SEAFOOD INCLUSION IN COMMERCIAL MAIN MEAL EARLY YEARS' FOOD PRODUCTS.

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COMPETING INTERESTS

The author(s) declare that they have no competing interests.

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AUTHORSHIP CONTRIBUTION

Substantial contributions to the conception or design of the work; analysis, and interpretation of data for the work were conducted by Sharon Carstairs under the supervision of Dr K Kiezebrink, Dr D Marais and Dr L Craig. Drafting of the work was the work of Sharon Carstairs with the revision for important intellectual content and final approval of the version to be published given by Dr K Kiezebrink, Dr D Marais and Dr L Craig. There is agreement between the authors that Sharon Carstairs is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

ABSTRACT

Seafood consumption is recommended as part of a healthy, balanced diet. Under-exposure to seafood during early years feeding, when taste and food acceptance is developed, may impact on the future development of a varied diet. This study aimed to investigate the availability and nutritional content of seafood in commercial infant meals compared to other food types. A survey was conducted of all commercial infant main meal products available for purchase in supermarkets, high street retailers and online stores within the United Kingdom. The primary food type (seafood, poultry, meat, and vegetables) within each product, nutritional composition per 100g, and ingredient contribution were assessed. Of the original 341 main meal products seafood (n=13; 3.8%) was underrepresented compared to poultry (103; 30.2%), meat (121; 35.5%) and vegetables (104; 30.5%). The number of seafood meals increased three years later (n=20; 6.3%) vegetable meals remained the largest contributor to the market (115; 36.4%) with meat (99; 31.3%) and poultry (82; 26.0%) both contributing slightly less than previously. Seafood-based meals provided significantly higher energy (83.0 kcal), protein (4.6g), and total fat (3.2g) than vegetable (68kcal, 2.7g, 1.9g), meat (66kcal, 3.0g, 2.1g) and poultry-based meals (66kcal, 3.0g, 2.1g) and higher saturated fat (1.3g) than poultry (0.4g) and vegetable-based (0.6g) meals (all per100g) which may be attributed to additional dairy ingredients. Parents who predominantly use commercial products to wean their infant may face challenges in sourcing a range of seafood products to enable the introduction of this food into the diet of their infant.

Keywords: Infant Feeding; Seafood; Complementary Feeding; Pre-prepared foods; Baby food; Early Years'

INTRODUCTION

The infant food industry has expanded rapidly in the last decade with an increasingly extensive range of products sold across all early years' feeding stages. In recent years, the Diet and Nutrition Survey of Infants and Young Children (Public Health England and Food Standards Agency 2014) identified that 50% of UK infants aged 4 to 11 months had consumed commercial infant meat and fish-based foods over a 4-day period. During the first few months of complementary feeding (4-6 months) the survey concluded that 36% of the infants "always" or "almost always" ate a commercially prepared infant meal for the main meal of day. This decreased to 5% at 12-18 months where over two thirds (63%) of toddlers were said to eat the same food as their parents (Department of Health 2011, Scottish Government 2011). The vast availability of commercial infant food products provides parents with a convenient alternative to home-cooked family meals (Synott et al. 2007, Maguire, Owens & Simon 2004) and despite the fact that homemade food is often seen as the ideal option, commercial foods can provide a variety of flavours to help identify and develop infants' preferences (Hoddinott et al. 2010).

Infancy and early childhood has been shown to be a key period for the development of taste and future eating habits (Birch et al. 1990, Birch, Fisher 1998, Sullivan, Birch 1994). It has been suggested that under-exposure to foods or food groups during early childhood may impact on acceptance of these foods in later life (Birch et al. 1998) and that repeated exposure is required (Caton et al. 2014). A child's exposure to new tastes begins during the introduction to solid foods, also known as complementary feeding. This is the period in which breast milk is no longer able to solely provide an infant's nutritional needs and is recommended that it should not begin before six months of age (World Health Organization 2001).

By the age of one year infants should be consuming a varied diet providing a balance of nutrients similar to that recommended for the general population (NHS Health Scotland 2010). This diet should progress towards achieving the guideline recommendations that people should eat at least two portions of fish per week with one portion being oily fish (Scottish Government 2013a, Scientific Advisory Committee on Nutrition 2004).

Fish (seafood) has long been advocated as a vital component of a healthy, balanced diet by providing essential nutrients, polyunsaturated fatty acids, and lower saturated fat than other animal sources. The inclusion of essential omega-3 fatty acid, docosahexaenoic acid (DHA), in seafood has been shown to be important for brain and neural development (Innis 2007) and higher seafood consumption in adults has been associated as a marker of health consciousness (Altekruse et al.

