristics for children

Sweet taste, flavoursome, familiarity with existing products

Evaluation by parents

Most parents already had tried sweet treats with hidden vegetables with their children and some were positive about the concept. Not all parents were positive about hiding vegetables as they said it was important their children learn to like vegetables, and some said a treat should be a treat and children should eat vegetables in other ways.

Concept A6: Veggie snack bar

Product description

A savoury, tasty, chewy bar. Healthier alternative than regular snack bars.

Loaded with vegetables (between 12-50%) and grains/ nuts. Snack on the go. Variety of flavours (e.g. BBQ, honey soy chicken)

Potential appealing characteristics for children

Bright colours, flavoursome, taste contrast, crunchiness, familiarity with existing products

Evaluation by parents

This concept got mixed responses from parents, particularly, the chewy texture seemed to be polarising. Most parents were also confused about the savoury flavour of the bars as they were thinking of muesli bars being sweet. Parents were also worried about the sugar content, but if eaten as an alternative to something unhealthy, it was fine. As children are not allowed to bring foods containing nuts to school, it wouldn't be appropriate for lunch boxes, but it could be a convenient snack on the go.

Concept A7: Vegetable bliss balls

Product description

Bliss balls with vegetables

Potential appealing characteristics for children

Bright colours, atypical colours, bite-sized, sweet taste, flavoursome, fun eating experience

Evaluation by parents

Some parents said their child already likes protein balls or 'bliss balls', due to their sweet taste. The bite size pieces were positively received as it would be easy to eat. Some parents thought the green colour would be appealing for their child, while others mentioned it would be a barrier for their child. Some parents see 'bliss balls' as a treat; others see it as an everyday thing.