1995) and healthy dietary patterns in individuals (Trondsen et al. 2004). By including seafood into a child's diet we can develop preferences that aide healthy dietary patterns into later childhood and adulthood. The availability of suitable infant seafood meal options may contribute to the under-exposure to seafood in this age-group and could affect their current and future acceptance of this distinctive flavour. Despite previous research comparing the nutritional composition of commercial pre-prepared products to breast milk and home-cooked meals (Garcia et al. 2013) there is a lack of evidence for the availability and nutritional suitability of seafood-based commercial meals. The primary objective of this research was to investigate the availability and nutritional content of seafood in pre-prepared main meal food products aimed towards early years feeding stages in comparison to other main meal products.

MATERIALS AND METHODS

Data Collection

A search of United Kingdom (UK) online infant food stores, supermarkets; - Asda; Tesco; Morrisons; Sainsburys; Aldi; Lidl, and non-food retailers; - Boots and Superdrug, was conducted to identify manufacturers of pre-prepared infant and toddler main meal products between September and December 2012. Only pre-prepared main meal (savoury) products aimed towards the early years feeding were included for analysis. Breakfast, dessert, formula milk, snacks, finger foods and products aimed towards children aged five years and older were excluded from this investigation. Details of each product were identified from the manufacturer's own websites and by viewing products in store. Where no information was available direct enquiry to the manufacturer was carried out and additional product details were provided by email. An updated search of product availability was conducted in January 2015 to investigate any changes or growth of the market.

Product names were used to categorise the primary food type within each meal i.e. vegetable, poultry (chicken and turkey), meat (beef, lamb, pork), and seafood-based (fish and shellfish). Vegetables contributed to many of the products however vegetable-based meals were categorised as meals with no other primary food type(s) present. Details of the recommended age, nutritional composition, ingredients and their contribution in the products were collected from product labels, manufacturers' websites or through personal communication with manufacturers.

A number of products had nutrient labels which stated 'trace', for example salt, these were designated 0.05g/100g to enable analysis. According to the Food Standards Agency's Guidance notes on nutrition labelling, 'trace' can be used when values are below 0.1g/100g and values between 0.05g and 0.15g may be rounded to 0.05g (Food Standards Agency 1999).

Data Analysis

The proportional contribution of seafood-based products was compared to non-seafood based main meal products. Data was not normally distributed thus the non-parametric Mann-Whitney U Test was conducted to examine and compare the nutritional content per 100g between each food type. P-values <0.05 were considered statistically significant. Statistical analysis was conducted using IBM SPSS Statistics 21 software (IBM Corp 2013).

RESULTS

General Characteristics

Fourteen manufacturers were initially identified but two were excluded from the study as the product ranges only included breakfast and dessert-based products or were aimed towards children five years and over.

Three hundred and forty one main meal products were identified. Seafood-based main meal products contributed 3.8% (n=13) of the total available products compared with poultry (30.2%), meat (35.5%), and vegetable-based (30.5%) products. A review conducted in January 2015 identified that seafood production in commercial infant meals increased to 6.3% (n=20), whilst poultry meals contributed 26.0% (n=82), meat 31.3% (n=99) and vegetables meals 36.4% (n=115). Over two thirds (n=8) of the identified manufacturers produced seafood-based products with an average of 1.1 seafood meals per manufacturer and each manufacturer producing no more than two seafood products (Table 1). This increased to an average of 2.5 seafood meals in 2015 with an overall decrease in the market with four manufacturers no longer selling any main meal products within the UK. Over the past three years, all except one manufacturer increased the number of seafood meals. Boots Baby Organic and Hipp Organic introduced one and three seafood meals (respectively) to their production range and the main meal market.

Table 1: Absolute number and percentage contribution of seafood-based main meal products.

Manufacturer	Number of main meal products in 2012 (percentage contribution to total main meal range) (n=341)	Number of seafood-based products in 2012 (percentage contribution to the manufacturers range) (n=13)	Number of main meal products in 2015 (percentage contribution to total main meal range) (n=316)	Number of seafood-based products in 2015 (percentage contribution to the manufacturers range) (n=20)
Annabel Karmel	10 (2.9)	1 (10.0)	17 (5.4)	2 (11.8)
Asda's Little Angels	12 (3.5)	1(8.3)	-	-
Boots Own/ Boots Baby Organic	24 (7.0)	0 (0.0)	24 (7.6)	1 (4.2)
Cow and Gate	48 (14.1)	3 (6.3)	61(19.3)	5 (8.2)
Ella's Kitchen	27 (7.9)	2 (7.4)	52 (16.5)	3 (5.8)
Heinz	70 (20.5)	1 (1.4)	59 (18.7)	3 (5.1)
Hipp Organic	52 (15.3)	0 (0.0)	69 (21.8)	3 (4.4)
Holle	15 (4.4)	0 (0.0)	18 (5.7)	0 (0.0)
Little Dish	12 (3.5)	2 (16.7)	16 (5.1)	3 (18.8)
Mumtaz	7 (2.1)	0 (0.0)	-	-
Organix	44 (12.9)	1 (2.3)	-	-
Plum Organic	20 (5.9)	2 (10.0)	-	-

Product availability across early years' stages

Four early years' feeding stages were classified from the manufacturers' product recommended age; - stage 1: 4-6 months; stage 2: 7^+ months; stage 3: 10^+ months; and stage 4: 12^+ months. Manufacturers produced a higher number of main meal products (68.9% of products) aimed at the first two early years' stages (31.1% and 37.8% respectively) compared with the latter two stages (17.3% and 13.8% respectively). Vegetable-based products were predominant at stage 1 with lower and relatively equal contributions from poultry and meat products (Figure 1). However at stage 2 vegetable-based products were displaced by poultry and meat-based meals and at stage 3 there was an overall reduction in the total number of products which continued towards stage 4. Throughout all stages seafood-based meals consistently had the lowest number of products.

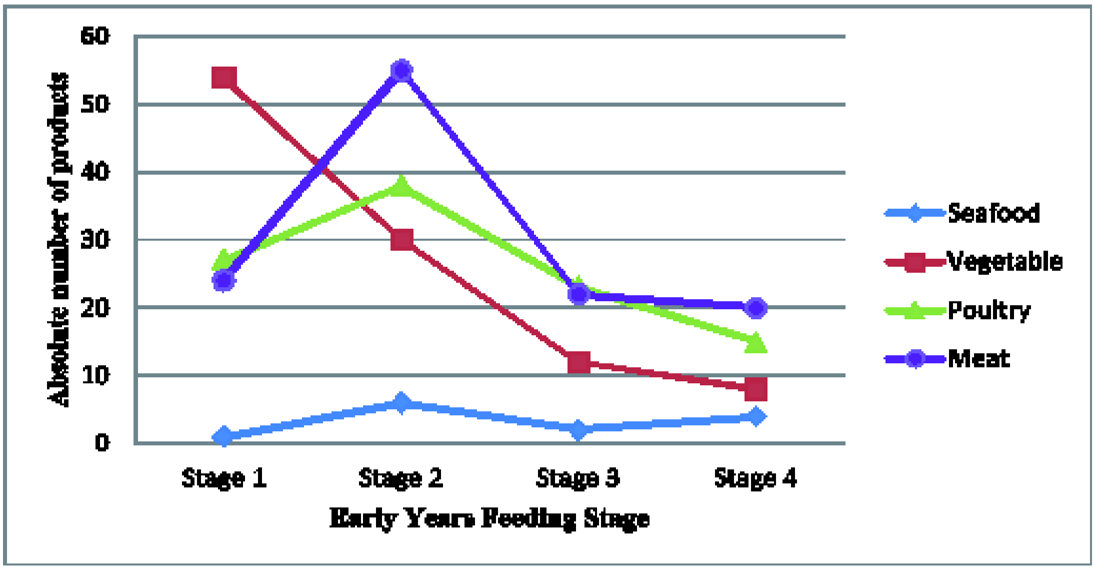

Figure 1: The absolute number of main meal products of each food type across the stages of early years feeding.

Seafood-based Meals

Three varieties of seafood were included within the seafood meals, tuna (n=4), salmon (n=9), and cod (n=2) but cod was only used in combination with salmon. The seafood-based meals were combined with pasta (n=4), rice (n=2), potatoes (n=1), or as a fish pie/bake (n=6) option.

An increase in the variety of seafood species used within commercial meals is evident from the 2015 review, revealing that pollack (n=5), sole (n=1) and hake (n=1) species were additionally used and that seafood-based meals were also combined with vegetables (only) or as fish cakes in addition to previous accompaniments.

Nutritional Content of Main Meals

Seafood-based main meals showed significantly higher energy (83.0 kcal/100g) and total fat (3.2g/100g) contents than their poultry (66.0 kcal, 2.1g/100g), meat (66.0 kcal, 2.0g/100g) and vegetable-based (68.0 kcal, 1.9g/100g) counterparts ($p \leq 0.012$) and significantly higher saturated fat content (1.3g/100g;) than both poultry (0.4g/100g) and vegetable-based (0.6g/100g) meals ($p \leq 0.020$) (Table 2). In addition, seafood-based meals contained significantly higher protein (4.6g/100g) contents compared to all other food types ($p \leq 0.001$) whilst vegetable meals contained significantly lower protein (2.7g/100g) content than both poultry (3.0g/100g) and meat (3.1g/100g) ($p \leq 0.001$). Vegetable-based meals contained significantly higher carbohydrate (9.4g/100g), fibre (1.9g/100g), and sugars (3.0g/100g) contents compared to all other food types ($p \leq 0.048$) whilst seafood contained significantly lower sugars (1.5g/100g) in comparison to poultry (2.0g/100g) and meat (2.1g/100g) ($p \leq 0.033$) (Table 2). There were no significant differences in salt content between the different food types (0.1g/100g; $p=0.845$) (Table 2).

Ingredient contribution

Ingredients of main meal products were investigated to identify the contribution of each main food type to the product. The mean percentage contribution of seafood in the seafood-based main meal products (11.6%) was higher than that of poultry (9.4%) and meat (9%) but lower than that of vegetable-based meals (52%).

On further investigation of the seafood-based products, eight of the 13 products contained dairy products (milk and/or cheese) within the list of ingredients (mean dairy contribution of 33.8% per product), those of which did not contain dairy contained high levels of vegetables (mean vegetable contribution of 44.6% per product). Despite a small sample size within the non-dairy seafood meal group, non-parametric comparative analysis indicates that non-dairy seafood meals contained less energy (72.0 kcal/100g; $p \leq 0.019$), protein (4.2g/100g; $p \leq 0.006$), total fat (1.9g/100g; $p \leq 0.011$), and saturated fat (0.3g/100g; $p \leq 0.002$) than their dairy-based counterparts producing nutritional contents more similar to poultry, meat and vegetable-based meals (Table 2). In addition, non-dairy seafood meals contained significantly more protein (4.2g/100g; $p=0.022$) and significantly lower sugars (1.1g/100g; $p=0.031$) than vegetable-based meals and significantly lower saturated fat content (0.3g/100g) than meat products ($p=0.017$).

Table 2: The nutritional content of commercial main meal products by the different food types.

Nutrient	Food Type						
	Poultry (P) (n=103)	Meat (M) (n=121)	Vegetable (V) (n=104)	Seafood (S) (n=13)	Dairy Seafood (D) (n=8)	Non-Dairy Seafood (ND) (n=5)	Post Hoc Comparison[a]
Energy (kcal)	66.0 (31.0, 413.0)	66.0 (40.0, 193.0)	68.0 (30.0, 422.0)	83.0 (66.0, 190.0)	94.5 (74.0, 190.0)	72.0 (66.0, 86.0)	S>V,M,P; D>ND
Total Carbohydrate (g)	8.4 (3.4, 68.6)	8.1 (5.1, 24.4)	9.4 (4.6, 70.5)	8.9 (1.3, 11.2)	9.0 (1.3, 11.2)	9.1 (8.9, 9.3)	V>S,P,M
Sugar (g)	2.0 (0.4, 12.2)	2.1 (0.1, 9.7)	3.0 (0.5, 13.8)	1.5 (0.6, 3.9)	1.8 (0.6, 3.6)	1.1 (0.8, 3.9)	V>M,P>S; V>ND
% energy from sugars	**12.1**	**12.7**	**17.7**	**7.2**	**7.6**	**6.1**	
Fibre (g)	1.4 (0.3, 4.4)	1.5 (0.1, 3.8)	1.9 (0.3, 5.6)	1.3 (0.3, 6.5)	1.4 (0.2, 2.9)	1.7 (0.9, 2.9)	V>M,P,S
Protein (g)	3.0 (2.0, 16.2)	3.1 (1.9, 11.2)	2.7 (0.5, 16.8)	4.6 (3.1, 13.1)	5.9 (4.3, 13.1)	4.2 (3.1, 4.6)	S>P,M>V; D>ND>V
Total Fat (g)	2.1 (0.2, 9.1)	2.0 (0.5, 10.4)	1.9 (0.0, 10.6)	3.2 (1.8, 10.5)	4.5 (2.3, 10.5)	1.9 (1.8, 3.7)	S>P,M,V; D>ND
% energy from total fat	**28.6**	**27.3**	**25.2**	**34.7**	**42.9**	**23.8**	
Saturated Fat (g)	0.4 (0.1, 4.2)	0.6 (0.1, 5.9)	0.6 (0.0, 4.8)	1.3 (0.3, 6.5)	2.6 (1.3, 6.5)	0.3 (0.3, 0.6)	S>V,P; M>P; D>ND; M >ND
% energy from saturated fat	**5.5**	**8.2**	**7.9**	**14.1**	**24.8**	**3.8**	
Salt (g)	0.1 (0.0, 1.3)	0.1 (0.0, 2.0)	0.1 (0.0, 1.8)	0.1 (0.1, 0.3)	0.2 (0.1, 0.3)	0.1 (0.1, 0.1)	

Data are median and minimum and maximum range for nutrient content per 100g of product.
[a] Presence of '>' in post hoc comparison indicates a significant difference at $p<0.05$ between groups.

DISCUSSION

During early years feeding, the recommendations are that cereals, fruit and vegetable purees are the ideal first taste accompaniment to an infant's milk diet followed by the introduction of poultry, meat and seafood to improve digestive development and to minimise risk of allergies (NHS Health Scotland 2010). Vegetable-based main meals are the leading product type in the first stage of early years feeding (4-6 months) supporting findings from previous research (Hurley, Black 2010) and first taste recommendations (NHS Health Scotland 2010), mirroring recorded consumption patterns (Public Health England and Food Standards Agency 2014). The large contribution of poultry and meat-based main meals apparent in the stage 2 market denotes the replacement of the lower energy and protein vegetable-based meals for the higher energy and protein of poultry, meat and seafood meals required for the growing infant. The limited range of main meals available at the later stages of early years' feeding reflects the lower use by parents for specialised, commercial infant meals from 12-18 months (Public Health England and Food Standards Agency 2014). The growing infant may now have developed taste preferences and habits, which parents believe can be attained from shared family meals (Food Standards Agency 2002).

The initial limited range of seafood species used in commercial infant foods has grown over the past few years from including only tuna, salmon and cod to additionally including pollack, hake and sole. These findings mirror those of the European Commission which indicate these species (except sole) are within the top seven consumed fish species within the European Union (EU) (European Commission 2014). It is encouraging to see an increase in the number of seafood-based meals available in the commercial infant market however we still see a limited number of options compared to other meat types. Manufacturers should be encouraged to keep introducing more seafood options into their market range to meet their ranges of poultry and meat-based meals. Brand buying based on an infant's acceptance, availability, personal preference (McEwen 2005) quality and price (Maguire, Owens & Simon 2004, Harris 1997) can further augment the lack of available commercial seafood meal options. This brand buying could in turn hamper seafood introduction during taste development stages, contributing to the low seafood consumption rates in pre-school and school age children currently evident in the UK (Department of Health 2011, Scottish Government 2011). Despite a growth in the availability of commercial seafood-based infant meals, the limited infant range may reflect a lack of consumer demand, a trend following that of the adult population (Public Health England and Food Standards Agency 2014, Scottish

Government 2012). It could be suggested that parents may be imparting their own aversion to seafood and food preferences on their infant by failing to offer this food (McManus et al. 2007, Neale et al. 2012). It should also be considered that the organoleptic properties of seafood may be a strong barrier to food selection and preferences (McManus et al. 2007, Neale et al. 2012, Leek, Maddock & Foxall 2000) contributing to the avoidance of seafood meals and therefore requires further investigation.

Understandably growing infants require complementary foods which are energy dense, providing plentiful kilocalories per gram of food. The World Health Organization's (WHO) guiding principles in complementary feeding (World Health Organization 2009) stipulate that infants aged 6-8 months require an additional 67-100kcal per meal (based on 200 total kcal across 2-3 meals per day recommendations) from solid foods. Infants aged 9-11 months require 75-100kcal per meal (300kcal total across 3-4 meals per day), and infants aged 12-23 months require an additional 138-183kcal per meal (550kcal total across 3-4 meals per day). It is evident that the commercial main meals investigated provide adequate energy levels with seafood-based meals being the most energy dense. Seafood-based products also achieve 30% (8% higher than that of poultry and meat) of an infant's protein reference nutrient intake (RNI) even without the presence of dairy (based on average RNI of 13.95g per day for infants aged 4-24 months (Department of Health 1994)) which may help to achieve essential dietary requirements. These findings complement previous UK findings that commercial infant foods exceed the RNI for protein (Zand et al. 2012a, Zand et al. 2012b). The findings of this study indicate that seafood-based meals alone contain sugar levels below the recommended <10% of energy from sugars for children (Scottish Government 1996; World Health Organization 2009; Garcia et al. 2013)

Despite health campaigns urging the reduction of fat and saturated fat in the daily consumption of the adult population (Scottish Government 2013b) fat is required by infants for essential growth and nourishment and to help meet high energy demands (World Health Organization 2003). The high prevalence of dairy products can be seen to influence the percentage of energy from fat in seafood meals. Less than 35% of energy from fat was evident in these meals however the presence of dairy contributed to excessive energy from saturated fats surpassing dietary recommendations that energy from saturated fats should be no more than 11% (Scottish Government 1996). Parents are encouraged to include a nutritiously balanced diet which contains fat and are advised that implementing a low-fat diet should not occur until the child is two years of age (Department of Health 1994). However, it should be considered that to help combat obesity we need infants to develop healthy dietary patterns which they take into adulthood. Manufacturers need to be encouraged to replace current high-fat dairy ingredients for more lower-fat alternatives. This will help provide parents with a larger range of lower saturated fat, non-dairy commercial seafood meals which rivals poultry, meat and even vegetable-based meals for low saturated fat contents.

The tendency of the commercial seafood meal market to be high in saturated fat may deter health conscious parents (Harris 1997) from purchasing these meals for their infant thus reducing their seafood meal options further. However, currently unpublished qualitative work by the authors reveals that the aversion to seafood-based meals may come from the parent's perception of an infant's taste preferences rather than nutritional composition (Carstairs, Marais & Kiezebrink In preparation). By continually exposing children to seafood varieties parents will provide an increased opportunity for the acceptance of this flavour to occur.

Contrary to Garcia et al's (2013) conclusion that commercial foods are unsuitable to serve the intended purpose of providing additional nutrients to the milk diet, our findings indicate that main meal products, in particular seafood-based meals, are energy dense options that meet early years recommendations (World Health Organization 2009). The study by Garcia et al did however compare nutrient content of ready-made foods to breast and formula milks as well as a home-cooked comparator meal (Garcia et al. 2013) and not to dietary recommendations as in our study. We conclude that caution should be conveyed to parents who predominantly use commercial products to wean their infant due to the high prevalence of energy from sugars within vegetable, poultry and meat-based meals, and due to the high amount of energy derived from saturated fats in dairy-based seafood meals.

We assumed that parents select meal options for their infant based on the name of the product and so the classification of meal food types was based on the name of the product and not on the full ingredient content. Our analysis was interested in looking at the nutritional information provided to consumers using on-product nutrition labels. It is important to note nutrient analysis was not conducted in this study and discrepancies may exist in the nutrient composition of the meals (Kanzler, Lammer & Wagner 2015). However, despite evidence identifying that commercial ready-to-feed baby meals contain variations between actual and declared nutrient concentrations (Zand et al. 2012b), nutritional composition information on product labels is permitted to vary providing they comply with regulatory recommendations (The Commission of European Communities 2006). This study did not investigate full micronutrient composition or the inclusion of artificial preservatives, flavourings, colourings, or stabilizers. These are important aspects to consider in the overall healthiness and acceptability of the meals. Sensory appeal of the main meal products was not examined in this study and it must be acknowledged that these factors will play an important role in the selection and consumption of these products.

A structured review of the commercially available main meal food products reveals a limited range of seafood-based meals available across the early years' stages. The presence of dairy products in seafood-based meals significantly contribute to the nutritional composition of these meals resulting in conflicting high saturated fat contents in this otherwise energy and protein dense meal option. Parents who predominantly use commercial products to wean their infant are likely to face challenges in sourcing a range of products to enable the inclusion of seafood, which is likely to hinder the introduction of this food into the diet of their infant. Health practitioners should encourage parents to regularly and continually introduce different seafood species to their infant throughout the early years' stages to reduce potential consequences of avoiding this omega-rich food.

Key Messages

- Parents who predominantly wean their infant using commercial infant meals will be challenged by a limited availability and range of seafood-based meals
- Energy dense commercial seafood-based meals benefit from high protein contents whilst containing low levels of sugars.
- Infants who are predominantly given commercial seafood-based infant meals may be exposed to high saturated fat levels from additional dairy ingredients.

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